J Knowl Econ (2017) 8:254–278
DOI 10.1007/s13132-015-0323-y

The Impact of FDI Inflows and Environmental Quality on Economic Growth: an Empirical Study for the MENA Countries

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

Received: 22 July 2015 / Accepted: 8 October 2015 /
Published online: 29 October 2015

Abstract This study examines the impact of foreign direct investment (FDI) inflows, environmental quality, and capital stock on economic growth in 17 Middle East and North African Countries (MENA) countries. We did our analysis in the panel framework over the period 1990–2012 using both the static (ordinary least squares method (OLS), fixed effect (FE), and random effect (RE)) and dynamic (difference-generalized method of moments (Diff-GMM) and system-generalized method of moments (Sys-GMM)) panel data approaches. The empirical results show that the increases in FDI inflows and capital stock enhance the economic growth process in MENA countries. On the other hand, our findings demonstrated that economic growth in MENA countries reacts negatively to the environmental degradation. These empirical insights are of particular interest to policymakers as they help build sound external and environmental policies to sustain economic growth.

Keywords Economic growth · FDI inflows · CO_2 emissions · Static and dynamic panel data · MENA countries

Introduction

In the second decade of the twenty-first century, the effects of foreign direct investment (FDI) inflows and CO_2 emissions on economic growth become a very significant topic both at the national and international level. However, economic growth is the mainstay of any country's economic development because of its overall benefits in the different

✉ Mohamed Abdouli
mohamedabdouli3@gmail.com

✉ Sami Hammami
sami_hammami2005@yahoo.fr

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

sectors of the economy. In addition, economic growth can increase the living standard if the nation's wealth is fairly distributed. By the way, because of the positive influence on the aggregate demand, growth raises employment rates. Further, growth provides fiscal dividend through extra tax revenue that can be used to finance public projects. In fact, it enhances the effect by encouraging investment in new technology which can then help sustain economic growth through increased aggregate supply and boost business confidence through its positive impact on the firm's profits, which in turn boost their stock exchange values resulting in the growth of big companies (Razmi and Refaei 2013). On the one hand, the FDI inflows and environmental quality are well known as very important factors in the economic growth process. The FDI inflows can play an important role by increasing and raising the supply of funds for domestic investment in the host country. This can be done through the production chain when foreign investors buy locally made inputs and sell intermediate inputs to local enterprises. Furthermore, the FDI inflows can increase the host country's export capacity, causing the developing country to increase its foreign exchange earnings. FDI can also encourage the creation of new jobs, enhance technology transfer, and boost overall economic growth in the host countries (Belloumi 2014). On the other hand, environment pollutants affect economic growth. There is a proof of a global nature of air pollution and its effects on the earth's surface. The distress fullness and the long-term damaging effect of environmental pollution can contribute to destructive consequences on human wellbeing and economy. This will lead to the increase of health and social costs (Borhan et al. 2012). Therefore, pollution may directly decrease the output by decreasing productivity of man-made capital and labor. Here, pollution appears as a negative externality. Because of health problems, there are losses of labor day, and due to polluted air or water, there are deteriorations in the quality of the industrial equipment. Secondly, the firm's production costs are increased when firms abate pollution emissions.

The nexus between FDI inflows and CO_2 emissions to economic growth has been intensively and empirically analyzed over the last few years. This research can be categorized into two parts. The first part investigates the impact of FDI inflows on economic growth. Most of the past studies are concerned with the questions of whether a higher level of FDI inflows leads to higher additional economic growth. However, the role of foreign investment in economic growth has been considered one of the basic principles in economics. Empirical studies concluded that there is a broad consensus that investment is good for economic growth (Edwards 1998 and Baldwin 2003). These studies showed that the accumulation of foreign capital is one of the main determinants of economic growth. On the other hand, other empirical studies, Barrell and Pain 1999; Chakrabarti 2001; Schiff and Wang 2008; Batten and Vo 2009; Hooi and Wah 2010; Aizhan and Makaevna 2011; Soltani and Ochi 2012; and Melnyk et al. 2014) confirm that there is a positive impact of FDI inflow on economic growth. However, others concluded negative impacts (e.g., Sanders and Secchi 1974; Saltz 1992; Elboiashi et al. 2009; Ahmed 2012; Saqib et al. (2013); and Bayar 2014). Finally, according to studies (see Blomstrom et al. 1994; Katerina et al. 2004; Duasa 2007; Mah 2010; Azman-Saini et al. 2010; and Aga 2014); it seems that FDI has no effect on economic growth. Moreover, other studies concluded that FDI is considered to be one of the major channels of technological transfer. They state that FDI can positively affect economic growth through the transfer of technology and know-how, and this impact can be positive (Frindlay 1978; Borensztein et al. 1998; Ford et al. 2008; Yu et al. 2011). Inversely, the transfer of technology can also bring negative effects (Sen 1998; Vissak and Roolaht 2005)

The second part of this research examines the impact of CO_2 emissions on economic growth. Several studies examined the link between CO_2 emissions and economic growth (see, e.g., Grossman and Krueger 1991 [1]; Shafik 1994; Manag 2006; Markandya et al. 2006; Richmond and Kaufman 2006; Ang 2007; Song et al. 2008; Soytas and Sari 2009; Halicioglu 2009; Chebbi et al. 2009; Fodha and Zaghdoud 2010; Pao and Tsai 2010; Christopher and Douglason 2011; Arouri et al. 2012; Jayanthakumaran et al. 2012; Borhan et al. 2012; Saidi and Hammami 2014; Bastola and Sapkota 2015; Omri et al. 2015).

Thus, the objective of this study is to empirically examine the influence of FDI inflows and environmental quality on economic growth in the selected countries of the Middle East and North African Countries (MENA) group such as Algeria, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, Yemen, and UAE, for the period 1990–2012 using both static and dynamic panel data approaches. All these countries have the same level of economic structure. Therefore, there is an attempt to answer the following: *How do FDI inflows and environmental quality affect economic growth in the MENA countries*?

The rest of the paper is organized as follows: "Literature Review" section deals with the literature review; "Econometric Method and Data" section outlines the econometric modeling approach and describes the used data; "Data and Descriptive Statistics" section reports and discusses the empirical results; and "Results and Discussions" section concludes the article and offers some policy implications.

Literature Review

Although several studies dealt with the nexus between economic growth and foreign direct investment (FDI) inflows and economic growth and CO_2 emissions, this paper is interested in reviewing the results of all the studies that investigated the impact of FDI inflows, CO_2 emissions, and capital stock, on economic growth using panel data modeling techniques. We focus on the studies on panel data models since they are very close to our study and provide some insights of the impact of FDI inflows and CO_2 emissions on economic growth.

To explain the influence of each variable on economic growth, literature can be divided into three subtitles, e.g., (a) How does FDI inflows influence economic growth?; (b) How does CO_2 emission affect economic growth?; and (c) How does capital stock impact economic growth? We discuss some of the selected studies below.

[1] The first showed the relationship between environmental quality and economic growth. They found that CO_2 emissions have reduced the per capita GDP at higher levels of income. For these two indicators of environmental quality, these determinations were depicted statistically as an evidence for the existence of an EKC relationship.

(a)- How does FDI inflows influence economic growth?

In this strand, using regression to panel data, Borensztein et al. (1998) tested the effect of FDI on economic growth in 69 developing countries over the period 1970–1979. According to the results, FDI has a positive effect on economic growth. However, it has been seen that FDI is an important vehicle for the transfer of technology, contributing relatively more to economic growth, when advanced technology is accompanied by capital and human capital at a certain level. Using ordinary least squares (OLS) fixed effects panel data estimates to examine the effects of FDI on growth in 25 central and eastern and former Soviet Union transition economies for the period 1990–1998, Campos and Kinoshita (2002) indicated that FDI had a significant positive effect on the economic growth of each selected country. In these countries, FDI was a pure technology transfer, which means that the results are consistent with the theory that equates FDI with technology transfers that benefit for the host country. In the same context, for the period 1990–2008, Yu et al. (2011) examined the effect of foreign direct investments on economic growth in the ASEAN countries and found results that support the existence of technology spillovers in ASEAN, which have a positive effect on the economic development of ASEAN. However, FDI is considered to be one of the major channels of technological transfer.

By using panel data of 18 countries in Latin America, Bengoa and Sanchez-Robles (2003) conclude that the effect of FDI on economic growth is positive only when these countries have adequate human capital, economic stability, and liberalized markets. Ford et al. (2008) tested the link between foreign direct investment, economic growth, and the human capital in the USA for the period 1977–1997 by means of fixed effect model. Their results demonstrate that FDI has a greater impact on per capita output growth. Similarly, Lee and Chang (2009) set up a cointegration panel and error correction panel for the period 1970–2002. They reported that FDI has a large direct effect on economic growth and extends the potential gains associated with FDI.

For the period 1996–2005, Anwar and Nguyen (2010) examined the link between foreign direct investment and economic growth in Vietnam using the generalized method of moments (GMM) estimation model. These results indicate that FDI inflows have positive and significant effects on economic growth. However, the FDI inflows reduced the technology gap between the foreign and local firms. Alfaro et al. (2010) based on a realistic parameter values, studied how foreign direct investment promotes growth in host country. According to them, there is a range of possible factors that ensure that FDI promotes economic growth. However, FDI leads to higher additional growth in the developed economies.

Using a fixed effects model to examine the link between FDI and economic growth in the Asian countries for the period 1986 to 2008, Tiwari and Matascu (2011) suggest that foreign direct investment enhances economic growth process in the Asian countries. In Turkey's case, using data from 1992 to 2007 and the OLS, Temiz and Gökme (2014) explored the relation between FDI inflow and gross domestic product (GDP) growth. The main results show that there is an insignificant impact of FDI on economic growth. Hence, there is no evidence for the hypothesis that foreign direct investment leads to economic growth. In a Granger causality test, using annual data in Malaysia, during the 1970–2009, Hooi and Wah (2010) revealed that FDI has unidirectional effects on GDP. Therefore, FDI inflows had a positive effect on economic growth.

Anwar and Sun (2011) used the GMM to analyze the dynamic interrelationships between FDI, financial development, and real output in Malaysia for the period 1970–2007. They recognized that the stock of foreign investment in Malaysia has contributed to an increase of economic growth.

In a more recent research, Nistora (2014) has made a Durbin–Watson test, using cross-country data for the period 1990–2000. The main results indicated that FDI has a positive effect on economic growth. Using fixed effect and random effect, in 26 developing and transition countries for the period 1998–2010, Melnyk et al. (2014) found that FDI has a positive effect on economic growth in host countries. Similarly, for the period 2002–2010, Nahidi and Badri (2014) tested the impact of FDI inflows on employment in six countries using fixed effect models and random effect models. Their findings showed that FDI inflows have a significant and positive effect on employment, therefore a positive impact on economic growth.

Furthermore, studies confirm a negative impact of FDI on economic growth. First, Sanders and Secchi (1974) investigated the effects of FDI on US companies on the host country's growth for the period 1965–1969. Their results revealed a negative effect of FDI inflows on economic growth. Hence, most FDI was coming through capital raised in the host country instead of the USA which led FDI to cause a redistribution of capital from labor intensive countries to capital intensive countries. In the same context, using time series data for the period 1981–1999 and the result of the application of GMM panel estimators, Alfaro et al. (2010) found that the FDI inflows have a negative effect on economic growth.

In addition, Ahmed (2012) examined the influence of human capital, labor force and absorptive capacity, physical capital as a control variable, FDI, and GDP on Malaysia's productivity growth for the period 1999–2008 using OLS regression. Their empirical result revealed that FDI inflows negatively contributed to the total factor productivity (TFP); therefore, they exert a negative impact on economic growth.

Recently, Mazenda (2014) has studied the effect of foreign direct investment on economic growth in South Africa using the Johansen cointegration and vector error correction modeling (VECM) for the period 1960–2002. This result showed that FDI has a negative impact on economic growth in South Africa. Similarly, Bayar (2014) used cointegration test and vector error correction model based on autoregressive distributed lag to investigate the effects of foreign direct investment inflows and domestic investment on economic growth in Turkey for the period 1970–2009. They found that FDI inflows negatively affected economic growth in the short and long run, whereas gross domestic investments positively affected economic growth in the short and long run.

On the other hand, other studies concluded that FDI has no effect on economic growth. Carkovic and Levine (2002) tested the relationship between FDI and economic growth for 72 countries for the period 1960–1995, using the GMM panel estimator to determine the impact of FDI inflows on economic growth. Their results indicated that FDI inflows did not exert an independent influence on economic growth for both developed and developing economies. Moreover, Katerina et al. (2004) investigated the relationship between foreign direct investment and economic growth in 17 transition economies by using the data over the period 1995–1998. Their results suggest that foreign direct investment has a positive but insignificant impact on economic growth in transition economies, therefore no effect on economic growth. Then, using a cointegration test for the period, Mah (2010) observed the link between FDI inflows and economic growth in China. Their results showed that FDI inflows have not caused GDP. In Jordan, Louzi and Abadi (2011) tested the effect of foreign direct investment on economic growth for the period 1990–2009 using a vector error correction approach. The results of the study showed that FDI inflows do not exert an independent influence on economic growth. In a more recent research, Belloumi (2014) have examined the relationship between trade, FDI, and economic growth in Tunisia using an autoregressive distributed lag model (ARDL) for the period 1970–2008. The empirical evidence supports that FDI inflows have no affect on economic growth. Moreover, using the OLS, Aga (2014) tested the effect of foreign direct investment on economic growth in Turkey over the period 1980–2012. The empirical results indicate that FDI has not played an important role in economic growth in Turkey. However, it is found that there is a statistically insignificant but positive short-run impact of foreign direct investment on GDP.

(b)- How does environmental degradation influence economic growth?

It is well known that higher level of CO_2 emissions (environmental degradation) might lead to the reduction of the productive capacity of a country and also to climatic change, which indicate that there is a negative effect on economic growth. The early sets of EKC studies focused on the environmental impacts of economic growth. At first, Grossman and Krueger (1991) tested the link between the air quality and economic growth in 42 countries. Their findings demonstrate that the global impact of CO_2 emissions has provided little incentive for countries to implement unilateral actions for these emissions. The empirical results indicate an "inverted-U" shape for the relationship between per capita GDP and several air pollutants. This is consistent with a scenario in which industrial development initially leads to greater raw emissions, but net emissions eventually decline as the concomitant increase in income raises the demand for health and environmental quality. Using fixed effect models, for 130 countries for the years 1951–1986, Shafik (1994) investigated the relationship of economic development and carbon dioxide emissions. Their result indicated that there is a systematically significant relationship between income and all the indicators of environmental quality. In Malaysia, Ang (2008a, b) examined the long-run relationship between output, pollutant emissions, and energy consumption during the period 1971–1999 using the VECM. The results indicated that pollution use is positively related to the output in the long run. Using an ARDL approach, Sari and Soytas (2009) tested the relationship between carbon emissions, income, energy, and total employment in selected five OPEC countries (including Algeria and Saudi Arabia) for the period 1971–2002. They found that none of the countries needs to sacrifice economic growth to decrease its emission levels. Arouri et al. (2012) exploring the relationship between carbon dioxide emissions, energy consumption, and real GDP for 12 Middle East and North African Countries (MENA) for the period 1981–2005 by means of a unit root test and cointegration techniques. Their result demonstrated that CO_2 emissions have a positive impact on economic growth. This means that reduction in CO_2

emissions per capita might be achieved at the same time as GDP per capita in the MENA region continues to grow. Halicioglu (2009) tested the link between CO_2 emissions, energy consumption, GDP, and foreign trade in Turkey for the period 1960–2005 using cointegration procedure. Their results indicated that environmental degradation damages economic growth. The same result was found by Pao and Tsai (2010) for a panel of the BRIC countries over the period 1992–2004.

On the other hand, Jayanthakumaran et al. (2012) tested the links between CO_2 emissions, energy consumption, trade, and income for China and India, over the period 1971–2007, using the ARDL methodology test. Their study found that a high level of pollution emissions might lead to the reduction of the production capacity of a country. Similarly, Borhan et al. (2012) examined the nature of causality between CO_2 emission and income for the period 1965–2010 using two-stage least square (2SLS). Their results indicated that CO_2 shows a negative significant relationship with income. This conforms to the theory that as pollution level increases, the income decreases; therefore, pollution may directly decrease output by decreasing the productivity of man-made capital and labor. Recently, Omri et al. (2014) have investigated the relationship between FDI inflows, economic growth, and CO_2 emissions for 54 countries over the period 1990–2011 using a dynamic simultaneous equation. Their finding indicated the existence of a unidirectional causality running from CO_2 emissions to economic growth.[2]

Finally, other studies concluded that there is no significant relationship between economic growth and CO_2 emissions. A forest study covering the period 1973–1997 is of Richmond and Kaufman (2006) who investigated the relationship between incomes, energy, and carbon emission in both OECD and Non-OECD nations using the fixed or random effect estimators. Their results showed that an increase of CO_2 emissions has no effect on economic growth.[3]

In a more recent research, Bastola and Sapkota(2015) examined the relationships between energy consumption, pollution emission, and economic growth in Nepal for the period 1980 to 2011, using the Johansen cointegration and ARDL models. This proved that CO_2 emissions have no impact on economic growth. However, the reductions of carbon emissions to protect environment would not affect economic growth[4] of the country.

(c)- How does capital stock influences economic growth?

[2] In the same vein, Omri et al. (2015) investigated the relationship between financial development, CO_2 emissions, trade and economic growth using simultaneous equation panel data models for a panel of 12 MENA countries over the period 1990–2011 using the generalized method of moments (GMM). Their results indicated that the CO_2 emissions have a negative impact on economic growth.

[3] Gosh (2009) established a long-run equilibrium relationship between the quantity of imported crude oil, its income, and price of the imported crude in India for the time span 1970–1971 to 2005–2006. The empirical results showed no causality between economic growth and CO_2 emissions in India. This implies that an increase in the CO_2 emissions has no effect on economic growth.

[4] Begum et al. (2015) tested the dynamic impacts of GDP growth, energy consumption, and population growth on CO_2 emissions in Malaysia using econometric approaches. Their results showed that there is no significant relationship between economic growth and environmental pollutants.

Several studies examined the effects of capital on economic growth. For the period 1972–2002, Narayan and Smyth (2008) tested the relationship between capital formation, energy consumption, and real GDP in a panel of G7 countries using a panel unit root, panel cointegration, Granger causality, and long-run structural estimation. They found that capital formation has a positive impact on economic growth.[5] Similarly, Noor and Siddiqi (2010) investigated the causal relationship between energy use, capital, labor, and economic growth for five South Asian countries over the period 1971–2006. Their finding indicated that the coefficient of capital plays a significant and positive role in the GDP per capita. On the other hand, Shahbaz et al. (2011) explored the relationships between energy consumption, capital, and economic growth in Romania for the period 1980–2008 using ARDL bounds testing approach of cointegration. The authors found that the capital use is positively linked with economic growth and statistically significant at 1 % level of significance. This implies that capital is also an important stimulant for economic growth.[6] Using panel cointegration and panel vector error correction modeling techniques, for the period 1995–2007, Wang et al. (2011) investigated the causal relationships between carbon dioxide emissions, energy consumption, and real economic output in China. Their empirical results showed that capital affects economic growth. Similarly, in Nigeria, Olumuyiwa (2012) estimated the long-run relationship between energy consumption and economic growth. This strand of literature considers that the capital has a positive impact on economic growth. Indeed, using an ARDL bounds testing approach of cointegration tests, a causality between energy use and economic growth by incorporating financial development, international trade, and capital, Shahbaz et al. (2013) reported capital as an important factor of production in China. Omri and Kahouli (2013) estimated the nexus between foreign investment, domestic capital, and economic growth for the period 1990–2010 in 13 MENA countries using GMM estimation. Their findings indicated that the human capital is positively and significantly related to economic growth.

Recently, Omri et al. 2014 have investigated the causal relationship between two types of energy variables and economic growth using dynamic simultaneous equation panel data models for 17 developed and developing countries for the period 1990–2011. Their findings indicated that the capital has a positive and statistically significant effect on real GDP for the global panel. During the period 1985–2011, Omri and Sassi-Tmar (2014) estimated the relationship between FDI inflows and the economic growth for three African economies (Tunisia, Morocco, and Egypt). Using the GMM, they found that the human capital variable has a positive and significant effect on economic growth in Morocco, but an insignificant one for Tunisia and Egypt.

[5] Lee and Chang (2008) tested the links between energy consumption and economic growth in 16 Asian countries during the period 1971–2002, using cointegration and causality test. The empirical evidence showed that the capital stock has a positive impact on economic growth.

[6] Shahbaz et al. (2012) investigated the relationship between energy (renewable and nonrenewable) consumption and economic growth in Pakistan over the period of 1972–2011, using a Cobb–Douglas production function.

Econometric Method and Data

Econometric Method

Empirical researches concerning the impact of foreign direct investment (FDI) and environmental quality on economic growth increased in the last few decades. Several estimation techniques were used to empirically address this issue. We will use the static panel data models which were estimated with pooled ordinary least squares (OLS), fixed effects (FE), and random effects (RE) estimators, and dynamic panel data models are estimated to GMM system and GMM difference for dynamic panel.

Therefore, the objective of this paper is to use production function approach to estimate the impact of FDI inflows, CO_2 emissions, and capital stock on economic growth. The gross domestic product (GDP) depends on endogenous variables including FDI inflows, CO_2 emissions, and capital stock.

For this purpose, the Cobb–Douglas production functions include capital as an additional factor of production (Hall and Mairesse 1995; Kosztowniak 2013; Omri et al. 2014). Income or output also depends on energy consumption, which is directly related to CO_2 emissions (Pao and Tsai 2010; Arouri et al. 2012; Omri and Kahouli 2013). Likewise, Anwar and Sun (2011), Soltani and Ochi (2012), Olumuyiwa (2013), Omri et al. (2014), among others, include FDI in the production function to examine the impact of this variable on economic growth. They found that FDI stimulates economic growth. Specifically, we consider the Cobb–Douglas type production function:

$$Y = e^{\varepsilon} A K^{\alpha} E^{\lambda} (FDI)^{\psi} L^{\beta} \tag{1}$$

Where Y is the real GDP, A is the total factor productivity, K is the capital stock, E is the energy consumption, and L is the labor force; ε is the error term, and α, λ, ψ, and β are the production elasticities with respect to domestic capital, energy consumption, FDI, and labor force, respectively. This model indeed augments the standard Cobb–Douglas production function by taking into account the fact that energy consumption and FDI are inputs required to generate national output. Given the technology level at a given point in time, there is a direct linear relationship between energy consumption and CO_2 emissions (Pereira and Pereira 2010), such as $E=bCO_2$. Therefore, the new expression of the equation is

$$Y = b^{\lambda} e^{\varepsilon} A K^{\alpha} \mathrm{CO_2}^{\lambda} (FDI)^{\psi} L^{\beta} \tag{2}$$

In Eq. (2), we divide both sides by population to obtain all series in per capita terms. We further assume that the production function has constant returns to scale, or $\alpha+\lambda+\psi+\beta=1$. These provisions lead to

$$Y = b^{\lambda} e^{\varepsilon} A K^{\alpha}\ \mathrm{CO_2}^{\lambda} FDI^{\psi} L^{\beta}$$

After dividing Eq. (3) by L, we have

$$\frac{Y}{L} = b^{\lambda} e^{\varepsilon} A \left(\frac{K}{L}\right)^{\alpha} \left(\frac{\mathrm{CO_2}}{L}\right)^{\lambda} \left(\frac{FDI}{L}\right)^{\psi} \tag{3}$$

Then, the productions function in Eq. (3) is transformed into linear log as follows:

$$\log(Y) = \log\left(b^{\lambda}A\right) + \alpha\log(K) + \lambda\log(CO_2) + \psi\log(FDI) + \varepsilon\log(e)$$

So, the production function after the logarithmic transformation deviate equals

$$\log(Y) = \log\left(b^{\lambda}A\right) + \alpha\log(K) + \lambda\log(CO_2) + \psi\log(FDI) + \varepsilon \tag{4}$$

It is assumed that $\log(b^{\lambda}A)=a$; therefore, the new writing deviate

$$\log(Y) = a + \alpha\log(K) + \lambda\log(CO_2) + \psi\log(FDI) + \varepsilon \tag{5}$$

We write Eq. (5) in growth form with a time series specification, as follows:

$$g(Y)_{it} = a + \psi_{1i}g(FDI)_{it} + \alpha_{3i}g(K)_{it} + \lambda_{2i}g(CO_2)_{it} + \varepsilon_{it} \tag{6}$$

The subscript i=1,…, n denotes the country (n=17 in our study) and 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, $g(FDI)$ the growth rate of per capita foreign direct investment, and ε is the error term.

$$g(Y)_{it} = a + \psi_{1i}g(FDI)_{it} + \alpha_{3i}g(K)_{it} + \lambda_{2i}g(CO_2)_{it} + \varepsilon_{it} \tag{7}$$

In the above equations, Eq. (7) 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 Mustopha 2012;Omri et al. 2014).

Estimation Procedure

In this study, both the static and dynamic panel estimation techniques are estimated by using the OLS and fixed and random effects for static panel and the generalized method of moments (GMM) to estimate our dynamic panel data model which also allows for the lagged level of economic growth. This method uses a set of instrumental variables to solve the endogeneity problem of the regressors. There are two types of GMM estimators (difference and system), and they can be both alternatively considered in their one-step and two-step versions. The set of instruments of the difference-GMM estimator (diff-GMM) includes all the available lags in difference of the endogenous variables and the strictly exogenous regressors (Arellano and Bond 1991). The system-GMM estimator (sys-GMM) includes not only the previous instruments but also the lagged values of the dependent variable (Blundell and Bond 1998). It helps solve the endogeneity problem arising from the potential correlation between the independent variable and the error term in dynamic panel data models (Topcu 2013). It also permits to deal with omitted dynamics in static panel data models, owing to the ignorance of the impacts of lagged values of the dependent variable (Bond 2002).

Panel Unit Root Tests

Testing unit roots on time series data has become one of the important tests among economists, especially econometricians, though testing unit roots on panel data is more recent. Panel unit root tests have become popular among economic researchers dealing with panel data structures because they are much more powerful compared to the normal unit root tests for individual time series. From among different panel unit root tests developed in the literature, Levin, Lin, and Chu (LLC) (2002) and Im, Pesaran, and Shin (IPS) (2003) are the most popular. Both of the tests are based on the ADF principle. However, LLC assumes homogeneity in the dynamics of the autoregressive coefficients for all panel members. In contrast, the IPS is more general in the sense that it allows for heterogeneity in these dynamics. Therefore, it is described as a "heterogeneous panel unit root test". It is particularly reasonable to allow for such heterogeneity in choosing the lag length in ADF tests when imposing uniform lag length is not appropriate. In addition, slope heterogeneity is more reasonable in the case where cross-country data is used. In this case, heterogeneity arises because of differences in economic conditions and degree of development in each country. Levin et al. (2002) consider the following basic ADF specification:

$$\Delta y_{i,t} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{pi} \mu_{i,t} \Delta y_{i,t-1} + \varepsilon_{i,t} \tag{8}$$

where $y_{i,t}$ (i=1, 2,…..,N; t=1,2,…….,T) is the series for panel member (country) i over period t, μ_i is the number of lags in the ADF regression, and the error terms i,t; ε_i is a white-noise disturbance with a variance of σ_i^2. Both β_i and the lag order μ in Eq. (6) are allowed to vary across sections (countries). Hence, they assumed $\begin{cases} \beta_i = 0 \\ \beta_i \prec 0 \end{cases}$, where alternative hypothesis corresponds to $Y_{i,t}$ being stationary.

According to the LLC test, compared with the single-equation augmented Dickey–Fuller test, the panel method sensibly raises power in finite samples. The proposed model is as follows:

$$\Delta Y_{i,t} = \alpha_i + \beta_i Y_{i,t-1} + \sum_{j=1}^{pi} \mu_{i,t} \Delta Y_{i,t-1} + \varepsilon_{i,t} \tag{9}$$

Accordingly, Levin et al. (2002) also assumed $\begin{cases} H_0 : \beta_1 = \beta_2 = \ldots = \beta = 0 \\ H_1 : \beta_1 = \beta_2 = \ldots = \beta \prec 0 \end{cases}$, where the statistic of test is $t_\beta = \frac{\beta}{\sigma}(\beta), \beta$ is the OLS estimate of β in Eq. (9) and $\sigma(\beta)$ is its standard error.

Im et al. (2003) proposed a testing procedure based on the mean group approach and also on the augmented Dickey–Fuller regression presented by Eq. (9). By contrast, the null and alternative hypotheses are not similar to the LLC test, where the rejection of the null hypothesis involves that all the series are stationary. We now haveH_0:β_1=β_2=…=β=0; vs. H_1: Some but not necessarily all $\beta \prec 0$

In statistics with and without trend, the IPS test is calculated as the average alternative t-bar statistic for testing the null hypothesis of unit root for all individuals (β_i=0) as follows:

$$\bar{t} = \frac{\sum_{i=t}^{N} T\boldsymbol{\beta}_i}{N} \tag{10}$$

Where t is the estimated ADF statistics from individual panel members; n is the number of individuals. Using Monte Carlo simulations, IPS show that the t-bar $(\bar{t})$ is normally distributed under the null hypothesis, and it outperforms M-bar in small samples. They then use estimates of its mean and variance to convert $(\bar{t})$ into a standard normal z-bar $(\overline{Z})$ statistic so that conventional critical values can be used to evaluate its significance. The $(\overline{Z})$ test statistic is defined as

$$\overline{Z} = \frac{\sqrt{N}\left(\bar{t} - E\left[\bar{t}|\boldsymbol{\beta}_i = 0\right]\right)}{\sqrt{Var}\left[\bar{t}|\boldsymbol{\beta}_i = 0\right]} \rightarrow N(0, 1) \tag{11}$$

Where $\bar{t}$ is as defined before, $E\ [\bar{t}|\boldsymbol{\beta}_i = 0]$ and $Var\ [\bar{t}|\boldsymbol{\beta}_i = 0]$ are the mean and variance of t_{it} obtained from the Monte Carlo simulations with i=1, 2… n.

The LLC and IPS unit root tests are used in this paper to test for stationarity of the panel data obtained for MENA countries.

We begin our analysis with the implementation of the panel unit root tests. In panel data analysis, the panel unit root test must be taken first in order to identify the stationary properties of the relevant variables. In this study, we choose two panel unit root tests, Levine et al. (LLC) (2002) and Im et al. (IPS) (2003). The null hypothesis of the above two unit root tests is that there exist unit root (i.e., the variables are non-stationary), whereas the alternative hypothesis states that no unit root exists in the series (i.e., the variables are stationary).

Table 1 shows the results of panel unit root tests for the levels of variables. It can be seen that all the variables in the levels are statistically significant under the LLC and IPS tests, which indicates that all variables are integrated of order one, I (1).

The correlation between the dependent and independent variables is presented in Table 2. The correlation coefficients show that the reported regression models will not be seriously distorted by multicollinearity. This table shows that economic growth positively correlates with the stock of foreign investment, the CO_2 emissions, and the human capital.

Data and Descriptive Statistics

Data

We use annual data for the per capita GDP, per capita CO_2 emissions, per capita FDI inflows, and per capita capital stock; all the data collected for the period 1990–2012 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.

Table 1 Results of panel unit root tests

Variables	LLC test		IPS test	
	Level		Level	
	T-Statistics	*p* Value	*T*-Statistics	*p* Value
GDP	−2.668**	(0.0038)	−3.289*	(0.0005)
FDI	−7.292*	(0.0000)	−5.742*	(0.0000)
CO_2	−3.657*	(0.0001)	−3.99028*	(0.0000)
K	−2.560*	(0.0052)	−2.69138**	(0.0036)

All panel unit root tests were performed with restricted intercept and trend for all variables. In addition, lag length of variables is shown in small parentheses

*Coefficient significant at the 1 % level, **Coefficient significant at the 5 % level

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; (b) 5 North African countries, namely: Algeria, Morocco, Tunisia, Egypt, and Libya.

Descriptive Statistics

Table 1 shows the descriptive statistics of the variables used in our estimation. On average, this table provides a statistical summary associated with the actual values of the used variables for each country. The highest means of per capita emissions (53.272) and real GDP per capita (53144.08) are in Qatar, whereas the highest mean of FDI inflows (61431.64) is in the UAE. The lowest means of CO_2 emissions (0.907) and GDP per capita (765.119) are in Yemen

Then, the lowest mean of FDI inflows (0.3158) is in Algeria and (0.3838) in Syria, respectively. Additionally, Iraq has the highest volatility (defined by the standard deviation) in per capita CO_2 emissions (37.496). The highest FDI inflows of 203536.9 and GDP per capita of 8444.758 are in the UAE, while the least volatility in CO_2 emissions and GDP per capita are in Yemen, 0.1104 and 66,583, respectively.

However, the lowest volatility of FDI inflows (0.256) is in Algeria. It is also noted that the UAE is very volatile in FDI inflows, with a variation coefficient of 3.313, which is the highest compared to other countries' coefficient of variation. Moreover, we can see that Iraq is volatile in CO_2 emissions; its coefficient of variation of 1.1200 is the

Table 2 Correlations between the various variables used in the regression models

	g(GDP)	*g*(FDI)	*g*(CO_2)	*g*(*K*)
g(GDP)	1.0000			
g(FDI)	0.5529	1.0000		
g(CO_2)	0.9241	0.4286	1.0000	
g(*K*)	0.7780	0.5188	0.6917	1.0000

highest when compared to other countries' coefficient of variation. In addition, the highest coefficient of variation of GDP per capita, when compared to other countries' coefficient of variation is 0.4053 of Kuwait.

Overall, for the MENA countries, Qatar and the UAE have the greatest means of per capita emissions, GDP, and FDI inflows. On the other hand, the greatest volatilities are in Iraq and in the UAE, respectively, while the lowest means and variances are in Yemen. Besides for per capita, CO_2 emissions and FDI inflows are in Algeria.

For trade, the high income countries are relatively more open to trade compared to the low income countries.

Results and Discussions

Results of Static Panel Estimations

To examine the impact of FDI inflows, CO_2 emissions, and capital stock on economic growth in the MENA countries, we consider a set of static panel estimation techniques including cross-section ordinary least squares (OLS), fixed effects and random effects (RE) models.

The results from the estimated model are presented in Table 4, which contains the OLS and FE results.

The empirical results for individual panel about Eq. (6) are presented in Table 3, which shows that FDI inflows have a positive and significant impact on GDP per capita for Algeria, Jordan, and Libya, respectively, an insignificant impact for Iran, Iraq, Kuwait, Oman, Qatar, Morocco, Saudi Arabia, Syria, Tunisia, Turkey, Yemen, and UAE, and a significant negative impact for Egypt and Lebanon. This suggests that an increase in FDI inflows per capita tend to decrease economic growth in Egypt and Lebanon. From the elasticities, it can also be inferred that due to the increase in FDI inflows per capita, growth drop more in Lebanon than in Egypt (0.167<0.014).

In Algeria, Jordan, and Libya, the results suggest that a 1 % increase in foreign direct investment raises economic growth by around 0.022, 0.064, and 0.082 %, respectively

Inversely, the increase of FDI from a 1 and 5 % level reduce the economic growth of Egypt and Lebanon by 0.014 and 0.167 %, respectively. These results are in line with those of Sanders and Secchi (1974) in host country, Saqib et al. (2013) in Pakistan, and Bayar (2014) in Turkey.

The FDI inflows have no impact on economic growth for 12 countries. This result is consistent with the findings of Carkovic and Levine (2002) for 72 countries, Duasa (2007) in Malaysia, Louzi and Abadi (2011) for Jordan, Belloumi (2014) for Tunisia, and Aga 2014 for Turkey.

Regarding the pollutant variable, we find that CO_2 emissions have a significant impact on GDP per capita for all the countries, except Iraq, Jordan, Lebanon, Libya, Qatar, Syria, and Yemen. For these seven countries, there is an insignificant negative and positive impact. This implies that the environmental degradation has no effect on economic growth. This result is consistent with the findings of Richmond and Kaufman (2006) for both OECD and Non-OECD nations and Begum et al. (2015) for Malaysia. Only for Algeria, Iran, Kuwait, Morocco, Oman, Saudi Arabia, Tunisia, Turkey, Yemen, and UAE there is a negative significant impact. A coefficient of 0.363,

Table 3 Summary statistics (before taking logarithm), 1990–2012

Panels	Descriptive statistics	GDP per capita (constant 2005 USD)	FDI (net inflows)	CO_2 (metric tons per capital)	Capital stock (constant 2005 USD) (per capita)
Algeria	Mean	2709.083	0.315	3.063	675.746
	Std. Dev.	337.472	0.256	0.242	208.311
	CV	0.124	0.813	0.079	0.308
Egypt	Mean	1175.913	0.643	2.054	217.081
	Std. Dev.	233.535	0.629	0.522	61.811
	CV	0.198	0.979	0.254	0.284
Iran	Mean	2482.948	0.486	5.889	611.223
	Std. Dev.	506.992	0.565	1.532	204.573
	CV	0.204	1.162	0.260	0.334
Iraq	Mean	1921.003	1.654	33.477	177.784
	Std. Dev.	243.966	1.501	37.496	201.260
	CV	0.126	0.907	1.120	1.132
Jordan	Mean	2166.443	2.118	3.375	592.915
	Std. Dev.	411.470	2.184	0.254	122.939
	CV	0.189	1.031	0.075	0.207
Kuwait	Mean	26,113.050	11.904	29.332	4405.879
	Std. Dev.	10,584.450	33.644	3.232	953.885
	CV	0.405	2.826	0.110	0.216
Lebanon	Mean	5697.711	26.401	4.485	1481.125
	Std. Dev.	819.686	19.514	0.527	313.075
	CV	0.143	0.739	0.117	0.211
Libya	Mean	7158.602	1.734	9.403	1036.483

Table 3 (continued)

Panels	Descriptive statistics	GDP per capita (constant 2005 USD)	FDI (net inflows)	CO_2 (metric tons per capital)	Capital stock (constant 2005 USD) (per capita)
	Std. Dev.	1143.769	2.432	0.617	378.156
	CV	0.159	1.402	0.0656	0.364
Morocco	Mean	1869.858	0.411	1.385	483.625
	Std. Dev.	365.509	0.362	0.311	164.113
	CV	0.195	0.881	0.224	0.339
Oman	Mean	12,144.700	3.359	12.500	7365.378
	Std. Dev.	1787.024	4.067	6.001	2681.148
	CV	0.147	1.210	0.480	0.364
Qatar	Mean	53,144.080	15.468	53.272	13,595.010
	Std. Dev.	4515.345	16.033	9.401	4160.869
	CV	0.0849	1.036	0.176	0.306
Saudi Arabia	Mean	13,768.42	4.067	15.257	2400.222
	Std. Dev.	1830.044	4.969	2.045	160.048
	CV	0.132	1.221	0.134	0.066
Syria	Mean	1519.974	0.383	3.023	327.945
	Std. Dev.	182.337	0.325	0.283	42.203
	CV	0.119	0.849	0.093	0.128
Tunisia	Mean	2985.873	1.075	2.140	646.045
	Std. Dev.	648.598	0.801	0.269	86.24328
	CV	0.217	0.744	0.125	0.133
Turkey	Mean	6485.020	21.773	3.386	1236.389
	Std. Dev.	1045.912	47.893	0.531	328.165

Table 3 (continued)

Panels	Descriptive statistics	GDP per capita (constant 2005 USD)	FDI (net inflows)	CO_2 (metric tons per capital)	Capital stock (constant 2005 USD) (per capita)
	CV	0.161	2.199	0.156	0.265
Yemen	Mean	765.119	1.218	0.907	3222.032
	Std. Dev.	66.583	2.273	0.110	957.955
	CV	0.087	1.866	0.121	0.297
UAE	Mean	40,569.470	61,431.640	26.512	7545.951
	Std. Dev.	8444.758	203,536.900	5.661	767.058
	CV	0.208	3.313	0.213	0.101
Panel	Mean	10,745.720	3619.027	10.5532	2708.925
	Std. Dev.	15,157.460	50,461.410	13.892	3761.490
	CV	1.410	13.943	1.316	1.388

Std. Dev standard deviation, CO_2 indicates per capita carbon dioxide emissions, *GDP* per capita economic growth, *FDI* FDI inflows per capita, *K* real capital per capita, *UAE* United Arab Emirates, *CV* the coefficients of variation (standard deviation-to-mean ratio)

0.273, and 0.201 % indicates that GDP per capita will increase by 0.363, 0.273, and 0.201 %, when there is a 5 % decrease in per capita CO_2 emissions in Algeria, Oman, and Saudi Arabia, respectively.

In other words, the magnitude of 4.284, 1.513, 0.855, 0.615, 0.283, 0.270, and 0.201 % implies that a 1 % increase in the growth rate of per capita CO_2 emissions decreases the economic growth by 4.284, 1.513, 0.855, 0.615, 0.283, 0.270, and 0.201 % in Egypt, Iran, Kuwait, Morocco, Tunisia, and Turkey, respectively. However, in the UAE, economic growth is elastic regarding CO_2 emissions, and a 10 % increase in environmental degradation decreases economic growth within a range of 0.317 %. This implies that an increase in the environmental degradation tends to decrease economic growth. This result is consistent with the findings of Jayanthakumaran et al. (2012) for China and Omri et al. (2014) for 54 countries.

Finally, the coefficient of capital has a positive and significant impact for 15 countries out of 17. Only for Turkey and Tunisia, no significant impact is found; however, for Algeria, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Yemen, there is a significant positive impact at 1 % level. In the UAE, the GDP per capita increases by 1.35 % when there is a 5 % increase in capital. This result is consistent with the findings of Shahbaz et al. (2011) for Romania, Shahbaz et al. (2012) for Pakistan, and Omri and Sassi-Tmar (2014) for Morocco.

The results of static panel regression are presented in Table 4. To choose between FE and RE models, we use the Hausman specification test to examine the null hypothesis that the random effects are consistent and efficient. Similarly, if this hypothesis is rejected, then the estimation results provided by the FE model are found to be more robust than others (Feki and Chtourou 2014).

The coefficient of Hausman specification test rejects the null hypothesis of RE model which is appropriate and more efficient. In this case, it be can said that the results of the FE model are more appropriate than those of the RE model.

In the FE model, the *R*-square value is 0.92, which explains that the relationship between the dependent variable (GDP) of the MENA countries and all the independent variables (FDI, CO_2, K) are high. The value means about 92% of the variation that occurs in GDP can be explained by FDI, CO_2 emissions, and capital stock. As expected, we find that FDI inflows and capital stock have positive and significant impacts on economic growth in the MENA countries, while the impacts of CO_2 emissions are negative.

Therefore, we can say that FDI inflows and capital have the highest impacts on economic growth in MENA countries. The results suggest that a 1 % increase in the capital raises economic growth for the MENA countries by around 0.20 %. This implies that capital is an important factor of production; therefore, it stimulates economic growth. The findings are in line with those of Wang et al. (2011) for China, Shahbaz et al. (2012) for Pakistan, and Omri and Kahouli (2013) for 13 MENA countries.

We also see that FDI inflows have positive and statistically significant impact on economic growth at 5 % level. The magnitude of 0.015 implies that a 1 % increase in FDI inflows increases per capita GDP of the MENA countries by around 0.01 %. This implies that the FDI inflows have an important role in stimulating economic growth but with a low coefficient. This is in line with the findings of Chee (2010) for Asia and Oceania countries and Nahidi and Badri (2014) for six countries. On the other hand, the findings indicate that CO_2 emissions significantly cause changes in economic growth at 1 % level. Economic growth is also negatively and significantly affected by CO_2 emissions. In fact, a

Table 4 Regression results of Eq. (6)

Countries	Dependent variable: economic growth (GDP)							
	Intercept		FDI		CO_2		*K*	
Algeria	5.701*	(0.000)	0.022**	(0.004)	−0.363**	(0.024)	0.407*	(0.000)
Egypt	5.803*	(0.000)	−0.014***	(0.093)	−0.615*	(0.000)	0.152**	(0.022)
Iran	4.816*	(0.000)	−0.005	(0.271)	−0.270*	(0.002)	0.393*	(0.000)
Iraq	7.150*	(0.000)	−0.007	(0.299)	−0.074	(0.536)	0.094*	(0.000)
Jordan	4.675*	(0.000)	0.064*	(0.001)	0.008	(0.986)	0.469*	(0.001)
Kuwait	−19.265*	(0.002)	−0.043	(0.100)	−4.284*	(0.000)	1.764*	(0.001)
Lebanon	6.918*	(0.000)	−0.167*	(0.000)	0.085	(0.219)	0.288*	(0.000)
Libya	9.749*	(0.000)	0.082*	(0.002)	0.553	(0.286)	−0.305	(0.136)
Morocco	5.042*	(0.000)	0.002*	(0.508)	−0.283*	(0.002)	0.390*	(0.000)
Oman	3.432*	(0.000)	−0.007	(0.454)	−0.273**	(0.012)	0.749*	(0.000)
Qatar	7.991*	(0.000)	−0.001	(0.752)	0.0479	(0.234)	0.284*	(0.000)
Saudi Arabia	−0.268	(0.929)	0.010	(0.458)	−0.201**	(0.037)	1.187*	(0.007)
Syria	2.717*	(0.003)	0.011	(0.465)	−0.063	(0.498)	0.810*	(0.000)
Tunisia	5.999*	(0.001)	0.017	(0.409)	−1.513*	(0.000)	0.130	(0.608)
Turkey	6.932*	(0.000)	0.005	(0.388)	−0.855*	(0.000)	0.111	(0.176)
Yemen	2.717*	(0.003)	0.011	(0.465)	−0.063	(0.498)	0.810*	(0.000)
UAE	−2.561	(0.596)	0.005	(0.727)	−0.317***	(0.051)	1.35**	(0.024)
Panel (Fixed effect)	6.335*	(0.000)	0.015**	(0.017)	−0.417*	(0.000)	0.201*	(0.000)
Observations	391							
No. of countries	17							
R2	0.924							
Hausman test (*p* value	23.48	(0.000)						

Values in parenthesis are the estimated *p* values

OLS ordinary least squares, *Hausman test* the Hausman specification test

*Coefficient significant at the 1 % level, **coefficient significant at the 5 % level, ***coefficient significant at the 10 % level

1 % increase in CO_2 emissions decreases the economic growth by around 0.0.41 %. Hence, a high level of pollution emissions might lead to the reduction of the production capacity of a country. This result is consistent with the findings of Borhan et al. (2012), Omri et al. (2014), and Omri et al. (2015).

To explain the evolution of economic growth over time, the economic growth model must be dynamic because economic behavior is dynamic. In this study, we will also estimate our dynamic panel data model using both the difference and the system generalized method of moments (GMM) estimators.

Results of Dynamic Panel Estimations

In this study, we used a dynamic panel specification where lagged levels of economic growth are taken into account using both diff- and sys-GMM estimators. The consistency of the GMM estimator depends on the validity of instruments. To address this issue, we consider two specification tests: first is the Hansen test of over-identifying restrictions, which tests the overall validity of the instruments (the null hypothesis is that the instruments are valid); and second is the second-order autocorrelation test for error term, which tests the null hypothesis according to which there is no autocorrelation.

Table 5 shows that the Hansen test for diff-GMM estimation rejects the null hypothesis of over-identifying restrictions. Therefore, we conclude that the diff-GMM estimation may not be suitable in this context; therefore, we proceed to estimate our dynamic model using the sys-GMM estimator wherein both specification tests indicate that the used instruments are valid. Accordingly, we can conclude that the sys-GMM estimation is robust and appropriate.

The results of the sys-GMM estimator indicate that the estimated coefficient of the lagged variable (adjustment coefficient) is positive and statistically significant. This implies that one period lagged value of GDP has a positive and significant impact on its current value at 1 % level. The result is in line with that of Omri et al. (2014). In addition, the impact of the FDI inflows on economic growth is positive and significant at the 5 % level. In fact, a 5 % increase in FDI inflows is expected to raise economic growth by 0.003 %. FDI inflows promote economic growth in the MENA countries. These results are consistent with the findings of Chee (2010) for Asia and Oceania countries and Nahidi and Badri (2014). Whereas CO_2 emissions have negative 1%, the magnitude of 0.008 indicate that a 1 % increase in CO_2 emissions decreases economic growth in the MENA countries by 0.008 %. This result is consistent with Jayanthakumaran et al. (2012) for China and Omri et al. (2015) for the MENA countries. Therefore, these results are as it is showed in the static estimation. Finally, the coefficient of capital has negative and insignificant impact on economic growth in MENA countries.

Table 5 Results of sys-GMM and diff-GMM for Eq. (7)

Independent variables	Dependent variable: economic growth (GDP)			
	Sys-GMM		Diff-GMM	
GDP(−1)	0.871*	(0.000)	0.890*	(0.000)
FDI	0.003**	(0.032)	0.006*	(0.003)
CO_2	−0.170*	(0.000)	−0.182*	(0.009)
K	−0.008	(0.615)	0.085**	(0.032)
Intercept	0.908*	(0.000)		
Observations	374		357	
No. countries	17		17	
AR (2) test (*p* value)	1.26	(0.209)	1.31	(0.189)
Hansen J-test (*p* value)	15.41*	(0.021)	14.93	(0.667)

Values in parenthesis are the estimated *p* values. AR(2) are tests for autocorrelation in differences. Hansen J-test refers to the over-identification test for the restrictions in GMM estimation

*Coefficient significant at the 1 % level, **coefficient significant at the 5 % level

For both static and dynamic estimations, the overall findings show that economic growth of the MENA countries is very sensitive to the level of the FDI inflows and environmental quality, whereas the capital is not very sensitive for dynamic estimations.

Accordingly, policymakers should take into account these phenomena in order to build favorable external and environmental policies to sustain economic growth.

Conclusions and Policy Implications

In this article we have scrutinized the impact of foreign direct investment, environmental quality, and capital on economic growth in the MENA countries. We assessed the growth effect of FDI, environmental quality, and the capital stock using data from 17 MENA countries over the period 1990–2012. To properly deal with static and dynamic panel models, we used ordinary least squares (OLS), fixed effects (FE) and random effect (RE) models, and GMM estimators designed by Arellano and Bond (1991) and Blundell and Bond (1998).

Our findings may be summarized in two points; firstly, the empirical results for individual panel show that increases in FDI inflows raise economic growth for Algeria, Jordan, and Libya, which implies that the FDI inflows are the major drivers of economic growth. However, for Egypt and Lebanon, the increases in FDI inflows decrease the economic growth. On the other hand, there is no significant independent impact of FDI on economic growth for Iran, Iraq, Kuwait, Oman, Qatar, Morocco, Saudi Arabia, Syria, Tunisia, Turkey, Yemen, and UAE, respectively. Finally, the estimated results for the global panel indicate that the FDI inflows have a positive impact, which implies that the FDI inflows could be justified by the new strategies implemented by the MENA countries in the last decade in order to attract foreign capital such as privatization, exploitation of petroleum, and multiple domain energy. This led to an increase of FDI in the country and promoted growth through increased PIB; the FDI inflows have encouraged the creation of new jobs, enhanced technology transfer, and boosted overall economic growth in the MENA countries. We also found that economic growth for Algeria, Iran, Kuwait, Morocco, Oman, Saudi Arabia, Tunisia, Turkey, Yemen, and UAE negatively reacts to the environmental degradation; while for the remaining countries, there is no effect on economic growth. This implies that the environmental degradation decreases economic growth almost for all the countries. Therefore, pollution may directly decrease the output by reducing productivity of man-made capital and labor. Here, pollution plays as a negative externality. For instance, health problems cause decline of labor productivity due to polluted air, or water deteriorates the quality of industrial equipment. Secondly, the firm's production costs increase when firms reduce pollution emissions.

Thirdly, the empirical results, for both estimation techniques (FE and SYS-GMM), show that the increase of the FDI inflows increases economic growth in the MENA countries, which indicates that the FDI inflows promote economic growth. This implies that FDI inflows are an important vehicle for the transfer of technology, which contributes relatively to more economic growth. When advanced technology is accompanied by capital stock at a certain level, there will be an increase in a specific region. Hence, FDI and the capital stock are important sources of GDP growth. By against, we also find that economic growth of MENA countries is negatively affected by environmental degradation. Therefore, environmental degradation may directly decrease the output by reducing the productivity of man-made capital and labor. Here, environmental degradation plays as a negative externality. Actuality health problems entail losses of labor day; polluted air or water leads to the deterioration of the quality of industrial equipment. Secondly, the firm's production costs increase when firms abate pollution emissions.

The main policy implications arising from our study can be presented as follows: Firstly, based on the impact of FDI inflows on economic growth in the MENA countries, it is important for policymakers to implement sound economic policies to eliminate legal and non-legal barriers that prevent local firms from establishing economic linkages as well as access to technology and financing conditions from the foreign markets.

Secondly, the negative effect of CO_2 emissions on economic growth for policymakers should implement policies that encourage environmental friendly energy production and utilization as well as green technologies in order to reduce carbon emissions and promote economic growth.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no competing interests.

References

Aga, A. A. K. (2014). The impact of foreign direct investment on economic growth: a case study of Turkey 1980–2012. *International Journal of Economics and Finance, 6*, 71–84.

Ahmed, E. M. (2012). Are the FDI inflow spillover effects on Malaysia's economic growth input driven? *Economic Modeling, 29*, 1498–1504.

Aizhan, K., & Makaevna, M. D. (2011). Impact of foreign direct investment on economic growth in Kazakhstan. *International Proceedings of Economics Development & Research, 10*, 414.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2010). How does foreign direct investment promote economic growth? Exploring the effects of financial markets on linkages. *Journal of Development Economics, 91*, 242–256.

Ang, J. B. (2007). CO2 emissions, energy consumption, and output in France. *Energy Policy, 5*, 4772–4778.

Ang, J. B. (2008a). Determinants of foreign direct investment in Malaysia. *Journal of Policy Modeling, 30*, 185–189.

Ang, J. B. (2008b). Economic development, pollutant emissions and energy consumption in Malaysia. *Journal of Policy Modeling, 30*, 271–278.

Anwar, S., & Nguyen, L. P. (2010). Foreign direct investment and economic growth in Vietnam. *Asia Pacific Business Review, 16*, 83–202.

Anwar, S., & Sun, S. (2011). Financial development, foreign investment and economic growth in Malaysia. *J Asian Economics, 22*, 335–342.

Arellano, M., & Bond, S. R. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies, 58*, 277–297.

Arouri, M. E., Youssef, A., M'henni, H., & Rault, C. (2012). Energy consumption, economic growth and CO_2 emissions in Middle East and North African countries. *Energy Policy, 45*, 342–349.

Azlina, A. A., & Mustapha, N. H. N. (2012). Energy, economic growth and pollutant emissions nexus: the case of Malaysia. *Procedia Social and Behavioral Sciences, 65*, 1–7.

Azman-Saini, W. N., Zubaidi Baharumshah, A., & Law, S. H. (2010). Foreign direct investment, economic freedom and economic growth: international evidence. *Economic Modelling, 27*, 1079–1089.
Baldwin, R. E. (2003). In R. E. Baldwin & L. A. Winters (Eds.), *Openness and growth: what's the empirical relationship?* Chicago: University of Chicago Press.
Barrell, R., & Pain, N. (1999). Domestic institutions, agglomerations and foreign direct investment in Europe. *European Economic Review, 43*, 925–934.
Bastola, U., & Sapkota, P. (2015). Relationships among energy consumption, pollution emission, and economic growth in Nepal. *Energy, 80*, 254–262.
Batten, J. A., & Vo, X. V. (2009). An analysis of the relationship between foreign direct investment and economic growth. *Applied Economics, 41*, 1621–1641.
Bayar, Y. (2014). Effects of foreign direct investment inflows and domestic investment on economic growth: evidence from Turkey. *International Journal of Economics and Finance, 6*, 69–78.
Begum, R. A., Sohag, K., Abdullah, S. M. S., & Jaafar, M. (2015). CO_2 emissions, energy consumption, economic and population growth in Malaysia. *Renewable and Sustainable Energy Reviews, 41*, 594–601.
Belloumi, M. (2014). The relationship between trade, FDI and economic growth in Tunisia: an application of the autoregressive distributed lag model. *Economic Systems, 38*, 269–287.
Bengoa, M., & Sanchez-Robles, B. (2003). FDI, economic freedom, and growth: new evidence from Latin America. *European Journal of Political Economy, 19*, 529–545.
Blomstrom, M., Lipsey, R. E., & Zejan, M. (1994). What explains developing country growth? In W. J. Baumol (Ed.), *Convergence of Productivity: Cross-National Studies and Historical Evidence* (9th ed.). New York: Oxford University Press, Incorporated.
Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*, 115–143.
Bond, S. R. (2002). *Dynamic panel models: A guide to micro data methods and practice*. Institute for Fiscal Studies / Department of Economics, UCL, CEMMAP (Centre for Microdata Methods and Practice) Working Paper No.CWPO9/02.
Borensztein, E., De Gregorio, J., & Lee, J. (1998). How does foreign direct investment effect economic growth. *Journal of International Economics, 45*, 115–135.
Borhan, H., Ahmed, E. M., & Hitam, M. (2012). The impact of CO_2 on economic growth in Asean 8. *Procedia Social and Behavioral Sciences, 35*, 389–397.
Campos, N.F., & Kinoshita, Y. (2002). Foreign direct investment as technology transferred: some panel evidence from the transition economies, centre for economic policy research. Discussion Paper No 3417. Paper also available at www.cepr.org/pubs/dps/DP3417.asp.
Carcovic, M., Levine, R. (2002) Does foreign direct investment accelerate economic growth? Department of business finance, University of Minnesota, Working Paper Series. Paper also available at www.worldbank.org/research/conferences/financial_globalization/fdi.pdf.
Chakrabarti, A. (2001). The determinants of foreign direct investment: sensitivity analyses of cross-country regressions. *Kyklos, 54*, 89–113.
Chebbi, H., Olarreaga, M., & Zitouna, H. (2009). Trade openness and CO_2 emissions in Tunisia. ERF 16th Annual Conference, November 7–9, 2009.
Chee, L. Y. (2010). The impact of FDI and financial sector development on economic growth: empirical evidence from Asia and Oceania. *International Journal of Economics and Finance, 2*, 2–17.
Christopher, O. O., & Douglason, G. O. (2011). Environmental quality and economic growth: searching for environmental Kuznets curves for air and water pollutants in Africa. *Energy Policy, 39*, 4178–4188.
Duasa, J. (2007). Malaysian foreign direct investment and growth: does stability matter? *Journal of Economic Cooperation, 28*, 83–98.
Edwards, S. (1998). Openness, productivity and growth: what do we really know? *The Economic Journal, 108*, 383–398.
Elboiashi, H., Noorbakhsh, F., Paloni, A., & Azemar, C. (2009). The casual relationships between foreign direct investment, domestic investment and economic growth in North African non-oil producing countries: empirical evidence from cointegration analysis. *Advances in Management, 2*, 19–25.
Feki, C. H., & Chtourou, N. (2014). Social capital and economic growth: empirical analysis of panel data. *International Journal of Innovation and Scientific Research, 2*, 164–176.
Findlay, R. (1978). Relative backwardness, direct foreign investment, and the transfer of technology: a simple dynamic model. *The Quarterly Journal of Economics, 92*, 1–16.
Fodha, M., & Zaghdoud, O. (2010). Economic growth and pollutant emissions in Tunisia: an empirical analysis of the environmental Kuznets curve. *Energy Policy, 38*, 1150–1156.
Ford, T. C., Rork, J. C., & Elmslie, B. T. (2008). Foreign direct investment, economic growth, and the human capital threshold: evidence from US states. *Review of International Economics, 16*, 96–113.

Ghosh, S., (2010). Examining carbon emissions economic growth nexus for India: a multivariate co integration approach. *Energy Policy, 38*, 2613–3130.

Grossman, G.M., Krueger, A.B. (1991). Environmental impacts of a North American free trade agreement. National Bureau of Economics Research Working Paper, No. 3194NBER, Cambridge.

Halicioglu, F. (2009). An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy, 37*, 1156–1164.

Hall, B. H., & Mairesse, Q. J. (1995). Exploring the relationship between R&D and productivity in French manufacturing firms. *Journal of Econometrics, 65*, 263–293.

Hooi, L. H., & Wah, T. B. (2010). Linkages between foreign direct investment, domestic investment and economic growth in Malaysia. *Prosiding Prekem, 2*, 48–57.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*, 53–74.

Jalil, A., & Mahmud, S. F. (2009). Environment Kuznets curve for CO2 emissions: a cointegration analysis for China. *Energy Policy, 37*, 5167–5172.

Jayanthakumaran, K., Verma, R., & Liu, Y. (2012). CO_2 emissions, energy consumption, trade and income: a comparative analysis of China and India. *Energy Policy, 42*, 450–460.

Kahouli, B., & Kadhraoui, N. (2012). Consolidation of regional groupings and economic growth: empirical investigation by panel data. *International Journal Euro-Mediterranean Studies, 5*, 71–92.

Katerina, L., John, P., & Athanasios, V. (2004). Foreign direct investment and economic growth in transition economies. *South East European Journal Economics, 2*, 97–110.

Kosztowniak, A. (2013). Foreign direct investment as a factor of economic growth in Poland. Empirical analysis for the period 1995–2012. *Advances in Economics and Business, 1*, 203–212.

Lee, C. C., & Chang, C. P. (2008). Energy consumption and economic growth in Asian economies: a more comprehensive analysis using panel data. *Resource and Energy Economics, 30*, 50–65.

Lee, C. C., & Chang, C. P. (2009). FDI, financial development, and economic growth: international evidence. *Journal of Applied Economics, 12*, 249–271.

Levin, A., Lin, C. F., & Chu, C. S. (2002). Unit root tests in panel data: asymptotic and finite sample properties. *Journal of Econometrics, 108*, 1–24.

Louzi, B.M., Abadi, A. (2011). The forgein direct investment on economic growth in Jordan. www.arpapress.com 8, 253–258.

Mah, J. S. (2010). Foreign direct investment inflows and economic growth of China. *Journal of Policy Modeling, 32*, 155–158.

Managi, S. (2006). Are there increasing returns to pollution abatement? Empirical analytics of the environmental Kuznets curve in pesticides. *Ecological Economics, 58*, 617–636.

Markandya, A., Golub, A., & Pedroso, G. (2006). Empirical analysis of national income and SO_2 emissions in selected European countries. *Environmental & Resource Economics, 35*, 221–257.

Mazenda, A. (2014). The effect of foreign direct investment on economic growth: evidence from South Africa. *Mediterranean Journal of Social Sciences, 5*, 95–108.

Melnyk, B. M., Gallagher, F. L., Long, L. E., & Fineout-Ovrholt, E. (2014). The establishment of evidence-based practice competencies for practicing registered nurses and advanced practice nurses in real world clinical settings: proficiencies to improve healthcare quality, reliability, patient outcomes, and costs. *Worldviews on Evidence-Based Nursing, 11*, 5–15. doi:10.1111/wvn.12021.

Nahidi, M. M., & Badri, A. K. (2014). The effect of foreign direct investment on economic growth. *International Journal of Management, Accounting and Economics, 1*, 175–184.

Narayan, P. K., & Smyth, R. (2008). Energy consumption and real GDP in G7 countries: new evidence from panel cointegration with structural breaks. *Energy Economics, 30*, 2331–2341.

Nistor, P. (2014). FDI and economic growth, the case of Romania. *Procedia Economics and Finance, 15*, 577–582.

Noor, S., & Siddiqi, M. W. (2010). Energy consumption and economic growth in South Asian countries: a co-integrated panel analysis. *Journal of Human and Social Sciences, 5*, 914–921.

Olumuyiwa, O. S. (2012). Long-run relationship between energy consumption and economic growth: evidence from Nigeria. *Journal of Humanities and Social Science (JHSS), 3*, 40–51.

Olumuyiwa, O. S. (2013). Impact of foreign direct investment inflow on economic growth in a pre and post deregulated Nigeria. A Granger Causality Test 1970–2010. *European Scientific Journal, 9*, 335–356.

Omri, A., & Kahouli, B. (2013). The nexus among foreign investment, domestic capital and economic growth: empirical evidence from the MENA region. *Research in Economics, 68*, 257–263.

Omri, A., Sassi-Tmar, A. (2014). Linking FDI inflows to economic growth in North African countries. Journal of the Knowledge Economy 10/2013; doi: 10.1007/s13132-013-0172-5

Omri, A., Nguyen, D. K., & Rault, C. H. (2014). Causal interactions between CO_2 emissions, FDI, and economic growth: evidence from dynamic simultaneous-equation models. *Economic Modeling, 42*, 382–389.

Omri, A., Daly, S., Rault, C. H., & Chaibi, A. (2015). Financial development, environmental quality, trade and economic growth: what causes what in MENA countries. *Energy Economics, 48*, 242–252.

Pao, H., & Tsai, C. (2010). CO_2 emissions, energy consumption and economic growth in BRIC countries. *Energy Policy, 38*, 7850–7860.

Pereira, A. M., & Pereira, M. R. M. (2010). Is fuel-switching a no-regrets environmental policy? VAR evidence on carbon dioxide emissions, energy consumption and economic performance in Portugal. *Energy Economics, 32*, 227–242.

Razmi, J. M., & Refaei, R. (2013). The effect of trade openness and economic freedom on economic growth: the case of Middle East and East Asian countries. *International Journal of Economics and Financial Issues, 3*, 376–385.

Richmond, A. K., & Kaufmann, R. K. (2006). Is there a turning point in the relationship between income and energy use and/or carbon emissions? *Ecological Economics, 56*, 176–189.

Saidi, K., Hammami, S. (2014). The impact of CO2 emissions and economic growth on energy consumption in 58 countries. *1*, 62–70

Saltz, S. (1992). The negative correlation between foreign direct investment and economic growth in the third world: theory and evidence. *Rivista Internazionale di Scienze Economiche e Commerciali, 39*, 617–633.

Sanders, M., & Secchi, C. (1974). *Private foreign investment in developing countries: a quantitative study on the macroeconomic effects*. Dordrecht: Reidel.

Saqib, N., Masnoon, M., & Rafique, N. (2013). Impact of foreign direct investment on economic growth of Pakistan. *Advances in Management & Applied Economics, 3*, 35–45.

Sari, R., & Soytas, U. (2009). Are global warming and economic growth compatible? Evidence from five OPEC countries? *Applied Energy, 86*, 1887–1893.

Schiff, M., & Wang Y. (2008). North–south technology spillovers: the relative impact of openness and foreign R&D, IZA DP No. 3383.

Sen, H. (1998). Different arguments for and against the role and impact of foreign direct investment on the development potentials of developing countries: an overview. *Journal of Economics and Administrative Sciences, 13*, 181–190.

Shafik, N. (1994). Economic development and environmental quality: an economic analysis. *Oxford Economic Papers, 46*, 147–162.

Shahbaz, M., Mutascu, M., Tiwari, A.K. (2011). Revisiting the relationship between electricity consumption, capital and economic growth: cointegration and causality analysis in Romania. Online at http://mpra.ub.uni-muenchen.de/29233/ MPRA Paper No. 29233, posted 6. March 2011 21:31 UTC.

Shahbaz, M., Zeshan, M., & Afza, T. (2012). Is energy consumption effective to spur economic growth in Pakistan? New evidence from bounds test to level relationships and Granger causality tests. *Economic Modelling, 29*, 2310–2319.

Shahbaz, M., Khan, S., & Tahir, M. I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: fresh evidence from multivariate framework analysis. *Energy Economics, 40*, 8–21.

Soltani, H., & Ochi, A. (2012). Foreign direct investment (FDI) and economic growth: an approach in terms of cointegration for the case of Tunisia. *Journal of Applied Finance Bank, 2*, 193–207.

Song, T., Zheng, T., & Tong, L. (2008). An empirical test of the environmental Kuznets curve in China: a panel cointegration approach. *China Economic Review, 19*, 381–392.

Soytas, U., & Sari, R. (2009). Energy consumption, economic growth and carbon emissions: challenges faced by an EU candidate member. *Ecological Economics, 68*, 1667–1675.

Temiz, D., & Gökme, A. (2014). FDI inflow as an international business operation by MNCs and economic growth: an empirical study on Turkey. *International Business Review, 23*, 145–154.

Tiwari, A. K., & Matascu, M. (2011). Economic growth and FDI in Asia: a panel data approach. *Economic Analysis and Policy, 41*, 173–1.

Topcu, S. C. M. (2013). The nexus between financial development and energy consumption in the EU: a dynamic panel data analysis. *Energy Economics, 39*, 81–88.

Vissak, T., & Roolaht, T. (2005). The negative impact of foreign direct investment on the Estonian economy. *Problems of Economic Transition, 48*, 43–66.

Wang, S. S., Zhou, D. Q., Zhou, P., & Wang, Q. W. (2011). CO2 emissions, energy consumption and economic growth in China: a panel data analysis. *Energy Policy, 39*, 4870–4875.

Yu, K., Xin, X., Guo, P., & Liu, X. (2011). Foreign direct investment and China's regional income inequality. *Economic Modeling, 28*, 1348–1353.