Reexamining the Foreign direct investment, Renewable energy consumption and Economic growth nexus: Evidence from a new Bootstrap ARDL test for Cointegration

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Abstract

This study examines the long-run relationship among foreign direct investment, renewable energy consumption, and economic growth for seven Middle East and North Africa countries over the period 1980–2017 using a newly developed cointegration test by McNown et al. (2018), the bootstrap autoregressive distributed lag (ARDL) test. The long run analysis reveals evidence of cointegraion among FDI inflows, renewable energy consumption, and economic growth in all countries except Iran and Turkey, where real GDP is used as the dependent variable. A similar result is observed in economies, with the exception of Mauritania when FDI inflow is treated as a dependent variable. Whereas, when RE is taken as a dependent variable, cointegration does occur in Algeria, Mauritania, Morocco, and Tunisia. In regards to the direction of causality, the short-term analysis provides varied results among diverse variable for various countries. In this context, this study recommends increasing public awareness and attention in the advantages of renewable energy and clean technologies. In addition, MENA governments need to attract more FDI that includes green technologies and renewable energy sources as a way to promote energy efficiency. Thus could contribute to economic development and boost environmental quality.

Keywords: FDI; Renewable energy consumption; Economic growth; Bootstrap ARDL; MENA.

JEL classification: F21, O11, Q43, C15.

1. Introduction

Over the past decade, the Middle East and North Africa (MENA) region are faced with the challenges of a growing population, surging demand for electricity, limited investments in new generation capacity, and in certain countries limited or no supply of

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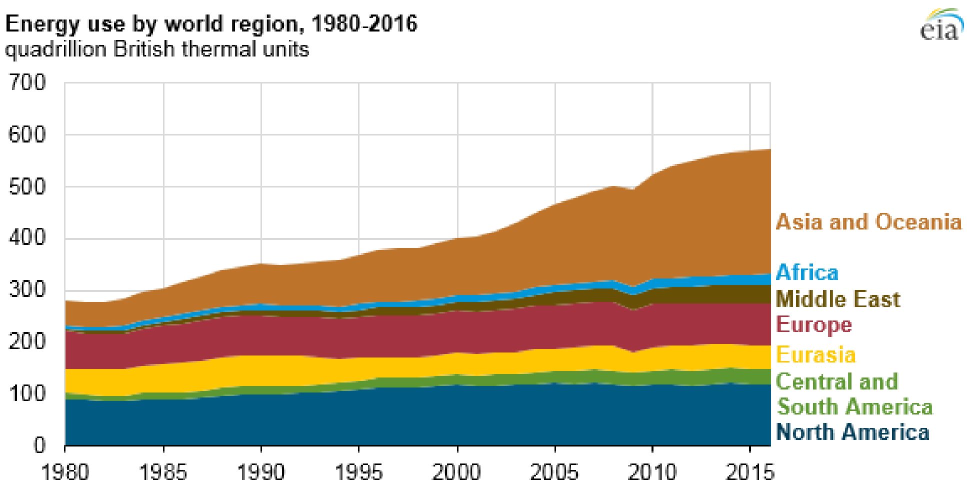
indigenous hydrocarbon resources. Really, the demand for energy is rising so rapidly in the MENA regions that even most countries, which have traditionally exported energy in the past, are facing the prospect of becoming energy importers themselves. Such situation may be further aggravated when countries seek to stimulate economic growth by recognizing that it can significantly affect directly energy demand (Siddiqui, 2004). Indeed, the MENA region ranks second in the world after Asia in terms of energy consumption as shown in Fig. 1. According to the Energy Information Administration, energy use continues to grow rapidly, with about 20 % growth in the region between 2010 and 2016.

Fig.1



Source: U.S. Energy Information Administration, International Energy Statistics.

Additionally, energy demand can be influenced indirectly by other determinants of economic growth, including financial globalization. Foreign direct investment (FDI), considered as one of the most relevant aspect of financial globalization (Bajo-Rubio et al., 2010), has surge spectacularly over the last three decades in the MENA regions. Theoretically, several works have considered FDI as a catalyst for economic growth in the host economy on several levels (Aitken and Harrison, 1999; Romer, 1993; Borensztein *et al.*, 1998; Adams, 2009; Maji and Odoba, 2011; Khan *et al.*, 2014; Aziz and Mishra, 2016). Indeed, FDI is sought for its ability to promote economic growth, particularly through the development of domestic investment, job creation, participation in the creation of direct value added through the production of foreign companies, and increased competition and competitiveness of the national economy. It is also about the contribution of new methods and managerial techniques, through direct and indirect contacts between foreign subsidiaries and local firms, which could facilitate the transfer of knowledge and technological standards to the host economy (Azman-Saini et al., 2010). Consistent with this view that FDI leads to greater economic growth is the likelihood that energy use should be positively influenced by raises in FDI inflows across the expansion of the development of the manufacturing and transportation sector (Mielnik and Goldemberg, 2002; Sadorsky, 2010; Omri and kahouli, 2014b; Doytch and Narayan, 2016; Abdouli and Hammami, 2017; Uzar and Eyuboglu, 2019).

All these challenges have led many countries in the region to revise their energy policy by putting ambitious strategic goals to take advantage of renewable energy resources. Consequently, many countries started to establish a massive investment plans to enhance renewable energies. As noted by the International Renewable Energy Agency (Irena), almost every country in the region has a goal of using renewable energies in a proportion of 5 to 15% by the year 2030. The stated objective of these countries is to fully cover their energy consumption over the long term for preserving the environmental framework through wind and solar energy[1]. Renewable energy should also play a fundamental role in boosting countries' economic growth by decreasing the cost of energy use in production, creating jobs, which is essential to ensure ongoing social and economic stability (Cai et al., 2011). However, according to the Renewable Global Status Report (2017), the investment in renewable energy in the MENA region has increased in some countries. For instance, it has increased by reaching USD 1.2 billion in Jordan in 2016, and amounted to nearly USD 700 million in Egypt (IRENA). Morocco reached 2.9 billion USD in 2018, equivalent to an increase of 157% compared to 2017 (Renewable Global Status Report (2019). Similarly, according to a report by the Middle East Solar Industry Association (2017), about 4 GW of photovoltaic power and 1.3 GW of concentrated solar energy are being developed in the MENA region.

Despite that FDI inflows can raise the energy demand through its increase of production processes, it's highlighted that host countries can benefits from FDI through it is positive impact on renewable energy development (Fan and Hao, 2020). In fact, FDI inflows can reduce the costs associated with the difficulties of developing renewable sources by providing financing and technical support to the renewable energy industry

[1] See the summary of the key renewable energy targets and plans in the MENA countries in Aghahosseini et al. (2020).

(Brunnschweiler, 2010). In addition, FDI inflows can lead to technology transfer and technology spillovers that can positively affect the technological advancement of firms in host countries, leading them to adopt high environmental standards (Doytch and Narayan, 2016). Likewise, as mentioned above, that FDI inflows can indirectly influence the demand for non-renewable energy through their impact on economic growth, this is may also recognized for renewable energy consumption. Thus, it would be interesting to address the long-term as well as short-term dynamic relationship between FDI inflows, renewable energy consumption and economic growth.

Given its bivariate important role in promoting economic growth as well as preventing further environmental degradation, the study of the causality between the development of renewable energy resources and economic growth as well as its components such as FDI can provide decision-makers with clear contributions to their policy making, whether economic or environmental. Indeed, four type of causality can rise behind the relationship between FDI inflows, renewable energy consumption and economic growth: i) in one hand, there may be an unidirectional causal direction from renewable energy consumption to FDI inflows and economic growth. This causality signify that the renewable energy consumption is an important factor for the two others variables (i.e. FDI inflows and economic growth) and any development of renewable energy consumption could enhance economic growth and attract FDI inflows; ii) in the second hand, an opposite causality may exist, i.e. from the FDI inflows and economic growth to the renewable energy consumption could meaning that both FDI inflows and economic growth are crucial of renewable energy development; iii) in the third hand, a two-way causal relationship may occur indicating that FDI inflows and economic growth boost and develop renewable energy resources, which in turn led to promote FDI inflows and economic growth; iv) in the fourth hand, there can be no causality, which could imply that the sudden stop of FDI inflows and economic recession do not affect the renewable energy consumption, and in the opposite direction the latter has no effect on the two former.

Although there have been many empirical studies focusing on the interrelationship between renewable energy use and economic growth, research on the interactions between renewable energy use, FDI inflows and economic growth is still scarce. Similarly, in reviewing the literature, there were only two studies; Farhani (2013) and Dees and Auktor (2018) that focused solely on the link between renewable energy consumption and economic growth in the MENA region for more than one country. Therefore, we seek to analyze the causal links between FDI inflows, renewable energy consumption and economic growth for seven selected countries in the region over the period 1980-2017.

For decades, MENA countries have often been sensitive to several shocks, whether they are economic, social, or geopolitical. These shocks can lead to structural breaks in macroeconomic series (Eren et al., 2019; Ghazouani et al., 2020). A Critical reason for researchers to take these structural breaks into account is to avoid unbiased results and, ultimately, to avoid fallacious recommendations to decision-makers. Taking into account structural break(s), the objective of this study is to add robust results to the empirical literature. For this purpose, we apply the Lee and Strazicich (2003) unit root test who takes into account of the presence of structural break(s) in the series to examine the stationarity of the variables. In addition to the fact that our study can be considered a first in examining the link between FDI inflows, renewable energy consumption and economic growth, it is also believed a pioneer in using the augmented Bootstrap ARDL approach by McNown et *al.* (2018) to test the existence of a possible cointegration between variables in the presence of structural breaks for the MENA region. Finally, in light of the results of the cointegration test, the Granger causality test was designed to analyze the causal directions of the relationships between the variables.

The rest of the study is organized as follows: Section 2 reviews the relevant literature related to the subject. Section 3 gives an overview on econometric specification and methodology while Section 4 reports and discusses the empirical results. Finally, Section 5 provides conclusion and drawn policy implications

2. Literature review

2.1.The energy consumption-growth nexus

Since the pioneer study of Kraft and Kraft (1978), various studies have started to examine the relationship between economic growth and energy consumption. Theoretically, it's provided four testable hypotheses about the correlation between energy and growth (Ozturk, 2010 and Payne, 2010). The first, known as *growth hypothesis* which supports a unidirectional causality from energy consumption to economic growth. In such situation, energy is considered one of the principal determinants of production beside labor and the capital, and an increase in the energy consumption may lead to the increase in economic growth. The second hypothesis named *conservation hypothesis* according to which there exists a unidirectional relationship from economic growth to energy consumption. The conservation hypothesis implies that political energy conservation resulting in a reduction of energy consumption does not have a negative impact on real GDP. The third is called *feedback hypothesis* which supports if there is bidirectional causality between economic growth and energy consumption, which proves their mutual relationship so that implementation of sustainable and efficient consumption policies have no negative effect on real GDP. At last, the neutrality hypothesis according to which energy consumption does not influence economic growth. Evidences show the absence total of causal link between energy consumption and growth in either direction. This considers that a change in economic growth will not affect energy consumption, and vice versa. The implication of evidence supporting this hypothesis, like the conservation hypothesis, is that policies that limit energy consumption will not have a negative impact on economic growth (Tugcu and Ozturkand Aslan, 2012).

Many studies have been done supporting each of the hypotheses relating to energy consumption and economic growth. Those studies use three energy proxies to study the relationships between energy consumption and economic growth. Some studies use only the total energy consumption, other use the renewable-energy consumption and there are studies using both the nonrenewable energy and renewable-energy consumption to examine their effect on economic growth. As a part of the aim of this study, we present here the literature review which examines the relationship between renewable-energy consumption and economic growth.

Sadorsky (2009) studied the existing relationship between renewable energy consumption and income. The author used a bivariate panel error correction method for 18 emerging countries from the 1994-2003 periods. Their results revealed the presence of unidirectional causality running from economic growth to renewable energy consumption. Panel cointegration estimations show a positive and significant impact of real income on the renewable energy consumption.

Apergis and Payne (2011) explored the relationship between renewable energy consumption and economic growth in a panel of six Central American countries for the period from 1980 to 2006 utilizing error correction model and concluded that the feedback hypothesis is valid in the relationship. Contrary, Menegaki (2011) used random effect model and supported the neutrality hypothesis when he examined the causal relationship between economic growth and renewable energy consumption for 27 European countries for 1997–2007 period. Menegaki (2011) suggested that the result may be due to the uneven and the limited exploitation of renewable energy sources in Europe.

Alper and Oguz (2016) examined the causality between economic growth, renewable energy consumption, capital and labor for eight new EU member countries for the period of 1990–2009, by using an asymmetric causality test approach and ARDL approach. They found a positive impact of renewable energy consumption on economic growth among all investigated countries. In their examination, there is no causal link between renewable energy consumption and economic growth for Cyprus, Estonia, Hungary, Poland and Slovenia while a unidirectional causality running from renewable energy consumption to economic growth is present in the Czech Republic. The growth hypothesis is supported only for Bulgaria.

Rafindadi an Ozturk (2017) investigated whether the impacts of renewable energy have consolidated the economic growth prospects of Germany for the period 1971–2013. They employed the Clemente-Montanes-Reyes detrended structural break test, the Bayer-Hanck combined cointegration test and the ARDL approach. In addition, the causality analysis was observed using a VECM Granger causality framework. Rafindadi an Ozturk (2017) showed that renewable energy consumption in Germany consolidates the country's economic growth prospects. Their causality analysis revealed the existence of feedback effect between renewable energy consumption and economic growth. Ozcana and Ozturk (2019) applied bootstrap panel causality test to analyze the renewable energy consumption-economic growth nexus in 17 emerging countries. They stated that renewable energy demand contributes for Poland's economic growth process, among these emerging economies studied.

Recently, Mafizur and Velayutham (2020) explored the relationship between renewable and non-renewable energy consumption and economic growth for five South Asian countries for the 1990–2014 period. Their study shown a positive impacts of renewable energy consumption on economic growth and revealed that there is a unidirectional causality running from latter to the former.

By addressing the potential problems of endogeneity and the precision of the long-term relationship, Bentill and Adom (2020) examined the impact of renewable energy supply on economic growth in Ghana for the period from 1975 to 2017. Their results showed a unidirectional causality from renewable energy supply to economic growth in the short run while an opposite direction (i.e., from economic growth to renewable energy supply) in the long run. Additionally, they reveal that renewable energy supply affect positively economic growth in the short run; however its long run impact remains negative.

While, Zhao et al. (2020) by exploring the effect of per capita income, trade openness, and financial development on renewable and non-renewable energy consumption find that per capita income is the important factor in spurring renewable energy consumption in China

In the case of the MENA region, Farhani (2013) used a panel cointegration technique to examine the causal relationship between renewable energy consumption, economic growth and CO2 emissions for a group of 12 economies for 1975-2008 period. He finds no causal relationship between renewable energy consumption and GDP in the short run, while GDP growth has an influence on renewable energy consumption in the long run; the sign however, differs within the countries and is not significant for the overall panel. On a single-country level in the MENA region, Dogan (2015) analyzes the short and long run estimates as well as the causal relationships between economic growth and electricity consumption from renewable sources using the ARDL approach to cointegration, the Johansen cointegration test and the Gregory–Hansen cointegration test with structural break. He found no causality between renewable electricity consumption and economic growth in Turkey. For the same country, Ocal and Aslan (2013) used the ARDL approach and Toda-Yamamoto causality tests and showed that the impact of renewable energy on growth is negative, but causality reveals the conservation hypothesis. The difference between both studies might be a result of the different variables they used.

Using the ARDL approach to cointegration, Ben-Salha and Sebri (2014) searched the relationship between renewable energy consumption and growth in Tunisia for the period from 1971 to 2010 and found a bidirectional, positive relationship between renewable energy consumption and growth. Ibrahiem (2015) used a similar method to examine the relationship between renewable electricity consumption and economic growth in Egypt for the period from 1980 to 2011 and concluded the validity of the feedback hypothesis; according to which there is bidirectional causality between economic growth and renewable electricity consumption. While Belaïd and Youssef (2017) by exploring the dynamic causal relationship between renewable and non-renewable electricity consumption, CO2 emissions and economic growth for the case of Algeria using the ARDL cointegration approach for the period 1980-2012, reveal a unidirectional causal relationship from GDP to renewable electricity consumption.

For the case of eleven MENA Net Oil Importing Countries, Kahia et al. (2017), by employing a multivariate panel framework to estimate the long run relationship between real GDP, renewable and non-renewable energy consumption, capital and labor force over the period 1980–2012, provide evidence for cointegration relationship between the studied variables, in addition their panel Granger causality tests support the feedback hypothesis between economic growth and renewable energy use. Similarly, Kahia et al. (2019) examined the relationship between renewable energy consumption, economic growth, FDI inflows and trade, and carbon dioxide emissions for a panel of 12 MENA countries for the 1980 to 2012 period; their results revealed bidirectional causality among the candidate variables.

In a very recent study, Waheed et al. (2020) used varied cointegration methods (ARDL bound, Johansen and Gregory-Hansen methods) to examine the relationship among economic growth, non-oil exports, tourism, renewable energy. Their cointegration analysis reveals that renewable energy, among the other variables, is an important long-term factor for economic growth in Saudi Arabia.

2.2. The foreign direct investment-growth nexus

Regarding the link between FDI and economic growth, previous research has failed to establish if there is a positive or negative relationship amongst these variables. On one hand, proponents of the positive association between FDI inflows and economic growth, in the literature, are attributed to Van Loo (1977), Findally (1978), Romer (1993), Gruben and McLeod (1998), Borensztein et al. (1998) and De Mello (1999). Based on the basic neoclassical growth model of Solow (1956), they underline that FDI enhance growth by exercising a positive impact on the level of capital accumulation through increased investment and by increasing total factor productivity of host countries from technology transfers and spillovers effect. On the other hand, dependency theorists (Caves, 1971 and Hymer, 1976) were highly critical of the role of FDI in the economic growth of host countries. They reject the notion that incoming FDI flows to developing countries promote growth, arguing that FDI is a strategy used by MultiNational Corporations (MNCs) in developed economies to advance monopoly power over local industries (Prebisch, 1968). The MNCs reinforce their competitive advantage over local firm, characterized by low power in terms of marketing and advertisement, by controlling the supply of inputs and earning the benefits of tax incentives in the host country.

With the nature of the association between FDI and economic growth, the causality issue has been the subject of many recent studies. Does FDI cause economic growth or does economic growth is an FDI attractor? Many studies have focused more directly on the causal relationships between FDI and growth. Based on an Error Correction Model, Zhang (2001) examined the causality relationship between FDI and GDP for 11 countries in East

Asia and Latin America over a period of 30 years. He found that FDI has a positive impact on economic growth more in East Asia than Latin America. A unidirectional causality from GDP to FDI was found in four countries, while only one country exhibited Granger causality from FDI to growth. Zhang (2001) concludes that the varied impact of FDI on economic growth is likely to be the outcome of country specific economic structures.

Chowdhury and Mavrotas (2006) tested the causal relationship between the FDI and economic growth using the Toda and Yamamoto approach, in Chile, Malaysia and Thailand for the period from 1969 to 2000.They found that FDI does not Granger-cause GDP in Chile, whereas there is bidirectional Granger causality between GDP and FDI in Malaysia and Thailand. While Choe (2003) assessed the relationship between FDI and growth by using the vector autoregression model in 80 countries for the period from 1997 to 1995 and concluded bidirectional causality between these variables, but the causal impact from FDI to GDP is shown to be weak.

Hanson and Rand (2006) used estimators for heterogeneous panel data to examine the causality between FDI and GDP in a sample of 31 developing countries covering 31 years and showed a Granger causality running for FDI to GDP, while GDP has no long run impact on FDI. According to Hanson and Rand (2006), this finding may be interpreted as evidence in favor of the hypotheses that FDI has an impact on GDP via knowledge transfers and adoption of new technology.

De Mello (1999) looks at causal links from FDI to GDP in 15 OECD and 17 non-OECD countries for the period 1970–1990. His analysis reveals three things: (i) FDI promotes growth when it complements domestic investment; (ii) the long run of FDI on GDP is heterogeneous across countries; (iii) in the non-OECD countries, there is no causality running from FDI to GDP. Like De Mello, Nair-Reichert and Weinhold (2001) emphasize highly heterogenous relationship across counties and find that FDI on average has a significant impact on growth when they used the mixed and random coefficient approach in order to test the impact of FDI on growth in 24 countries over the period 1991-1995.

Recently, Seyoum et al. (2015) used annual balanced panel data to examine the Granger causal link between FDI and economic growth for 23 African countries for the period 1970-2011. Using the recently developed panel econometric techniques, they indicated a two-way Granger causality link between FDI and economic growth and they showed that this causal link is non-homogeneous among individual countries. More specifically, Seyoum et al. (2015) observed unidirectional Granger-causality running from FDI to GDP growth only in three countries that are Egypt, Gabon, and Mauritania, and a causality relationship running from GDP growth to FDI only in Côte D'Ivoire, Kenya, South Africa and Zambia among the 23 investigated countries. Saidi et al. (2015) assessed the link between energy consumption, ICTs, FDI inflows, and economic growth for 13 MENA countries; support the existence of a unidirectional causality running from economic growth to FDI. While Belloumi (2014) indicated that there is no significant Granger causality from FDI to economic growth in and vice versa when he examine the relationship between FDI, trade and economic growth in Tunisia by applying the bounds ARDL approach for the 1970-2008 period.

Klai and Zghidi (2017) analyzed the interrelationship between FDI, and economic growth for 15 MENA economies for the period from 1999 to 2012 using ARDL bound test approach and the vector error correction model. They found a long-run unidirectional causality running from FDI to economic growth in MENA countries. Whereas, Omri and Kahouli (2014b) by using the generalized method of moments to study the association between FDI inflows, domestic capital and economic growth in 13 MENA countries for the 1990-2010 period, revealed bidirectional relathionship between FDI inflows and economic growth.

2.3.The foreign direct investment-energy consumption nexus

This nexus is analyzed by many studies. Theoretically, this link can be decomposed into three effects: (i) the increase in energy use brought about by a vibrant economic activity fueled by FDI known as a scale effect; (ii) the technique effect which describes a negative association between FDI and energy consumption that stems from foreign investors, introducing energy efficiency; and (iii) the composition effect which depends on the sectoral distribution of FDI and the level of economic development in the host country, for example, the concentration in the secondary sector of a developing country promotes a positive FDI-energy nexus, whereas such concentration in the tertiary sector of a developed country, encourages a negative effect (Salim and al., 2017).

Researches among the link between FDI and energy have concentered on the relationship between financial development and energy demand considering FDI as an important element of financial development (Shahbaz et al., 2013; Khan et al., 2014). Early, Mielnik and Goldemberg (2002) focused on 20 developing countries for the 1970 - 1998 period and found a negative FDI-energy consumption nexus. They attribute this finding to the introduction of modern technologies in the developing countries. Indeed, Using a GMM methodology to analyze the impact of stock market and FDI on energy in 22 emerging economies Sadorsky (2010) finds a positive and statistically significant impact of financial development on energy use but does not find any significant association between FDI and energy use.

Using similar methodology as Sadorsky (2010), Çoban and Topcu (2013) examined the impact of financial development on energy consumption in EU27 countries and found a positive significant effect of FDI on energy consumption. Omri and Kahouli (2014a), to avoid aggregation bias, examined the interrelationships among energy consumption, FDI and economic growth using dynamic panel data models in simultaneous-equations for 65 countries from 1990 to 2011 and show a bi-directional causality between FDI and energy consumption in the middle- and low-income countries, but indicate that the emphasis on environmental protection might have deterred energy-intensive FDI in high-income countries.

Salim and al. (2017) used the ARDL bound test approach to examine the relationship between FDI and energy consumption in China over the period from 1982 to 2012. They found stable relationship among these variable in the long run and a 1% increase in FDI leads to a drop in energy consumption by of 0.21%. However, they show a positive relationship between FDI and energy consumption in the short run. Salim and al. (2017) attribute this finding to the overriding of the scale effect and suggest that China should sustain the inward FDI in the tertiary and energy sectors. Abdouli and Hammami (2017) exploring the causal relationship among economic growth, FDI inflows, and energy consumption in a panel of 12 Middle East and 5 North African countries over the period 1990-2012, find evidence of unidirectional causality from energy consumption to FDI inflows.

We note that the majority of the studies mentioned, assessing the link between FDI and energy consumption, have largely neglected the effect of renewable energy sources on the FDI–energy nexus. Recently, some studies have emerged which have taken into account the role of renewable energy in FDI. Doytch and Naryan (2016) utilized a Blundell–Bond dynamic panel estimator to examine the relationship between FDI flows and both renewable and non-renewable industrial energies in 74 economies over the period from 1985 to 2012. They found that FDI contributes to the reduction of non-renewable energy consumption (halo effect and this outcome is depends of sectoral FDI in host country and income group.

Paramati et al. (2016) investigated the impact of FDI inflows on clean energy consumption in 20 emerging countries for the period from 1991 to 2012. They found a significant positive impact of FDI inflows on clean energy consumption in the long run and a unidirectional causality from the former to the latter in short run.

In a quite recent study, Fan and Hao (2020) tested the nexus among renewable energy consumption, FDI inflows and GDP in 31 Chinese provinces over the 2000-2015 period. They provide a long-term relationship between those variables. In addition, they find that FDI inflows affect positively renewable energy consumption and the granger causality analysis supports the unidirectional causality from the latter to the former. This result corroborates that of Kutan et al. (2018) who showed a positive association between FDI on renewable energy use in the BRICS countries.

After presenting the most important studies on the relationship between different interest variables, we turn in the following section to expose our research methodology by describing the ARDL bootstrap test, and to specify the data as well as the sample of our study.

3. Econometric specification and methodology

3.1.The Bootstrap ARDL test approach

To examine the relationships between GDP, FDI and renewable energy consumption, this study employs bootstrap test statistics from a dynamic single-equation error correction specification of the autoregressive distributed lag (ARDL) model proposed by McNown et al. (2018). Based on the ARDL limit test framework of Pesaran et al (2001), McNown et al. concluded that these tests have an appropriate size and suitable power characteristics. They add a further test on the lagged independent variable(s) with the two tests of Pesaran et al. (2001) to conclude the existence or not of cointegration. Therefore, to distinguish between cointegrated and non-cointegrated degenerate cases, as outlined by Pesaran et al., it is crucial to consider these three tests (Goh et al., 2017).

The bootstrap ARDL test considers a significance test on the coefficients of the lagged explanatory variables to deal with this problem. McNown et al. (2018) performed Monte Carlo simulations and proved that this new test had reasonable size and power characteristics. In general, consider as a dynamic single-equation error-correction specification, the ARDL (p,q_1,q_2,q_3) model can be specified as follows:

$$y_t = c + \sum_{i=1}^{p} \beta_i y_{t-i} + \sum_{j=0}^{q_1} \beta_j x_{t-j} + \sum_{k=0}^{q_2} \beta_k z_{t-k} + \sum_{l=0}^{q_3} \beta_l w_{t-l} + \sum_{m=1}^{r} \beta_m D_{t,m} + e_t \quad (1)$$

where *i*, *j*, *k*,*l* and *m* presents the indices of lags: *i* = *1*, *2*, ..., *p*; *j* = *0*, *1*,...., q_1; *k* = *0*, *1*, ..., q_2; *l* = *1*, *2*,..., q_3; *m* =*1*,*2*,...*r*; *t* = *1*, *2*, ..., *T* stands for time periods; y_t indicates the dependent variable; x_t, z_t and w_t presents the independent variables; $D_{t,m}$ is a dummy variable; β_i are coefficients on the lags of the dependent variable; β_j, β_k and β_l are coefficients on the lags of the independent variables; β_m is the coefficient of the *m*th dummy variable; c is the constant term; and e_t is an error term with a zero mean and a finite variance, σ^2.

Eq. (1) can be re-parameterized and expressed in an error-correction representation in the following way:

$$\Delta y_t = c + \sum_{i=1}^{p-1} \beta_i' \Delta y_{t-i} + \sum_{j=1}^{q_1-1} \beta_j' \Delta x_{t-j} + \sum_{k=1}^{q_2-1} \beta_k' \Delta z_{t-k} + \sum_{l=0}^{q_3-1} \beta'_l w_{t-l} + \sum_{m=1}^{r} \beta_m' D_{t,m} + \quad (2)$$

$$\alpha_1 y_{t-i} + \alpha_2 x_{t-j} + \alpha_3 z_{t-k} + \alpha_4 w_{t-l} + \mu_t$$

Where β_i', β_j', β_k', β'_l and β_m' are functions of the original parameters in Eq. (1), and $\alpha_1 = -(1 - \sum_{i=1}^{p} \beta_i)$; $\alpha_2 = \sum_{j=0}^{q} \beta_j$; $\alpha_3 = \sum_{k=0}^{r} \beta_k$; and $\alpha_4 = \sum_{l=0}^{s} \beta_l$

The derivation of (2) from (1) is the standard renormalization that is used in transforming a vector autoregression in levels in its error correction form.

Eq. (2) will be estimated with a constant term in the unconditional model as:

$$\Delta y_t = \hat{c} + \sum_{i=1}^{p-1} \hat{\beta}_i' \Delta y_{t-i} + \sum_{j=1}^{q_1-1} \hat{\beta}_j' \Delta x_{t-j} + \sum_{k=1}^{q_2-1} \hat{\beta}_k' \Delta z_{t-k} + \sum_{l=0}^{q_3-1} \hat{\beta}'_l w_{t-l} + \quad (3)$$

$$\widehat{\alpha_1} y_{t-i} + \widehat{\alpha_2} x_{t-j} + \widehat{\alpha_3} z_{t-k} + \widehat{\alpha_4} w_{t-l} + \mu_t$$

McNown et al. (2018) propose a cointegration among y_t, x_t, z_t and w_t that requires rejection of all three of the following null hypotheses:

- F_1-test on all error correction terms: H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ against H_1 : any $\alpha_1, \alpha_2, \alpha_3, \alpha_4 \neq 0$;

- F_2-test on lagged independent variables: H_0: $\alpha_2 = \alpha_3 = \alpha_4 = 0$ against H_1 : either $\alpha_2, \alpha_3, \alpha_4 \neq 0$.
- t-test on the lagged dependent variable: $H_0 : \alpha_1 = 0$ against $H_1 : \alpha_1 \neq 0$;

Two degenerate cases can arise. On one hand, degenerate case #1 occurs if the F_1-test and the t-test are significant, but F_2-test is not significant. On the other hand, degenerate case #2 occurs when the F_1-test and the F_2-test are significant, but the t-test is not significant[2].

After testing for the long-run relationship using the bootstrap ARDL, the standard Granger causality test will be used to assess the causality among the variables as follows:

- If no-cointegration is established between y, x, z and w when y is the dependent variable such as in Eq. (1), then the Granger-causality test for x to y should include the lagged differences on x only; that is, we test whether $\hat{\beta}_j' = 0$.
- If cointegration exists among y, x, z and w, then this means the dependent and the independent variables form a stationary linear combination. As a result, the lagged levels can be treated as $I(0)$ (Stock et al., 1990). In this case the Granger causality test for x to y should include the lagged differences on x and the lagged level of x, i.e. we test whether $\hat{\beta}_j' = \widehat{\alpha_1} = 0$.

3.2.Model specification and Data description

The prime objective of this paper is to examine the relationship between growth, FDI and renewable energy consumption. The concept of this association will reveal in the framework of the neoclassical Cobb-Douglas production function, whereas the level of the production is explained by the traditional determinants of economic growth, such as capital and labor. According to the importance of energy use in the production, Apergis and Payane (2009, 2010, 2011) include energy renewable consumption as another factor in the production function. Similarly, other studies (Maji and Odoba, 2011; Khan et al., 2014; Aziz and Mishra, 2016) consider that FDI improves economic growth. Consistent with the mentioned studies, among others, on the determinants of economic growth, we consider, specifically, a Cobb–Douglas type production function as follows:

$$Q = e^{\mu} A(FDI)^{\alpha_1} (RE)^{\alpha_2} K^{\alpha_3} N^{\alpha_4} \quad (4)$$

Where Q refers to the real GDP, A is the total factor productivity, FDI represents the foreign direct investment inflows, RE, is the renewable energy consumption, K is the

[2] For further explanation see McNown et al. (2018)

capital and N is the labor force. The α_1, α_2, α_3 and α_4 represent the output elasticities of foreign direct investment, renewable energy consumption, capital and labor, respectively.

In order to obtain per capita GDP, we divide both sides of Eq. (4) by N. Similarly, we assume that the production function exhibits constant returns to scale. This gives us the following function:

$$\frac{Q}{N} = e^{\mu} A \left(\frac{FDI}{N}\right)^{\alpha_1} \left(\frac{RE}{N}\right)^{\alpha_2} \left(\frac{K}{N}\right)^{\alpha_3} \tag{5}$$

Then, the logarithmic form of Eq. (5) is such that:

$$Ln\left(\frac{Q}{N}\right) = Ln\,(A) + \alpha_1 Ln\left(\frac{FDI}{N}\right) + \alpha_2 Ln\left(\frac{RE}{N}\right) + \alpha_3 Ln\left(\frac{K}{N}\right) + \mu \tag{6}$$

Finally, let $\frac{GDP}{N} = \frac{Q}{N}$ and $\alpha_0 = Ln\,(A)$ we get the following specification:

$$ln\_GDP_{i,t} = \alpha_0 + \alpha_1\, ln\_FDI_{i,t} + \alpha_2\, ln\_RE_{i,t} + \alpha_2\, ln\_K_{i,t} + \mu_{i,t} \tag{7}$$

Where $ln\_GDP_{i,t}$, $ln\_FDI_{i,t}$, $ln\_RE_{i,t}$,*and* $ln\_K_{i,t}$ are GDP, FDI, renewable energy consumption and capital per capita in logarithmic form, respectively. i and t refer to the country and the time, respectively. Eq. (7) is a renormalization of the four error correction terms in Eq. (3), which (y or $ln\_GDP_{i,t}$) is expressed in terms of the other three variables (x or $ln\_FDI_{i,t}$, z or $ln\_RE_{i,t}$ and w or $ln\_K_{i,t}$) and an error term $\varepsilon_{i,t}$ that represent deviations from the long run relationship.

To study this model, annual data covers the period from 1980 to 2017 are used for Algeria, Egypt, Iran, Mauritania, Morocco, Tunisia and Turkey. The period and economies are dictated by the availability of data along with the actual availability of the renewable energy consumption data. Economic growth is measured by GDP per capita (constant 2010 US$). For FDI measure, we use as key variable the FDI net inflows (current US$ (BOP)) adjusted by GDP deflator (constant 2010 US$). The gross fixed capital formation (current US$) adjusted by GDP deflator (constant 2010 US$) is used to measure the capital (K). Renewable energy consumption data cover electricity generation from geothermal, wind, solar, tide and wave, biomass and waste. The population data are used in order to obtain FDI, K, and RE per capita. GDP, FDI, gross fixed capital formation and population are sourced from World Development Indicators (2020) and RE consumption, measured in billion kilowatt hours is sourced from the U.S. Energy Information Administration (2020). All variables are converted into a log form in order to remove heteroscedasticity from the regression model and also to interpret the coefficients as long-term elasticities.

Table 1 displays the compounded annual growth rates of GDP, FDI an RE between 1980 and 2017. It shows that all countries had positive growth rates in all considered variables over the study period. Among the countries, Tunisia recorded the highest growth rate in renewable energy consumption with 8.96%, followed by Algeria and Mauritania with 8.15% and 7.50%, respectively. At the same time, these countries are also posting significant annual GDP growth rates of around 4%. With the exception of Egypt, the annual growth rates of energy consumption converge with those of real GDP in other countries. Roughly, observations indicate that for most of these economies, renewable energy consumption is increasing at about the same rate as GDP (5.33% compared to 4.38%). The annual growth rates of FDI inflows range from 2.41% for Algeria to 15.96% for Turkey. They evolve more than the GDP and renewable energy consumption in the economies with the exception of Algeria, Tunisia and Mauritania.

Table 1

Compound annual growth rates of the variables (percent), 1980-17

	GDP	FDI	RE	K
Algeria	4.15	2.41	8.15	2.79
Egypt	4.63	5.17	1.45	4.86
Iran	2.96	10.24	2.70	1.43
Mauritania	2.67	6.11	7.50	5.52
Morocco	4.82	8.96	3.04	4.44
Tunisia	3.61	2.82	8.96	2.71
Turkey	7.83	15.91	5.50	6.28
Total	4.38	7.38	5.33	4.00

Note: the compound annual growth rates are obtained using non-logarithmic data.

4. Empirical results and discussion

Before beginning the study of the cointegration tests between the variables, it is necessary to analyze, first of all, their stationarity in order to, finally, choose the appropriate cointegration method. The ADF by Dickeyand Fuller (1979) and the PP by Philips and Perron (1988) unit root tests are applied to examine the stationarity of each time series. The results of the stationarity tests in table 2 show that a few series are stationary in levels (I(0)), and the most series are integrated on order one ($I(1)$). However, these results may mislead the choice of method for the cointegration study between variables because of the low power of these traditional tests to study series with structural breaks. For this reason, we apply the LS unit root test by Lee and Strazicich (2003), which has great power in studying the stationarity of the variables in the presence of structural breaks.

Table 2

ADF and PP Unit root tests

Country	Algeriaa		Egypt		Iran		Mauritania	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
LnGDP	-0.401	-0.652	-1.054	-1.698	-0.517	-0.595	-2.365	-2.244
ΔLnGDP	-5.832*	-5.926*	-3.038**	-3.644*	-5.636*	-5.657*	-5.943*	-5.943*
LnFDI	-2.852***	-2.849	-2.048	-4.470*	-1.736	-1.412	-2.516	-2.461
ΔLnFDI	-6.517*	-12.248*	-8.704*	-13.108*	-8.063*	-11.128*	-7.618*	-8.472*
LnRE	3.082	-2.647	-2.511	-2.617	-2.662	-2.620	1.041	1.041
ΔLnRE	-4.758*	-7.139*	-6.811*	-7.149*	-5.716*	-8.128*	-5.571*	-5.589*
LnK	-2.497	-1.063	-1.106	-2.270	-1.598	-1.598	-2.022	-3.307**
ΔLnK	-3.163*	-5.998*	-5.993*	-4.038**	-5.283*	-5.258	-4.234*	-4.173**
Country	**Morocco**		**Tunisia**		**Turkey**			
	ADF	PP	ADF	PP	ADF	PP		
LnGDP	-0.637	-2.252	0.174	0.147	-0.092	-0.027		
ΔLnGDP	-12.835*	-11.723*	-5.851*	-5.869*	-4.657*	-6.547*		
LnFDI	-3.029	-3.397***	-2.439	-2.410	-2.494	-2.589		
ΔLnFDI	-8.631*	-8.631*	-8.358*	-9.225*	-7.855*	-13.702*		
LnRE	-1.884	-2.076	-1.491	-1.392	-1.510	-1.186		
ΔLnRE	-5.060*	-7.796*	-7.105*	-8.277*	-7.710*	9.173*		
LnK	-2.713***	-0.084	-0.750	-1.062	-0.247	0.010		
ΔLnK	-4.557*	-4.557*	-4.170*	-4.173*	-6.624*	-7.140*		

*Notes: *, **, and ***indicate the significance at the 1% , 5%, and 10% levels respectively.*

Table 3 summarizes the results of this test. for all variables, the null hypothesis that they have a unit root is rejected in their first differences when taking into account the presence of two structural breaks in the series. This leads us to conclude that the variables are integrated in order 1 (*I(1)*) for all countries. In summary, all these results (i.e. the ADF, PP, and LS unit root tests results) lead us to estimate ARDL bound test for all countries as this approach is based on the assumption that the variables are *I(0)* or *I(1)*.

Table 3

LS unit root test

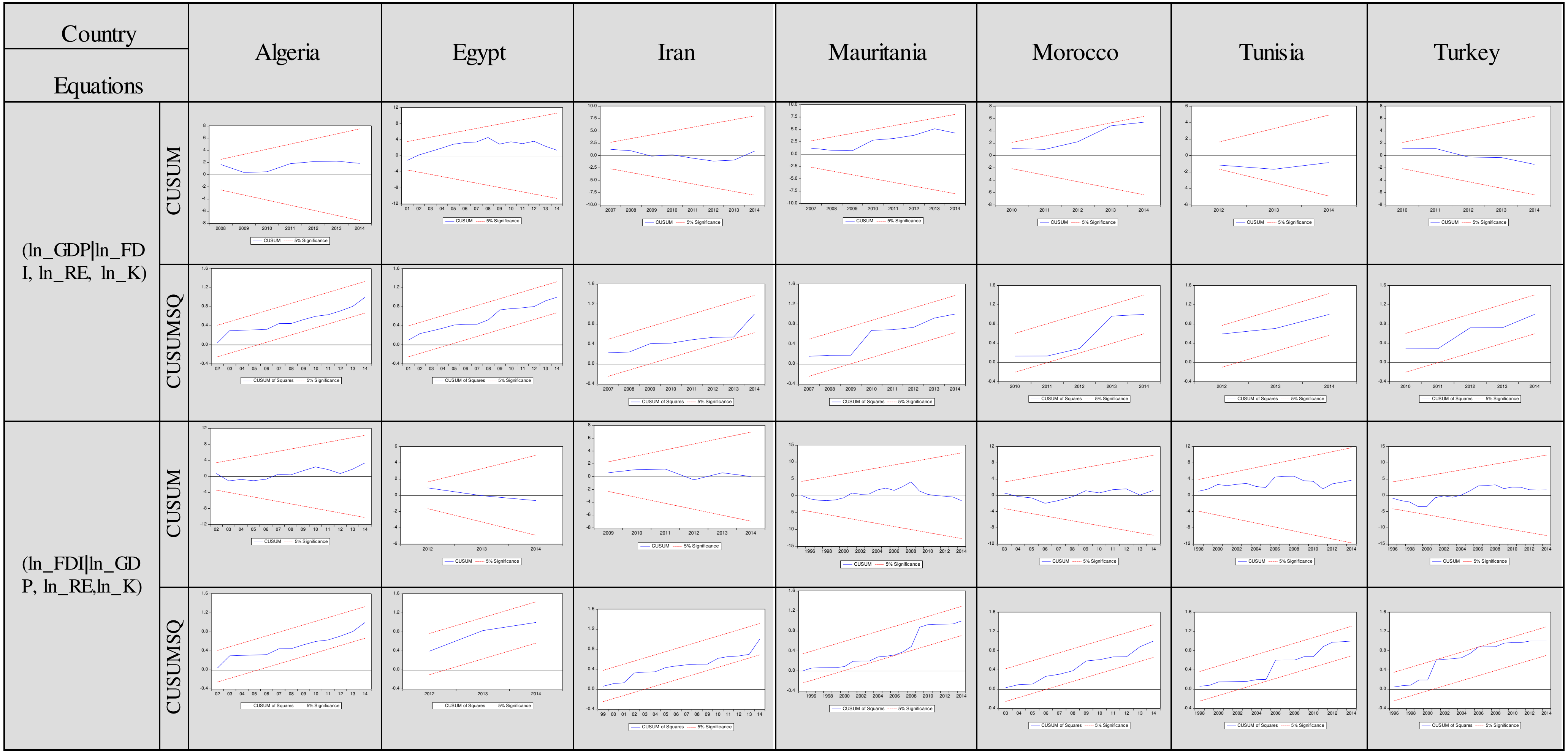
Country	Variable	Y^B_1	Y^B_2	T-statistic	*L*	Country	Variable	Y^B_1	Y^B_2	T-statistic	*L*
Algeria	LnGDP	1990	2009	-1.153	1	Morocco	LnGDP	1991	2000	-4.068	4
	ΔLnGDP	1985	2002	-7.855*	1		ΔLnGDP	1991	2004	-7.797**	1
	LnFDI	1990	1993	-3.047	0		LnFDI	1998	2002	-4.025	2
	ΔLnFDI	1990	1993	-8.162*	0		ΔLnFDI	1990	1992	-8.495*	0
	LnRE	1996	2004	-2.015	1		LnRE	1996	2010	-5.071	2
	ΔLnRE	1988	1995	-6.614*	1		ΔLnRE	1990	1993	-8.303*	1
	LnK	1986	1990	-2.005	2		LnK	1992	2005	-5.190	4
	ΔLnK	1990	2004	-7.755*	1		ΔLnK	2001	2011	-8.216*	6
Egypt	LnGDP	1983	1990	-3.400	1	Tunisia	LnGDP	1990	2006	-4.610	0
	ΔLnGDP	1989	1998	-7.427*	4		ΔLnGDP	1988	2011	-7.735*	0
	LnFDI	2002	2010	-5.573	1		LnFDI	1990	2013	-5.411	4
	ΔLnFDI	1991	2005	-8.395*	0		ΔLnFDI	1989	1994	-8.579*	0
	LnRE	1985	1999	-5.237	0		LnRE	1986	2013	-4.736	1
	ΔLnRE	1998	2001	-6.818**	1		ΔLnRE	1983	2011	-7.530*	0
	LnK	1990	1992	-3.864	3		LnK	1990	2012	-4.837	2
	ΔLnK	1990	1994	-5.358*	0		ΔLnK	1989	2012	-6.726**	3
Iran	LnGDP	1992	2001	-1.701	4	Turkey	LnGDP	1992	2005	-4.357	2
	ΔLnGDP	1995	2006	-4.496*	5		ΔLnGDP	1999	2010	-8.853*	7
	LnFDI	1989	2001	-2.697	5		LnFDI	1992	2008	-3.754	0
	ΔLnFDI	1986	1988	-5.692*	0		ΔLnFDI	1990	1995	-4.766**	0
	LnRE	2002	2008	-5.453	1		LnRE	1993	1999	-4.197	2
	ΔLnRE	1993	2006	-9.031*	7		ΔLnRE	1985	1989	-7.807*	0
	LnK	1990	1995	-2.085	3		LnK	1998	2003	-3.954	1
	ΔLnK	1990	1994	-6.747**	6		ΔLnK	1990	1995	-6.249*	0
Mauritania	LnGDP	1995	2004	-4.478	2						
	ΔLnGDP	1990	1994	-5.627*	0						
	LnFDI	1990	1998	-3.859	0						
	ΔLnFDI	1990	1992	-6.798*	0						
	LnRE	1986	2008	-3.370	2						
	ΔLnRE	1986	2006	-6.452**	0						
	LnK	1988	2007	-3.624	1						
	ΔLnK	1995	2005	-5.367*	6						

*Notes: * and ** indicates the statistical significance at the 1 and 5% levels respectively.* Y^B_1 and Y^B_2 are the times of structural break. L is the optimal lag.

As described in the previous section, to analyze the long-run relationship interactions among the variables of interest (GDP, FDI, RE), the new bootstrap ARDL tests are used. Table 4 reports the estimates and tests of this technique. In keeping with the recognition that all three variables can be considered endogenous and that the bootstrap test allows this kind of endogeneity, we renormalize the ARDL equation in order to treat each of the three series (GDP, FDI, or RE) as the dependent variable. Each country's equation presents their dummy variables which is added to capture shocks as the data show unexpected peaks and drops, as an example, the sudden stop of FDI, the financial crisis, the crude oil price shocks, etc. The optimal lag lengths are determined using the Akaike Information Criterion (AIC). All estimated equations have passed diagnostic tests (Table 4) such as: i) the Ljung-Box Q-test for residual autocorrelation[3]; the Jarque-Bera (J-B) test to check normality; ii) the L-M test for autocorrelation; and iii) the Breusch-Pagan-Godfrey (H) test to check the heteroscedasticity of the residuals. In addition, the CUSUM and the CUSUMSQ are applied to examine the stability of long run estimates (Fig. 5). Based on the critical values generated from the bootstrap technique proposed by McNown et al. (2018), we can conclude whether or not there is cointegration between the variables by comparing the empirical estimation results to these critical values $(F_1^*, F_2^* \; and \; t^*)$ at the 5% significance level.

[3] These results are not reported for the sake of space but are available from the author upon request.

Figure 3: Stability test showing CUSUM and CUSUM of squares



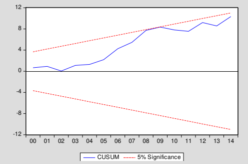
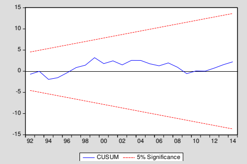
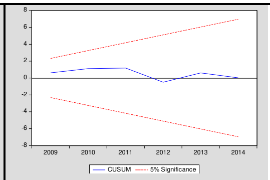
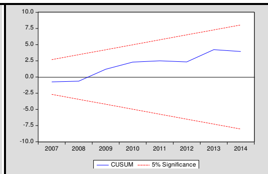
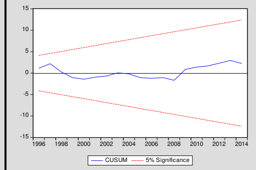
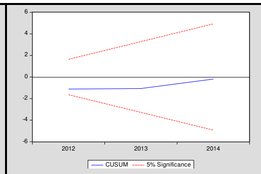
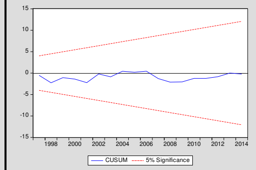
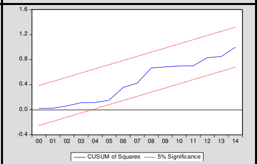
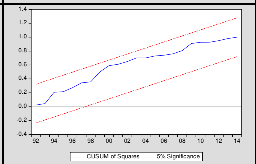
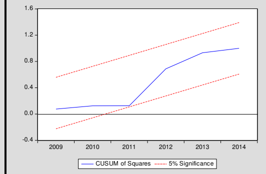
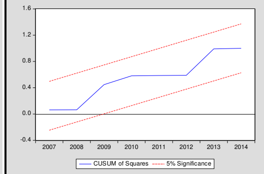
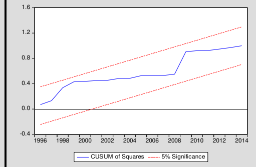
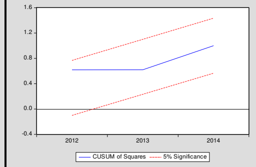
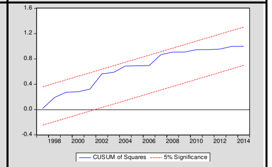
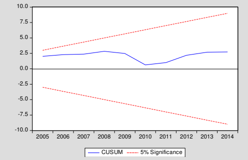
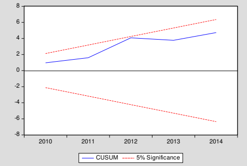
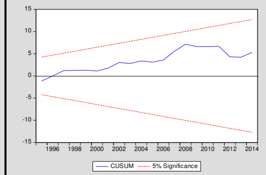
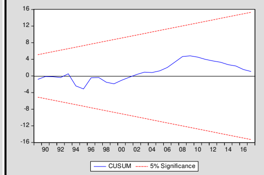
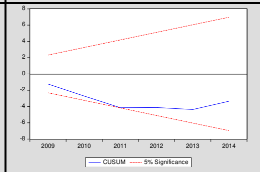
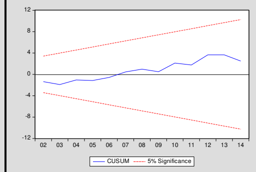
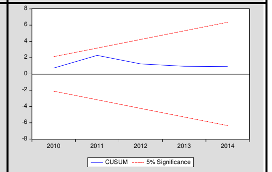
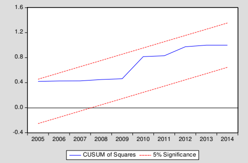
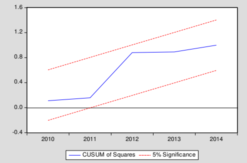
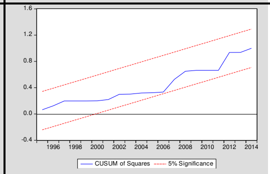
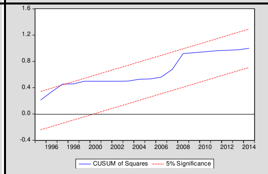
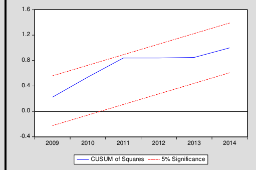
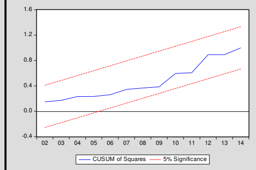
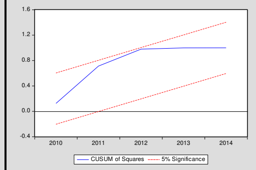
(ln_RE|ln_GDP , ln_FDI, ln_K	CUSUM							
	CUSUMSQ							
(ln_K|ln_GDP, ln_FDI, ln_RE)	CUSUM							
	CUSUMSQ							

Table 4

BARDL test analysis

	Dependent variable | Independent variables	Lag-Specification	F_1	F_1^*	F_2	F_2^*	t	t^*	Dummy Variables	Co-integration Status	Diagnostic analyzes		
											J-B	L-M	H
Algeria	(ln_GDP|ln_FDI, ln_RE, ln_K)	(4,4,3,0)	7.990	4.069	9.984	4.347	-4.158	-2.578	D91, D07	**Cointegration**	1.197	0.480	0.852
	(ln_FDI|ln_GDP, ln_RE,ln_K)	(0,0,1,4)	10.184	4.856	7.272	4.518	-6.136	-3.072	D93,D01	**Cointegration**	0.253	1.217	2.514
	(ln_RE|ln_GDP, ln_FDI, ln_K)	(0,4,1,3)	5.497	3.763	6.595	3.857	-3.117	-2.720	D90,D99	**Cointegration**	1.334	0.203	0.361
	(ln_K|ln_GDP, ln_FDI, ln_RE)	(1,1,0,1)	2.923	3.772	3.354	3.466	-2.036	-2.682	D90, D04	No-cointegration	7.186	0.774	1.066
Egypt	(ln_GDP|ln_FDI, ln_RE, ln_K)	(0,0,4,2)	6.871	2.894	8.854	3.123	3.193	-1.775	D00	**Cointegration**	0.574	1.175	0.696
	(ln_FDI|ln_GDP, ln_RE,ln_K)	(0,1,4,0)	19.874	4.061	5.367	4.394	-8.042	-2.826	D91,D11	**Cointegration**	0.471	0.165	1.835
	(ln_RE|ln_GDP, ln_FDI, ln_K)	(0,1,0,0)	5.030	4.313	2.071	3.684	-3.739	-3.270	D85,D91	Degenerate #1	1.504	2.440	0.693
	(ln_K|ln_GDP, ln_FDI, ln_RE)	(2,2,0,0)	4.484	3.813	5.150	3.276	-3.616	-2.818	D98, D09	**Cointegration**	1.065	0.384	0.403
Iran	(ln_GDP|ln_FDI, ln_RE, ln_K)	(4,1,3,0)	10.163	4.288	13.520	4.315	-2.182	-2.452	D91, D06	Degenerate #2	3.702	2.604	0.233
	(ln_FDI|ln_GDP, ln_RE,ln_K)	(1,3,1,2)	4.719	4.081	4.702	3.861	-2.745	-2.630	D88,D98	**Cointegration**	3.585	0.367	1.013
	(ln_RE|ln_GDP, ln_FDI, ln_K)	(0,1,0,3)	5.219	3.506	6.787	3.392	-2.072	-2.646	D02, D08	Degenerate #2	0.396	0.546	0.837
	(ln_K|ln_GDP, ln_FDI, ln_RE)	(1,1,2,0)	5.622	3.916	4.541	3.302	-0.520	-2.740	D88, D94	Degenerate #1	0.618	1.488	0.489
Mauritania	(ln_GDP|ln_FDI, ln_RE, ln_K)	(3,3,3,2)	13.785	3.973	13.761	3.814	-6.619	-2.166	D94, D06	**Cointegration**	4.492	0.014	0.464
	(ln_FDI|ln_GDP, ln_RE,ln_K)	(0,3,0,2)	4.488	4.216	4.386	4.561	-4.291	-3.330	D91	Degenerate#1	0.748	0.059	1.793

	(ln_RE|ln_GDP, ln_FDI, ln_K)	(0,2,0,1)	6.490	4.025	8.407	3.531	-2.901	-2.590	D86, D06	**Cointegration**	1.821	0.563	0.528
	(ln_K|ln_GDP, ln_FDI, ln_RE)	(1,1,0,0)	6.721	3.980	3.405	3.671	-4.849	-2.561	D94	Degenerate #1	0.216	0.283	2.034

Table 4 (continued)

Morocco	(ln_GDP|ln_FDI, ln_RE, ln_K)	(2,1,2,4)	9.656	3.505	12.540	3.789	-2.954	-1.829	D04,D09	**Cointegration**	0.301	1.942	0.781
	(ln_FDI|ln_GDP, ln_RE,ln_K)	(3,3,4,1)	7.746	3.952	5.441	4.179	-4.979	-2.055	D90,D92	**Cointegration**	0.452	1.119	0.880
	(ln_RE|ln_GDP, ln_FDI, ln_K)	(1,1,0,3)	5.402	3.670	4.860	3.163	-4.072	-1.980	D89, D93	**Cointegration**	0.018	0.669	0.814
	(ln_K|ln_GDP, ln_FDI, ln_RE)	(3,4,0,4)	4.436	3.339	3.722	3.644	-0.879	-1.763	D08	Degenerate #2	0.417	0.322	0.551
Tunisia	(ln_GDP|ln_FDI, ln_RE, ln_K)	(3,0,3,4)	3.627	3.279	3.990	3.574	3.261	-1.954	D98,D11	**Cointegration**	0.845	0.436	0.674
	(ln_FDI|ln_GDP, ln_RE,ln_K)	(0,2,2,3)	7.991	3.703	5.143	3.671	-4.950	-2.722	D89, D94	**Cointegration**	0.275	0.335	0.464
	(ln_RE|ln_GDP, ln_FDI, ln_K)	(0,0,1,1)	10.308	4.362	12.493	3.257	-5.787	-3.075	D85, D11	**Cointegration**	0.958	0.891	1.937
	(ln_K|ln_GDP, ln_FDI, ln_RE)	(3,4,1,3)	14.338	3.700	19.097	3.453	-4.089	-2.171	D89	**Cointegration**	0.381	0.503	0.678
Turkey	(ln_GDP|ln_FDI, ln_RE, ln_K)	(0,1,2,0)	3.489	3.189	4.632	3.424	-2.047	-2.445	D94, D09	Degenerate #2	0.670	0.120	0.623
	(ln_FDI|ln_GDP, ln_RE,ln_K)	(0,3,0,1)	5.564	3.836	4.460	3.792	-3.183	-2.861	D88, D95	**Cointegration**	0.133	0.302	1.289
	(ln_RE|ln_GDP, ln_FDI, ln_K)	(0,0,4,2)	4.786	3.740	3.342	3.736	-2.723	-2.845	D89	Degenerate #1	1.228	0.581	1.990
	(ln_K|ln_GDP, ln_FDI, ln_RE)	(3,4,0,0)	5.166	3.574	5.652	3.854	-1.480	-2.320	D93,D09	Degenerate #2	2.769	0.076	1.217

Note: - F_1 is statistic *for the coefficients* of the lagged dependent variable *[y(-1), x(-1), z(-1) and w(-1)];*

- F_2 is statistic *for the coefficients* of the lagged independent variable *[y(-1), x(-1), z(-1) and w(-1)];*
- t is statistic *for the coefficients* of the lagged dependent variable *[y(-1), x(-1), z(-1) and w(-1)];*
- *D## indicates the dummy year (for example, D92 and D08 for the year 1992 and 2008, respectively);*
- F_1^*, F_2^* *and* t^* *are the bootstrapped critical values.*

Test statistics (F_1, F_2, and t) and their relatively critical values (F^*_1, F^*_2 and t^*) at 5% level of Eq. (3) are summarized in Table 4. The existence of a long-term relationship in the model is not limited to the significance of the coefficients at the lagged level of the three variables. (i.e., the rejection of the hypothesis of the F_1-test ($F_1 > F^*_1$)). The presence of cointegration is supported by the significance of this test, the significance of the coefficients on the three lagged levels of the explanatory variables (i.e., $F_2 > F^*_2$) and also the significance of the coefficient on the lagged level of the dependent variable ($t < t^*$).

However, the significance of both F_1 and F_2-tests alone is not sufficient to establish the existence of the long-run relationship among variables without the significance of the coefficient on the lagged level of the dependent variable. This case is appeared in Turkey and Iran when GDP is the dependent variable and in Iran when RE is the dependent variable. Both equations show significance for F_1 and F_2-tests but the t statistic on lagged RE and on lagged FDI is not significant. These two cases presented the example of degenerate case #2. In addition to these two cases mentioned above, another case may arise. Known as degenerate case #1, it has occurred only with the significance of the F_1 and t-tests. For example, it's occurred in Egypt and Turkey when RE is the dependent variable and in Mauritania when the FDI is the dependent variable.

In summarizing, to confirm the existence of cointegration, i.e., a long-run relationship with a particular choice of dependent variable in the ARDL model, all three test statistics (F_1, F_2, and t) must be significant. Table 4 shows that cointegration is established in all economies except Iran and Turkey, where all the tests are significant at the 5% level, when the GDP is the dependent variable and FDI, RE, and K are the independent variables. This implies that either FDI, RE or K is an important long run determinant of GDP per capita in these economies. This result is surprising if we compare it with previous studies in terms of the existence of integration between these variables when GDP is the dependent variable. However, the evidence of the non-existence of a long-term relationship between these variables may be due to the failure to take into account the effects of structural breaks. In this sense, our result, supported by the ARDL Bootstrap test, avoids spurious evidence concerning the relationship between these variables.

For the causality analysis, as shown in table 5 and Fig.2, we find short run Granger causality from RE to GDP for all economies except Turkey. This result reveals the growth hypothesis; according to which the renewable energy contributes to GDP per capita for these economies in the short run. In this situation, renewable energy is considered one of the main factors of production alongside labor and the capital, and an increase in the renewable energy consumption may lead to the increase in economic growth in these economies. This evidence is similar to some studies, such as Ben-Salha and Sebri's (2014) and Ben Mbarek et al.'s (2018) for Tunisia; Ibrahiem's (2015) for Egypt; and Dees's (2018) for Morocco; in which they found causality running from renewable energy consumption to economic growth in Bulgaria. While, differ to those of to those of Dogan's (2015) for Turkey and Farhani (2013) for the selected MENA countries; which supported the neutrality hypothesis. Moreover, our result is not in line with Ocal and Aslan (2013) who supported the conservation hypothesis for Turkey.

Similarly, there is evidence for Granger causality running from FDI to GDP for all economies. This evidence is consistent with Seyoum et al. (2015) who found a one way causality running from FDI to GDP in Egypt and Mauritania. Same result was founded by Kalai and Zidi (2017) for all the selected MENA countries. This implies that FDI contributes to GDP per capita for these economies which allows as accepting the FDI-led growth hypothesis in these economies in the short run.

Table 5

Granger-causality analysis

	Dependent variable				
		$ln\_GDP_{t-1}, \Delta ln\_GDP_t$	$ln\_FDI_{t-1}, \Delta ln\_FDI_t$	$ln\_RE_{t-1}, \Delta ln\_RE_t$	$ln\_K_{t-1}, \Delta ln\_K_t$
		F or t statistic [p-value]			
Algeria	Δln_GDP_t	-	2.276*** [0.069]	5.609* [0.008]	4.404*[0.000]
	Δln_FDI_t	37.660* [0.000]	-	5.388** [0.014]	6.343*[0.001]
	Δln_RE_t	1.293 [0.318]	8.218* [0.003]	-	2.045 [0.139]
	Δln_K_t	**5.379** [0.026]**	-	**2.321** [0.029]**	-
Egypt	Δln_GDP_t	-	4.115* [0.000]	2.324*** [0.085]	11.436*[0.000]
	Δln_FDI_t	3.763** [0.043]	-	4.428*[0.007]	0.522 [0.479]
	Δln_RE_t	**2.700** [0.012]**	-	-	-
	Δln_K_t	3.566** [0.031]	1.115 [0.277]	0.820 [0.421]	-
Iran	Δln_GDP_t	-	**10.195* [0.006]**	**6.033* [0.006]**	-
	Δln_FDI_t	6.114* [0.003]	-	5.560** [0.013]	6.422* [0.034]
	Δln_RE_t	**2.995*** [0.098]**	-	-	**3.511** [0.000]**
	Δln_K_t	**4.789* [0.000]**	**6.883* [0.005]**	-	-
Mauritania	Δln_GDP_t	-	5.355* [0. 009]	8.743* [0. 001]	6.420* [0.006]
	Δln_FDI_t	**4.470** [0.014]**	-	-	**4.048** [0. 033]**
	Δln_RE_t	3.369** [0.036]	3.114* [0.005]	-	5.705** [0.010]
	Δln_K_t	**3.710*** [0. 065]**	-	-	-
Morocco	Δln_GDP_t	-	3.580*** [0.055]	6.859* [0.004]	5.225* [0.006]
	Δln_FDI_t	2.605*** [0.089]	-	5.538* [0.007]	5.660** [0.018]
	Δln_RE_t	7.950* [0.003]	0.002 [0.961]	-	-
	Δln_K_t	**4.888** [0.012]**	-	**4.562** [0.016]**	-
Tunisia	Δln_GDP_t	-	2.322** [0.037]	3.320** [0.044]	3.827** [0.023]
	Δln_FDI_t	5.444* [0.008]	-	1.680 [0.208]	2.151*** [0.071]
	Δln_RE_t	2.552** [0.017	8.805* [0.001]	-	9.791* [0.000]
	Δln_K_t	13.907* [0.000]	2.129 [0.158]	6.686* [0.003]	-
Turkey	Δln_GDP_t	-	**4.100*** [0.055]**	**1.919 [0.170]**	-
	Δln_FDI_t	4.059** [0.014]	-	-	6.844* [0.005]
	Δln_RE_t	-	**3.353** [0.032]**	-	**1.574 [0.234]**
	Δln_K_t	**7.041* [0.001]**	-	-	-

*Notes: [.] are refers to the p-value. Bold value represents the non-existence of co-integration. *, **, and ***indicate the significance at the 1% , 5%, and 10% levels respectively.*

When FDI is the dependent variable and GDP, RE and K are explanatory variables, the significance of all tests is verified in all countries except Mauritania, indicating the existence of a long-run relationship between FDI and the explanatory variables for these economies. This suggests that either GDP or RE or K does not determine FDI of these economies in the long run. The short run Granger causality tests indicate that GDP causes FDI in all economies, which implies that strong economic growth leads to high FDI inflows. This result is consistent with the findings of Goh et al. (2017) which show only five of eleven Asian economies exhibiting unidirectional short-run causality from GDP to FDI. Goh et al. (2017) return this result to the fact that FDI may take place in these economies because its growth prospects have made it more attractive to foreign investors. Also, Herzer et al. (2008) found this direction of causality only in three economies (Indonesia, Ghana and Tunisia)[4] in a sample of 28 developing economies. This is the reverse of the conventional view which suggests that the direction of causality runs from FDI to economic growth by sees FDI as an important driver of economic growth. Therefore, based on the overall results on the causality between economic growth and FDI inflows, we would conclude that there is a two-way causality between these variables that corroborates those of Omri and Kahouli (2014b) and Kahia et al. (2019) for MENA countries.

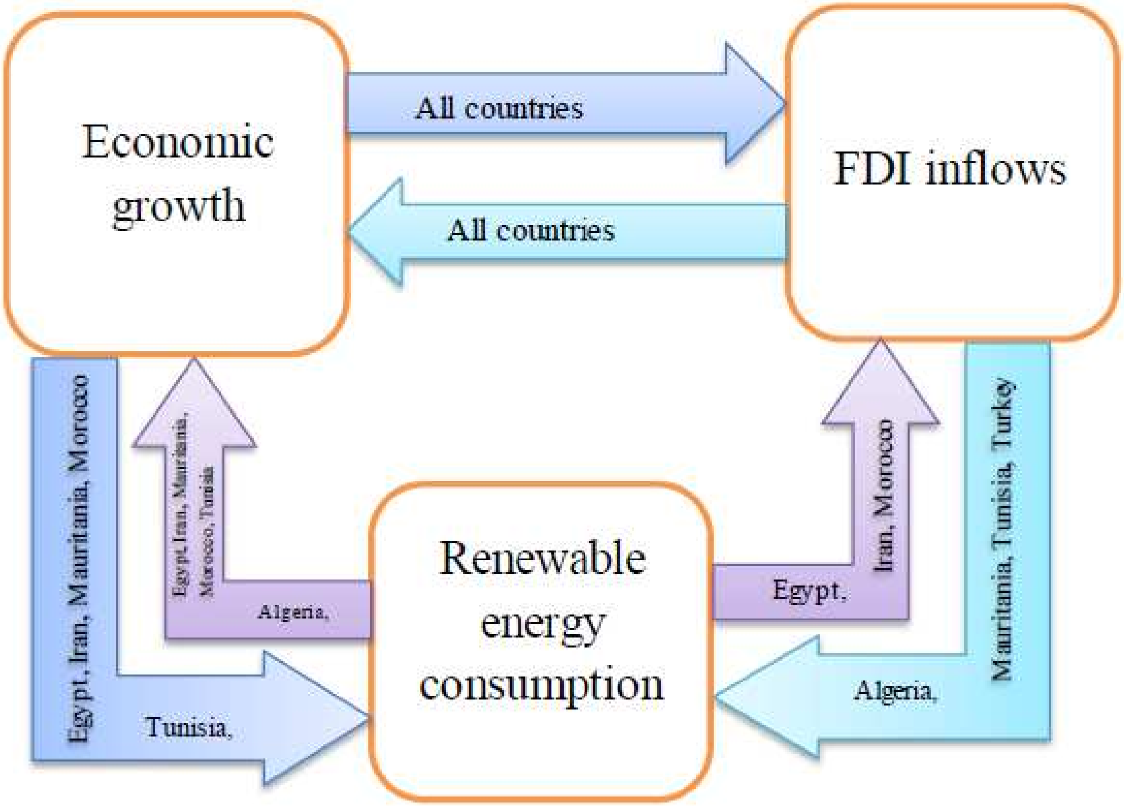
Similarly, we find short run Granger causality from RE to FDI (table 5 and Fig.3) for all economies except Mauritania, Tunisia, and Turkey which indicate that the RE is an important short-run determinant in promoting the FDI in these countries. This indicates that any strategy aimed to reduce renewable energy consumption (i.e., a renewable energy conservation policy) will stop FDI inflows.

Table 4 showed a long-run relationship only for Algeria, Mauritania, Morocco, and Tunisia when RE is the dependent variable. When the RE is used as the dependent variables and GDP, FDI and K are explanatory variables in these economies; all the three test statistics (F_1, F_2, and t) are significant in 5% level significance. This implies that either GDP or FDI or K is an important long run determinant of renewable energy consumption in these four economies. The short run Granger causality was found from GDP to RE for, Egypt, Iran, Mauritania, Morocco, and Tunisia. This suggests that political energy

[4] This is consistent with our finding for Tunisia.

conservation resulting in a reduction of renewable energy consumption does not have a negative impact on GDP per capita in these six economies. Evidence that economic growth causes renewable energy consumption is found in a few studies (Sardosky, 2009; Ocal and Aslan, 2013; Long et al., 2015; Omri et al., 2015; Alper and Oguz, 2016; Mbarek et al., 2017). Similarly, there is an evidence for Granger causality running from FDI to RE for four countries (Algeria, Mauritania, Tunisia, and Turkey) suggest that the FDI constitute an important short run explanatory variable of renewable energy consumption in these economies. This implies that any change in FDI flows will affect the consumption of renewable energy in these countries.

Fig. 3. the Granger Causality direction



5. Conclusion and policy implication

This paper has examined the empirical cointegration and the short-run causal relationships among economic growth, foreign direct investment and renewable energy consumption in the case of MENA economies over the period of 1980–2017. There is some thought that encouraging inward FDI constitute a source of finance that enhance economic growth and promote financial development specifically in host countries. On the other hand, many believe that FDI can be a source of innovation that promotes energy efficiency. Around these opinions and according to the view that renewable energy consumption can play a major role in boosting countries' economic growth, we expect the existence of a long run relationship among these variables and exceptionally when the proxy's variable for economic growth /or financial development is the dependent variable. We have applied a newly developed cointegration test, the bootstrap ARDL, to examine this long-run relationship between FDI, renewable energy consumption, and GDP in MENA economies.

Empirically, when GDP per capita is the dependent variable, we found evidence of cointegtation for all economies except Iran and Turkey, indicating that the foreign direct investment and the renewable energy consumption with the capital are among the main factors of economic growth in these economies, in the long term. In addition, we found evidence of cointegration for all the countries except Mauritania when FDI is the dependent variable. This implies that economic growth and benefits experienced by these economies in terms of growth in the use of renewable energy are a vital factor to attract foreign direct investment. Results that can motivate economists and policymakers to encourage countries to become more involve in renewable energy investment. Furthermore, our study finds evidence of cointegration for Alger, Mauritanioa, Morocco, and Tunisia when RE is the dependent variable. For these economies, GDP and FDI constitute important long run determinant of renewable energy consumption.

The short run Granger-causality analysis reveals that the bidirectional relations between GDP and FDI apply in all selected MENA countries. This two-way relationship means, on the one hand, that foreign direct investment can stimulate economic growth in MENA economies. On the other hand, economic growth can also encourage foreign direct investment because some domestic benefits can be enhanced through government policies. For the nexus of FDI and renewable Energy, our study found varied nature of the direction of causality. It shows a bidirectional relationship between these variables for Algeria, Mauritania, and Tunisia where improvements in renewable energy consumption lead to the encouragement of FDI inflows while the latter also contribute to promote renewable energy. For Egypt, Iran, and Morocco, we found a one-way causal direction of renewable energy consumption to FDI inflows, meaning that changes in renewable energy will influence FDI inflows while not vice versa. For the case of Turkey, the unidirectional causality running from FDI to renewable energy consumption implies that FDI inflow is crucial of renewable energy development in this country. Concerning the causality between economic growth and renewable energy consumption our finding supports a feedback hypothesis for five economies that are Egypt, Iran, Mauritania, Morocco, and Tunisia, while the growth and the neutral hypotheses are supported only for Algeria and Turkey, respectively. This result does indicate that renewable energy use contributes to economic growth advancement and vice versa.

In light of the above-mentioned results, an important number of policy implications could be straightforwardly drawn. First, the feedback causality between FDI inflows and economic growth implies that higher levels of the former mean higher levels of the latter and vice versa, and hence, in order to improve economic performance, policymakers in these economies should continue to support FDI by discovering their own benefits and provide better investment environments for foreign firms. Second, The short-run impact and the presence of the long-run dependence of FDI on renewable energy; and vice versa for some MENA economies, implicates two principal things: on one hand that strategy implemented to push the use of renewable energy will have a positive effect on foreign direct investment; on another hand, the positive impact on foreign direct investment from the utilization of renewable energy further speeds up the progress of the renewable energy sector. As pointed out by Amri (2016), policy makers should give importance still for renewable energy resources development since it has a vital role to attract foreign direct investment. In addition, MENA countries should pay more attention to guiding and spur foreign investment in renewable energy domain.

Finally, the interrelationship among economic growth and renewable energy consumption emphasize that this type of energy source is important for economic growth and at the same time, economic growth encourages the use of more renewable energy source. The causality found provides an avenue to continue the use of government policies that enhance the development of the renewable energy sector (Apergis and Danuletu, 2014). Again, given the natural characteristics of the Middle East and North Africa region, the expansion of the renewable energy sector may serve as an impetus for the modernization of the energy sector in meeting sustainability goals specified by policy makers (Kaygusuz, 2007). As pointed out by Apergis and Danuletiu (2014), generating resource needs for R&D in renewable energy technologies and corresponding infrastructure, require economic growth in order to facilitate expansion of the renewable energy sector. Furthermore, policy makers should encourage private investment in this area, provide adequate infrastructure for networks, and facilitate access to the vast areas needed to implement projects.

References

Abdouli, M., Hammami, S., (2017). Exploring Links between FDI Inflows, Energy Consumption, and Economic Growth: Further Evidence from MENA Countries. Journal of Economic Development 42 (1), 95-117.

Adams, S., 2009. "Foreign direct investment, domestic investment, and economic growth in Sub-Saharan Africa. J. Pol. Model. 31 (6), 939-949.

Aghahosseini, A., Bogdanov, D., Breyer, C., (2020). Towards sustainable development in the MENA region: Analysing the feasibility of a 100% renewable electricity system in 2030. Energy Strategy Reviews 28, 100466.

Aitken, B.J., Harrison, A.E., (1999). Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela. American Economic Review 89(3), 605-618.

Alper, A., Oguz, O., (2016). The role of renewable energy consumption in economic growth: evidence from asymmetric causality. Renewable and Sustainable Energy Review 60, 953-959.

Amri, F., (2016). The relationship amongst energy consumption, foreign direct investment and output in developed and developing Countries. Renewable and Sustainable Energy Review 64 (C), 694-702.

Apergis, N., Danuletiu, D.C., (2014). Renewable Energy and Economic Growth: Evidence from the Sign of Panel Long-Run Causality. International Journal of Energy Economics and Policy 4 (4), 578-587.

Apergis, N., Payne, J.E., (2009). Energy consumption and economic growth in Central America: evidence from a panel cointegration and error correction model. *Energy Economics* 31, 211-216.

Apergis, N., Payne, J.E., (2010). Renewable energy consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy* 38 (1), 656–60.

Apergis, N., Payne, J.E., (2011). The renewable energy consumption-growth nexus in Central America. Applied Energy 88 (1), 343-347.

Aslan, A., Ocal, O., (2016). The role of renewable energy consumption in economic growth: Evidence from asymmetric causality. Renewable and Sustainable Energy Review 60, 953-959.

Aziz, O.G., Mishra, AV., (2016). Determinants of FDI inflows to Arab economies. *Journal of International Trade and Economic Development* 25 (3), 325-356.

Azman-Saini W.N.W., Law, S.H., Ahmad, A.H., (2010). FDI and economic growth: new evidence on the role of financial markets, Econ. Lett. 107 (2), 211-213.

Bajo-Rubio, O., Díaz-Mora, C., & Díaz-Roldán, C., (2010). Foreign Direct Investment and Regional Growth: An Analysis of the Spanish Case. Regional Studies 44(3), 373-382.

Belaïd, F., Youssef, M., (2017). Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: assessing the evidence from Algeria. Energy Policy 102, 277-287.

Belloumi, M., (2014). The relationship between trade, FDI and economic growth in Tunisia: An application of the autoregressive distributed lag model. Economic Systems 38(2), 269-287.

Ben Mbarek, M., Saidi, K., Rahman, M.M.,(2018). Renewable and non-renewable energy consumption, environmental degradation and economic growth in Tunisia. Qual. Quant. 52, 1105–1119

Ben-Salha, O., Sebri, M. (2014). A Multivariate Analysis of the Causal Flow between Renewable Energy Consumption and GDP in Tunisia. *Economics Bulletin* 34(4), 2396–2410.

Bentil, A.M., Adom, P.K., (2020). Renewable Energy—Economic Growth Nexus: Addressing Potential Issues of Endogeneity and the Precision of the Long-Run Relationship. In: Shahbaz M., Balsalobre-Lorente D. (eds), Econometrics of Green Energy Handbook. Springer, Cham, pp 263-290. https://doi.org/10.1007/978-3-030-46847-7_13

Borensztein, E., Jose, D.G., Jong, W.L., (1998). How does foreign direct affect economic growth. Journal of International Economics 45 (1), 115–135.

Brunnschweiler, C., (2010). Finance for renewable energy: An empirical analysis of developing and transition economies. Environment and Development Economics 15(3), 241-274.

Cai, W., Wang, C., Chen, J., Wang, S, (2011. Green economy and green jobs: Myth or reality? The case of China's power generation sector. Energy 36, 5594–6003.

Caves, R.E., (1971). International corporations: the industrial economics of foreign investment. Economica 38 (149), 1–27.

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

Choe, J.I., (2003. Do foreign direct investment and gross domestic investment promote economic growth? Review of Development Economics 7, 44–57.

Chowdhury, A., Mavrotas, G., (2006). FDI and Growth: What Causes what? The World Economy 29 (1), 9-19.

Dalia, M.I., (2015). Renewable Electricity Consumption, Foreign Direct Investment and Economic Growth in Egypt: An ARDL Approach. Procedia Economics and Finance 30, 313-323.

De Mello, L.R., Luiz, R.J. (1999). Foreign direct investment-led growth: evidence from time series and panel data. Oxford Economic Papers 51 (1), 133–151.

Dees, P., Auktor, G.V., (2018). Renewable energy and economic growth in the MENA region: empirical evidence and policy implications. Middle East Development Journal 10 (2), 225-247.

Dogan, E., (2015). The relationship between economic growth and electricity consumption from renewable and non-renewable sources: A study of Turkey. Renewable and Sustainable Energy Review 52, 534–546.

Doytch, N., Narayan, S., (2016). Does FDI influence renewable energy consumption? An analysis of sectoral FDI impact on renewable and non-renewable industrial energy consumption. Energy Economics 54, 291-301.

Eren, B.M., Taspinar, N., Gokmenoglu, K.K., (2019). The impact of financial development and economic growth on renewable energy consumption: Empirical analysis of India. Science of The Total Environment 663, 189-197.

Fan, W., Hao, Y., (2020). An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China. Renewable Energy 146, 598-609.

Farhani, S., (2013). Renewable Energy Consumption, Economic Growth and CO2 Emissions: Evidence from Selected MENA Countries. Energy Economics Letters 1(2), 24-41.

Findlay, R., (1978). Relative backwardness, direct foreign investment and the transfer of technology: a simple dynamic model. Quartely Journal of Economics 92 (1), 1–16.

Ghazouani, T., Boukhatem, J., Sam, C.Y., (2020. Causal interactions between trade openness, renewable electricity consumption, and economic growth in Asia-Pacific countries: Fresh evidence from a bootstrap ARDL approach. Renewable and Sustainable Energy Reviews, 133,110094.

Goh, S.K., McNown, R., (2015). Examining the exchange rate-regime monetary policy autonomy nexus: Evidence from Malaysia. International Review of Economic and Finance 35, 292-303.

Goh, S.K., Sam, C.Y., McNown, R., (2017). Re-examining foreign direct investment, exports, and economic growth in Asian economies using a bootstrap ARDL test for cointegration. Journal of Asian Economics 51 (C), 12-22.

Gruben, W.C.,Darryl, M.L., (1998). Capital flows, savings, and growth in the 1990s. The Quaterly Review of Economics and Finance 38 (3), 287–301.

Hanson, H., Rand, J. (2006). On the causal links between FDI and growth in developing countries. The World Economy 29, 21–41.

Herzer, D., Klasen, S., Nowak-Lehmann, D.F. (2008). In search of FDI-led growth in developing countries: The way forward. Economic Modeling 25 (5), 793-810.

Hymer, S., (1976). The International Operations of National Firms: A Study of Direct Foreign Investment. Cambridge. MA: Massachusetts Institute of Technology Press 14 .

Kahia, M., Ben Jebli, M., Belloumi, M., (2019). Analysis of the impact of renewable energy consumption and economic growth on carbon dioxide emissions in 12 MENA countries. Clean Techn Environ Policy 21, 871–885.

Kahia, M., Ben Aissa, M., Lanouar, C., (2017). Renewable and non-renewable energy use-economic growth nexus: the case of MENA Net Oil Importing Countries. Renew Sustain Energ Rev 71, 127–140.

Kalai, M., Zghidi, N., (2017). Foreign Direct Investment, Trade, and Economic Growth in MENA Countries: Empirical Analysis Using ARDL Bounds Testing Approach. Journal of the Knowledge Economy, 1-25.

Kaygusuz, K., (2007). Energy for sustainable development: Key issues and challenges. Energy Sources, Part B: Economics. Planning, and Policy 2, 73-83.

Khan, M.A., Khan, M.Z., Zaman, K., Irfan, D., Khatab, H., (2014). Questing the three key growth determinants: energy consumption, foreign direct investment and financial development in South Asia. Renewable Energy 68, 203-215.

Kraft, J., Kraft, A., (1978). On the relationship between energy and GNP. The Journal of Energy Development 3, 401-403.

Kutan, A.M., Paramati, S.R., Ummalla, M., Zakari, A., (2018). Financing renewable energy projects in major emerging market economies: evidence in the perspective of sustainable economic development. Emerg. Mark. Finance Trade 54 (8), 1761-1777.

Long, X., Naminse, E.Y., Du , J., Zhuang, J., (2015). Nonrenewable energy, renewable energy, carbon dioxide emissions and economic growth in China from 1952 to 2012. Renewable and Sustainable Energy Review 52, 680-609.

Lee, J., Strazicich, M., (2003). Minimum LM unit root test with two structural breaks. Rev. Econ. Stat. 85, 1082–9.

Maji, A., Odoba, A.J., (2011). An Investigation of the Impact of Foreign Direct Investment on Economic. Growth in Nigeria. International Business and Management 3(1), 232-238.

Mbarek, M.B., Saidi, K., Amamri, M., (2017). The relationship between pollutant emissions, renewable energy, nuclear energy and GDP: empirical evidence from 18 developed and developing countries. International Journal of Sustainable Energy 0, 1-19.

McNown, R., Sam, C.Y., Goh , S.K., (2018). Bootstrapping the autoregressive distributed lag test for cointegration. Applied Economics 1-13.

Menegaki, A.N., (2011). Growth and renewable energy in Europe: a random effect model with evidence for neutrality hypothesis. Energy Economics 33 (2), 257– 63.

Middle East Solar Industry Association (2017), Solar outlook report. [Online]. Available at: http://www.mesia.com/wp-content/uploads/2017/09/MESIA-OUTLOOK-2017-Lowres.compressed.pdf [Accessed 15 July 2019].

Mielnik, O., Goldemberg, J., (2002). Foreign direct investment and decoupling between energy and gross domestic product in developing countries. Energy Policy 30, 87-89.

Ocal, O., Aslan, A., (2013). Renewable energy consumption–economic growth nexus in Turkey. Renewable and Sustainable Energy Review 28, 494-499.

Omri, A., Mabrouk, N.B., Timar, A.S., (2015). Modeling the causal linkages between nuclear energy, renewable energy and economic growth in developed and developing economies. Renewable and Sustainable Energy Review 42, 1012-1022.

Omri, A., Kahouli, B., (2014a). Causal relationships between energy consumption, foreign direct investment and economic growth: fresh evidence from dynamic simultaneous-equations models. Energy Policy 67, 913-922.

Omri, A., Kahouli, B., (2014b). The nexus among foreign investment, domestic capital and economic growth: Empirical evidence from the MENA region. Research in Economics
68(3), 257-263.

Ozcana, B., Ozturk, I., (2019). Renewable energy consumption-economic growth nexus in emerging countries: A bootstrap panel causality test. Renewable and Sustainable Energy Reviews 104, 30–37.

Paramati, S.R., Ummalla, M., Apergis, N., (2016). The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies. Energy Economics 56, 29-41.

Payne, J.E., (2010). Survey of the international evidence on the causal relationship between energy consumption and growth. Journal Economic Studies 37 (1), 53-95.

Pesaran, M. H., Shin, Y., Smith, R.J., (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econonomics 16, 289–326.

Prebisch, R., (1968). Development problems of the peripheral countries and the terms of trade. In D. James (Ed.), Economics of trade, development. New York: John Wiley and Sons Inc.

Rafindadi, A.A, Ozturk, I., (2017). Impacts of renewable energy consumption on the German economic growth: Evidence from combined cointegrationtest. Renewable and Sustainable Energy Review 75, 1130-1141.

Rahman, M.M, Velayutham, E., (2020). Renewable and non-renewable energy consumption-economic growth nexus: New evidence from South Asia. Renewable Energy 147, Part 1, 399-408.

REN21, (2017). Renewables Global Status Report. *Paris*. [Online]. Available at: https://www.ren21.net/gsr-2017/ [Accessed 10 July 2019].

Romer, P., 1993. Idea gaps and object gaps in economic development. Journal of Monetary Economics 32 (3),543–573.

Sadorsky, P., (2009). Renewable energy consumption and income in emerging economies. Energy Policy 37 (10), 4021-4028.

Sadorsky, P., (2010). The impact of financial development on energy consumption in emerging economies. Energy Policy 38, 2528-2535.

Saidi, K., Mbarek, M.B., Amamri, M., (2018). Causal Dynamics between Energy Consumption, ICT, FDI, and Economic Growth: Case Study of 13 MENA Countries. J. Knowl. Econ. 9, 228–238.

Salim, R., Yao, Y., Chen, G., Zhang, L., (2017). Can foreign direct investment harness energy consumption in China? A time series investigation. Energy Economics 66, 43-53.

Seyoum, M., Wu, R., Lin, J., (2015). Foreign direct investment and economic Growth: The case of developing African economies. Social Indicators Research 122 (1), 45-64.

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.

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

Solow, R., (1956). A contribution to the theory of economic growth. The Quarterly Journal of Economics 70 (1), 65–94.

Tugcu, C.T., Ozturk, I., Aslan, A., (2012). Renewable and non-renewable energy consumption and economic growth relationship revisited: evidence from G7 countries. Energy Economics 34 (6), 1942-1950.

U.S. Energy Information Administration, (2020). EIA International data. [Online] Available at: https://www.eia.gov/international/data/world [Accessed 13 August 2020].

Uzar, U., Eyuboglu, K., (2019). Is foreign direct investment an engine for energy consumption? An empirical investigation for Turkey. Environ. Sci. Pollut. Res. 26, 28092–28105.

Van, L.F. (1977), The effects of FDI on investment in Canada. The Review of Economics and Statistics 59 (4), 474–481.

Zhang, K.H., (2001). Does foreign direct investment promote economic growth: Evidence from East Asia and Latin America. Contemporary Economic Policy 19, 175–185.

Zhao, P., Lu, Z., Fang, J., Paramati, S.R., Jiang, K., (2020). Determinants of renewable and non-renewable energy demand in China. Structural Change and Economic Dynamics 54, 202-209.

Waheed, R., Sarwar, S., Dignah, A., (2020). The role of non-oil exports, tourism and renewable energy to achieve sustainable economic growth: What we learn from the experience of Saudi Arabia. Structural Change and Economic Dynamics 55, 49-58 .

World Bank, (2020). World development indicators. [Online] Available at: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators# [Accessed 12 August 2020].