Institutional and market factors driving renewable energy development in MENA region: A panel data approach

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ABSTRACT

While MENA countries have always been investing in traditional energy sources (oil, coal, and natural gas) due to their endowments, we recently observe a substantial growth of investments in Renewable Energy (RE) projects from some of those countries. However, such a behavior varies between countries. This paper explores the key factors at play in the MENA region to explain countries discrimination in development of renewable energy capacity. Some of the factors that are examined include governance quality based ICRG database In addition, trade openness is also considered as MENA countries experience different levels.
Despite the increasing literature on renewable energy, empirical analyses about factors promoting the investments in renewable energy sources continue to be scarce, especially as regards RE investment and countries governance. We analyze those drivers for MENA region, taking into account that some countries are oil producers while other ones are not. Over the period of time 2000–2013, we use panel data techniques. Findings confirm results of similar studies on factors promoting investments in renewable energy sources and including more developed countries. Surprisingly, our results suggest also that Corruption and "Law and order" increase renewable deployment. Moreover, trade openness appears to stimulate renewable energy investment in these countries.

Key words: Renewable energy, governance, trade openness, FDI, electricity policy

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1. Introduction

The application of clean energy, especially of renewable energy (RE), has become an inevitable trend[4]. Number of researchers have documented the benign effects of alternative energy (nuclear and renewable energy (RE)) on driving down the degree of CO_2 emissions (Menyah and Wolde-Rufael, 2010; Apergis*et al.*, 2010; Alfarra and Abu Hijleh, 2012; Lee, 2014). Moreover, Pao (2014) proposed that developing clean energy is a viable solution for addressing energy security and climate change issues in MIST (Mexico, Indonesia, South Korea, and Turkey). Saidi and Fnaiech (2014) debated the practices of renewable energy and energy efficiency in Tunisia and Glorioso and al. (2007) researched about clean energy and its relation with sustainable development in the Mediterranean. Pollin et al. (2009) estimated the economic benefits of investing in clean energy, proving that such investment could not only guide the U.S. out of high fossil fuel dependency, but also serve as a powerful engine of economic recovery and long-term economic development. And Liu and Liang (2013) stressed China's leadership in commercializing clean energy technology could eventually help lower its costs and promote its commercialization globally.

Middle East and North Africa (MENA) countries has quickly developed in recent years renewable energy markets with an increasing amount of investment and an expanding project pipeline to profit of the region's abundance of renewable energy resources. Nevertheless, while many governments claim to support the diffusion of renewable energy, the actual rate of investment in renewable energy varies considerably between countries.

Recently, Marques et al. (2010) analyze the drivers promoting renewable energy in European countries and they find that lobbies of traditional energy sources and CO_2 emission restrain renewable deployment. Yet, there is a lack of works in the fields of investment in renewable energy source and, in particular, in the discrimination between countries in their investment strategies especially for MENA region.

Then aim of this study is to examine why some MENA countries choose to invest in renewable energy whereas other countries choose the use of traditional methods with a special focus on Oil Producers countries. Where United Arab Emirates (UAE) developed the one of the largest Concentration of Solar Power plants in the world, shams, Kuwait, for example, doesn't invest in RE. In fact, literature supposes that the "rentier" economy allows the state to have sufficient resources to subsidize of most consumer products, which inhibit the emergence of an industrial spirit (Bouoiyour et al. (2014)).

The present paper will not challenge the above assumption about RE investment determinants. Indeed, it uses evidence as something of a benchmark. However, the paper

[4]e.g., the EU Directive 2001/77/EC (repealed by Directive 2009/28/EC from 1 January 2012) sets a target of 21% electricity generation from renewable energy sources in 2010, aims to make renewable energy account for 20% of its energy consumption by 2020. Mexico also has set the goal of generating 35% of its energy from renewable sources by 2024.

does maintain that there is another major phenomenon that plays at least as important a role in RE investment strategy. In fact, investment in renewable energy created opportunities, but also posed risks for renewable energy investors which have largely been neglected in previous research. Bouoiyour et al. (2014) add that energy policies cannot be designed without considering political factors. Our study differs from the previous works on the same field by incorporating institutional quality as an additional determinant of RE developing.

Middle East specialists have long invoked poor governance (weak quality of institutions), “rentier” economic development, severe social disparities and repression (Schwarz, 2008, Foley, 2010, Gray, 2010 and Elbadawi and Makdisi, 2011) as potential barriers to RE development. Despite these interesting conclusions that may have important economic implications, a limited number of works has concentrated on the interplay between RE investment and institutions. Theoretically, the weak governance has various harmful effects on energy sector policies, particularly electricity sector. Accordingly, Smith (2004 b) argues that the electricity thievery and ineffective institutions are strictly linked and adds that higher power fraud is intensely associated to corrupt practices within power sector organizations. Recently, Fouinhas and Marques (2013) show that the corruption is one of the most difficult problem for electricity sector. Nevertheless, some studies show that trade openness reduces the negative effects of weak governance, suggesting therefore that countries which do not favor institutional improvements can establish a policy of open market (Ades and Di Tella (1999) and Blake and Christopher (2002)). Given this evidence, it is interesting to include trade openness in our analysis to verify this evidence.

Due to the apparent lack of literature considering the link between RE investment, openness and governance in MENA region, we intend to fill this gap by providing new evidence on whether institutions matter or not for the focal nexus. This paper addresses these issues by using a panel data approach in a sample of 12 MENA countries over the period (2000-2014). We analyze the share of the investments in renewable energy in these countries depending on distinct political and social factors as well as different levels of economic development. Our results show that considering bad governance qualities of MEAN countries, corruption and bad law may favor RE investment

The remainder of the paper is organized as follows: A theoretical framework of the relationship between governance and renewable energy investment is discussed in Section 2. In Section 3, we give a description of renewable energy investment strategy in MENA countries. The data and the empirical strategy are described in section 4; while in Section 5 we report the empirical results and discuss the policy implications. Finally, our main conclusions are given in Section 6.

2. Renewable energy investment as a function of governance risk

When trying to understand what determines current levels of renewable energy investment, a basic model is to represent investments as a function of risk, return and policy. Risk and return have long been established as fundamental determinants of investments in finance theory. Investors, so the argument goes, rationally weigh the levels of risk and return of possible investment opportunities, and will pick those opportunities that provide the best return for a given level of risk[5].

Globally, the benign effects of renewable energy is in driving down the degree of CO_2 emissions (Menyah and Wolde-Rufael (2010), Apergis*et al.* (2010), Alfarra and Abu Hijleh, (2012) and Lee, (2014)) and in curbing the issues of global warming, energy insecurity and economic susceptibility to volatile energy prices.

However, policy or regulatory risks represent one of the major barriers for renewable energy investments, (Gatzert and Kosub (2015), Gatzert and Kosub (2014); Micale et al. (2013). In the literature, there are several definitions of policy or regulatory risks, which often considerably differ (Brink, 2004; Fitzpatrick, 1983; Smith, 1997). Empirical study of particular aspects of policy and regulatory risks as well as risk drivers can be found in Alesina and Perotti (1996), Hitzeroth And Megerle (2013), Holburn (2012) and in Lüthi and Wüstenhagen (2012), who present an empirical survey on specified preferences among photovoltaic project developers and advance their willingness-to-accept (in terms of an investment decision) for certain policy risks of their potential photovoltaic investments (Table A1, Appendix).

Smith (1997), for instance, defines *traditional political risks* as the risks related to expropriation, currency convertibility and transferability, in addition to political violence. In contrast, the author defines *regulatory risks* as the risks rising from the implementation of regulatory rules, at the economy and the industry level, comprising rules delimited in contracts with governments, in laws, and in other regulatory instruments. Brink (2004) analyzes *political risks* and distinguishes political risk drivers depending on economic, political and social factors.

Therefore, the term *political risk* typically covers a broad variety of risks associated with political action as, the intervention of politics into financial markets, expropriation, protectionism or civil disturbances (Bunn and Mustafaoglu (1978), De la Torre and Neckar (1988,; Fitzpatrick (1983) and Smith (1997)). Furthermore, particularly “traditional” *political risks* often comprise actions of political violence, such as war, riots or corruption that may

[5]While some observers see policy as the essential driver of RE investment (IPCC, 2011b), others, especially in the investment community, emphasize the role of private capital that is seeking opportunities with or without policies (Wustenhagen and Teppo, 2006). In the present study, we don’t consider this distinction, and we focus on country RE investment.

influence the political stability of a government and its regulation (e.g., Alesina and Perotti, 1996; Bunn and Mustafaoglu, 1978; Fitzpatrick, 1983; Smith, 1997) (Table 1).

Political uncertainty represents a *driver of policy risk* in case of a change in the political environment in general (accompanied by changing priorities affecting renewable energy subsidies, for example) or after the election of new political leaders supplemented by an ideological political change (Boomsma et al., 2012; Ramamurti, 2003)[6]. Alesina and Perotti (1996) empirically show, considering social conditions, that income inequality results in social dissatisfaction negatively affecting socio-political stability, which consecutively may influence political decision making when it arises to support schemes.

Considering the renewable energy investment in the Middle East and North African (MENA) region[7], Komendantova et al. (2009) found that three types of risk are of particular concern to investors, specifically *regulatory risk* (including corruption and complex bureaucratic procedures), *political risk* (including general political instability if it is a country) and *force majeure risks* (including terrorism). Other risks, such as technical, construction, operation, financial and environmental risks were seen as relatively less important. The authors conclude that mitigating *regulatory risk* and providing *stable and predictable policy* frameworks are key prerequisites to attract renewable energy investment for large-scale renewable energy projects in the North African region like Deserter (Komendantova et al. (2009).

In addition, theoretical and empirical studies on the determinants of environmental policy agree on the noticeable role of private and public interest in impacting policy outcomes (Peltzman 1976). The seminal paper of Grossman and Helpman (1994) has generally inspired the formal politico-economy models. This paper considers multiple lobbies which attempt to capture sector-specific policies by offering perspective bribes to politicians. The basic model's prediction is that the extent to which the chosen level of environmental tax differs from the optimal Pigouvian tax depends on the lobbies' capacity to influence policy (Fredriksson, 1997; Aidt, 1998). This difference depends on the weights the politician assigns to social welfare and citizens' preferences on the one hand and to the lobbies' bribes on the other. Empirically, the weight assigned to brown lobby bribes has been approximated by the level of corruption, which has been shown to negatively affect the stringency of environmental regulation[8].

[6]Country's political stability can be monitored based on political risk indices such as the BERI Political Risk Index (PRI), the World Governance Indicator for Political Stability, International Country Risk Guide (ICRG).

[7]Komendantova et al. (2009) conducted, before the Arab Spring started to unfold in the region in 2011, qualitative expert interviews to investigate the main risks perceived by European project developers that could influence the deployment of concentrated solar power (CSP).

[8]Although the negative effect of corruption on environmental policy is a consolidated result, using a sectorial measure of the brown lobby appears more appealing when the policy of interest is also sector specific, as in the case of Renewable Energy Policies.

Fredriksson and Svensson (2003) extend the Grossman and Helpman (1994) and Fredriksson (1997) models to include political instability. Their model argues that the effect of corruption declines when political instability rises because incumbent officeholders are less able to credibly commit to a policy. This forecast is confirmed in their empirical analysis of the stringency of environmental regulation. Considering the green lobby, Fredriksson et al. (2007) and List and Sturm (2006) show that its corruption may have substantial influence on the approval of ambitious environmental policies[9]. Other aspects of the impact of corruption on environmental policies are considered in variants of the same models and tested empirically by Damania et al. (2003), where the effect of corruption greatly depends on the degree of trade openness.

Fortunately, these risks, which are thus harder to solve, are also less of a concern. For this reason, our purpose is to highlight their importance as determinants of country RE investment. We consider that countries which improve their institution quality i.e. reduce their governance risks (regulation, political) invest more in RE. In addition, countries which establish a policy of open market favor RE investment. In fact, some studies show that trade openness reduces the negative effects of weak governance (Ades and Di Tella (1999) and Blake and Christopher (2002)). Besides, Liu and Liang (2013) stressed China's leadership in commercializing clean energy technology could eventually help lower its costs and promote its commercialization globally. This research could be additional efforts to conventional RE development into the ongoing efforts geared towards institutional and sustainable development (Transparency International, 2008). Making advancement on these issues could bring profits not only to countries pursuing to increase the level of FDI and energy-related FDI, but also be an important step towards reaching regional and global climate protection targets.

3. Mena countries, oil producers and renewable energy investment

The 21 MENA countries are usually clustered into two sub-groups: Net Oil-Exporting Countries (NOEC) which is composed of Algeria, Bahrain, Egypt, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, and Yemen, and Net Oil-Importing Countries (NOIC) including Djibouti, Israel, Jordan, Lebanon, Malta, Morocco, Palestine, and Tunisia. Whereas the reserves of the OECD (and in particular of the European) countries are depleting, 65 percent of global oil reserves are located in the countries of the Middle East with an R/P ratio of 92 years[10].Although, Gulf Cooperation Council Countries, GCC, have a vast oil and gas reserves which include approximately 40% of the world's oil reserves and approximately 25% of the world's natural gas reserves (Al-Saleh et al. 2012).

[9]For a theoretical treatment, see Canton (2008).

[10] R/P ratio stands for the duration of reserves of a country/region if the level of production remains the same. Data: (bp, 2005).

However, net importing countries (NOICs) suffered from economic losses incurred by rising fossil fuel consumption in the MENA region. Lebanon, Jordan, Morocco, and Tunisia have, for a long time relied, on what were often preferential oil supply contracts with allied Arab states such as Saudi Arabia and Iraq. However, the gradual erosion of such contracts, together with the increased need to pay for oil supplies at prices based on international price benchmarks, has increasingly raised the cost of their energy imports[11]. Both under old and new import contracts, the governments of NOICs only recovered a fraction of the actual import cost from domestic energy users, who throughout the region have benefited from extensive subsidies on all types of energy, including transport fuel, household gas, and electricity, as well as on the fuel and electricity supplied to industrial users.

In addition, the traditional argument against renewable energy in developing countries is that the costs and benefits surrounding renewables cannot adequately be captured in 'hard currency', implying that many of the benefits of renewables become a non-tangible luxury that only countries with high income levels, and hence access to capital, can afford to consider (IEA, 2011). The MENA region has suffered from this conflict of measurement. Indeed, more than half of MENA economies are middle-income economies, including Morocco, Tunisia, Egypt, Syria, Lebanon, and Jordan. All of these above face endemic crises relating to public debt and foreign currency reserves. Changing economics of technologies such as PV and wind have, since the early 2000s, nevertheless meant that the traditional argument against renewable energy in developing countries as a 'luxury' source of energy holds trues less and less – a factor that may also account in part for the gradual uptake of the technology at larger scale, in parts of the MENA region.

Furthermore, in order to meet the growing demand, Middle East countries have increased their production, in some cases, to 250 percent of the current level. This high production development has, as consequence, shortened the duration of their reserves. In addition, Gas reserves decreases as its demand has been increasing extraordinarily because natural gas is a comparatively "clean" source of energy. Then scarcity of hydrocarbons and the very high cost of gas infrastructure, call these countries for a new and concentrated push to guarantee safe energy, to increase its efficient use, and to raise the share of renewables in the energy mix worldwide (Westphal,2006).

Besides, given the rapid increase in their economic activity over the past 40 years, the Golf countries are amongst the highest per capita carbon dioxide (CO2) country emitters (Hertog and Luciani, 2009)[12]. They contribute approximately 8% of world CO2 emissions (Al-Saleh et

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[11] Some of these contracts have been renewed, although at far higher price levels than during the 1990s, reflecting higheroverall oil prices on global markets. For instance, see Al-Ghadd (2011); Ar-Ra'ii (2013).

[12] The rapid level of economic development in the GCC countries has been associated with high rates of economic growth, electricity consumption and CO2 emissions. Rates of economic growth and per capita electricity consumption have surpassed the levels of the major developed economies of the Organization of Economic Cooperation and Development countries (OECD) (World Bank, 2013).

al. 2012). Now, three of the six GCC countries are the world's highest CO2 emitters. Given this situation, the regions' commitment to sustainable energy policies seems to be a priority.

Furthermore, the literature studying the relationship between CO2 emissions, energy consumption and economic growth, involving the OPEC, the MENA (Middle East and North African) countries, as well as high income countries suggested that the Golf oil rents countries should reduce CO_2 emissions by a variety of measures as promoting the use of renewable resources and building nuclear energy plants.

In fact, MENA countries have a clear advantage over the rest of the world in renewable resources. The region is categorized by clear sky and an enormous amount of sunlight and wind and for more than 80% of days in a year with an average solar radiation of 2200 kWh/m^2 (Hertog, 2010). Therefore, in the region, the two most significant potential renewable sources for energy are solar and wind. Although Saudi Arabia and the UAE have already been following research on this potential, other Gulf Cooperation Council countries (GCC) don't make out and tap this opportunity. It is already evident that use of solar photovoltaic (PV) can significantly save CO_2 emissions in the electricity sector of Saudi Arabia and the UAE (Mansouri et al., 2013; Mondal et al., 2014). Solar PV is a very good technology possibility for long term investment in the energy sector. It will potentially allow GCC countries to achieve their renewable generation targets (Mondal et al. 2014).

Salahuddin, Gow, and Ilhan, (2015) recommend that the GCC countries need to significantly increase investment for research in clean energy technologies. This is not only to address the climate challenges and meet their current renewable energy targets only but also to take care of further challenges in the post-oil age. However, oil rent countries behave differently with in one hand leader ones and in other hand bystander ones.

The UAE government finance large-scale solar projects; clean-technology market and infrastructure projects to provide the renewable energy and carbon reduction targets. Moreover, the UAE government has encouraged international investors to invest in clean energy projects, the Shams 1 solar project: the largest concentrated solar power plant (CSP) in operation in the world[13]. In fact, UAE present less *regulation risk* based on his worldwide governance indicators which constitute an attractiveness factor for investors.

Considering Algeria (OPEC member), it behaves as bystander concerning investment in RE. Algeria is a large consumer of electricity compared to its Maghreb neighbors. The electricity is largely produced from gas in Algeria, which covers 96% of electricity demand in the country in 2013.Considering the impossibility to remove and reduce the subsidies, some

[13] Shams 1 is located in Abu Dhabi; its capacity is 100-megawatt, and it will provide clean energy to power 20,000 homes in the UAE energy consumption.

national reports highlight the risk of going to 70 billion of gas cubic meters of domestic consumption on the horizon 2017-2020, surpassing the volume of exports in 2012 and making problematic the extrapolation of 85 billion gas cubic meters expected in 2014 (Mebtoul, 2013). It is true that the current context and the events that know the MENA region (the aftermath of revolution) do not allow subsidies' limitations that may have detrimental effect on social peace. But the system slows down. Mebtoul (2013) predicts the depletion of oil reserves in 2020 and conventional gas reserves in 2030, taking into account the strong domestic consumption, the cost-of-living and the increased competition facing the new world energy markets.

Algeria chooses to be a typical “rentier” economy because most of the economic activity (90% of the national wealth and 96% of exports) is mainly linked to single sector, hydrocarbons. Besides the electricity sector concerns a major part of the population but it receives a low priority and a limited attention at policy level, this sector is not regulated, not organized between producers and consumers and stills an informal sector (Mebtoul, 2013). Bouoiyour, and al. (2014) argue that this excessive dependence and sizeable instability avoid the government and the administration to make credible predictions of budget and economic growth in the short-and-medium terms. Besides, this dependence is damaging not only for an economy as a whole, but also at the societal view of the values of work, efforts and self-sacrifice in order to achieve results. This obviously explains the wide diffusion of “rentier” mentality within society. Therefore, to take risk no longer offer guarantees to get rich. It is the “clientelism” rather than the predation that allow some close circles to get rich faster (Bouoiyour, and al., 2014). The recompense is related to a chance and not to a well-organized production process (Chatelus, 1982).

Considering these examples, MENA countries present difference governance qualities, environmental endowment and behave differently toward RE investment. For all reasons exposed before, we concentrate our study on the determinants of RE investment with a special focus on OPEC Countries.

4. Empirical strategy

4.1. Data description

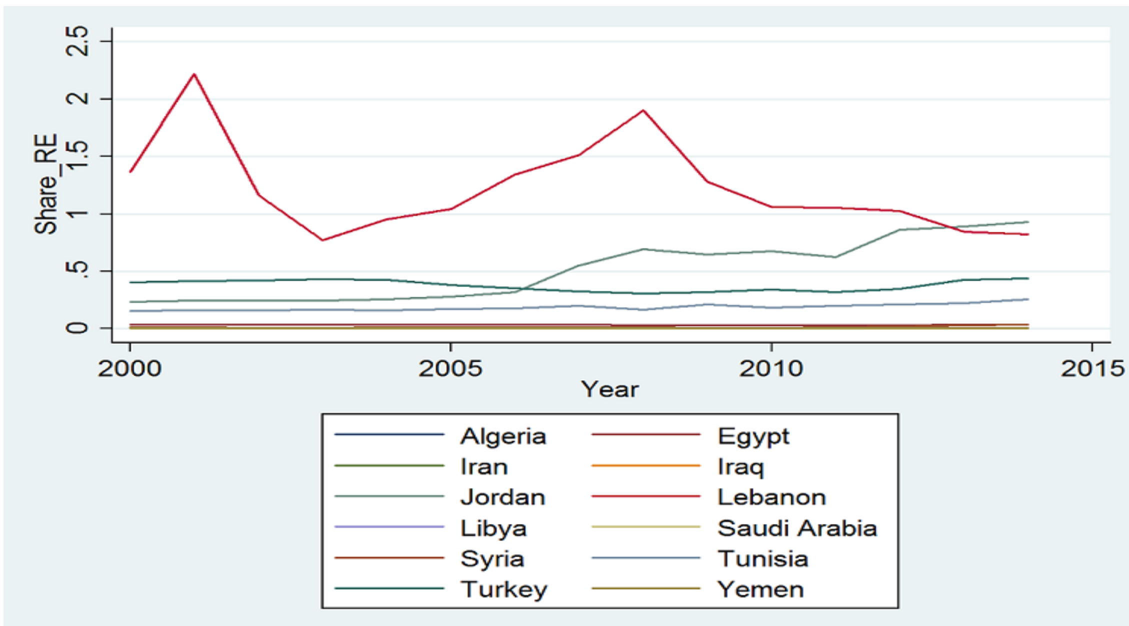
Given that environmental issues and especially renewables questions are recent issues in MENA countries, we rely on a variety of sources to collect all information needed for this study. Due to a lack of information or irrelevant data for some countries, we have deleted some of them from the study. We also dropped Morocco and Soudan which are considered as outliers. In addition, many MENA countries do not yet begin investment in renewable energy and are not in consequence included in our study. In another hand, as renewable energy investment policies are relatively recent in MENA countries and actually started during the 2000s, we limit our sample for the period of 2000-2014. In final, our sample includes 12 MENA countries for period 2000-2014[14].

Dependent variable

We follow Marques (2010) and use as a dependent variable the share of renewable energy in total energy produced (*Share_RE)*. This variable reflects the shift of energy production to renewables. It is measured by the natural logarithm of the ratio between the total renewable energy produced and the total energy produced. Related data have been gathered from two sources: the OECD as regards the volume of renewable energy and the Energy Information Administration (EIA) as regards the total energy produced.

Figure 1 gives the evolution of the share of renewable energy in total energy production for each country from our sample for period 2000-2014.

Figure 1: Evolution of the share of renewable energy



In general, there is not a big evolution regarding investment in renewable energy from 2000 to 2014. The share of renewable energy remains low in MENA region compared to other ones (United States or European countries for example). However, we observe some differences between countries. While Lebanon had the largest share in 2000 (1.37%), it has been overtaken by Jordan at the end of the period. Remaining countries show differentiated levels of this share, even if it remains lower than 0.5%.

Explanatory variables

The explanatory variables have been gathered from various sources as mentioned in Table 1 below. These determinants of renewable energy production are grouped into three

[14] Countries included in the sample : Algeria, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Saudi Arabia, Syria, Tunisia, Turkey., Yemen.

categories: resources endowments, renewable energy endowments and social and political factors.

Resources endowments

The contribution of the traditional energy sources (oil, gas and coal sources) to electricity generation is related to the resources endowments of a country. Literature refers to a lobbying of these traditional energy sources when their contribution is large, standing as a barrier to the deployment of renewable energy sources (Huang et al., 2007; Marques et al., 2010).The expected sign of variable *ElectOils* is therefore negative.

Another important driver for diversifying the energy sources is the dependence on external sources in meeting domestic demand in energy when local resources endowments are insufficient. We control for the energy imports through the variable *ShareImports*.

Renewable energy endowments

As mentioned above, MENA countries have a clear advantage in solar and wind energy renewable resources. We introduce in the base model the variable *Solar* measuring the mean radiation per day in mJ/m2. Unfortunately, we are not able to introduce a measure of wind potential since data on wind potential in MENA countries are not available.

Social and political factors

Social and political factors have been mentioned in literature as potential determinants for developing renewable energy (Carley, 2009; Marques et al. 2010). Usual factors are income, pollution emissions and demand.

We measure the income by the real GDP per capita (variable *Realgdpcap*). Richer countries are supposed to have more financial capacity to implement stricter environmental policies and encourage the use of renewable energy. Furthermore, population of rich countries should be sensitive to environmental issues and put pressure on governments for developing cleaner energy sources.

Pollution emissions are another potential driver for renewable energy. Larger polluting countries are supposed to have more incentives to reduce their environmental pressure. A major international environmental issue is the fight against the climate change, and CO2 emissions being a main greenhouse gas effects temming from the combustion of fossil fuels and causing the climate change, we introduce in our model the CO2 emissions per capita (*CO2cap*). We expect a positive sign for *CO2cap* variable. However, the presence of a negative effect highlights the persistence of an economy tied to fossil fuels, which is still unable to substitute the traditional energy sources (Romano, 2013).

Countries with growing demand are likely to seek for diversifying energy production sources in order to face rising demand. *Pop_Growth* variable is therefore expected to be positively correlated with the percentage of renewable energy in total energy production.

In addition to these determinants, we introduce three factors less used in literature.

First, we include a dummy variable *OPEC* to distinguish between oil exporting countries and oil importing ones in our sample. The former are likely to continue promoting oil energy source while the latter have a strong incentive to rely on their own renewable energy sources.

Second, we introduce trade openness measure (*TradeOp*) to control for a potential effect of openness on developing renewable energy.

Third, as mentioned in the theoretical background, in this work a particular attention has been paid to governance since it should greatly influence the use of renewable energy sources in MENA countries. We control for governance by using different measures provided by the International Country Risk Guide (ICRG) database. This database provides longitudinal rating for more than 140 countries. Risk rating is based on 22 variables classified into three categories of risks: political, financial and economic risks. To take into account various aspects of governance, we include six variables which are the most relevant for our work: *Corruption*, *Bureaucracy Quality*, *Government Stability*, *Internal Conflicts*, *Investment Profile* and *Law and Order*. In the ICRG methodology, a higher value of a variable means a lower risk. We therefore expect a negative correlation between governance measures and our dependent variable.

Table 1: Data sources and variables definitions

Variable	Definition	Source
Dependent variable		
ShareRE	Percentage of renewable energy in total energy production	OECD and EIA
Resourcesendowments		
ElectOils	Contribution of the traditional sources of energy (oil, gas and coal sources) to electricity generation (%)	World Development Indicators
Shareimports	Energy imports (% energy use)	World Development Indicators
Renewable energy endowments		
Solar	Mean radiation per day (mJ/m2)	Open solar DB
Social and political variables		
Realgdpcap	GDP per capita (constant 2005 US$)	World Development Indicators
CO2cap	CO2 emissions (metric tons per capita)	World Development Indicators
Pop_growth	Annual percentage	World Development Indicators
OPEC	Dummy variable for OPEC countries	Authors

Tradeop	Exports +imports(% GDP)	UNCTAD database
Governance factors:		ICRG database
Corruption	Corruption within the political system	
Bureaucracy Quality	Institutional strength and quality of the bureaucracy	
Internal Conflicts	Political violence in a country (civil war, terrorism, civil disorder)	
Government Stability	Government's ability to carry out its declared program(s), and its ability to stay in office	
Investment Profile	Risks to investment	
Law and Order	Strength and impartiality of the legal system and its popular observance	

4. 2. The model

In this paper, we adopt a panel estimation strategy which presents many advantages compared to time-series or cross-sectional ones. In fact, panel data contains more information, greater variability of data and less co-linearity between the variables. In another hand, it allows us to exploit the time-series dimension of the data and control for possible endogeneity and omitted variables pertaining to cross-sectional estimation. According to Greene (2003), panel data gives more efficient estimators since they have high number of degrees of freedom.

Two panel specifications are often used in the literature; fixed effects panel and random effects panel, conditional on the nature of the individuals (countries) specific effects. When these effects are not correlated with explanatory variables, the model is assumed to be random. In the opposite case (country specific effect correlated with explanatory variables), we rather speak on fixed effects panel. While fixed effects panel is generally preferable in practice because it allows us to control for the unobserved country heterogeneity, random effects panel presents the advantage of allowing the introducing of time-invariant or rarely-changing variables.

In practice, to decide between the two models, we usually use the test of Hausman. This test allows us to check the relevance of the non-observed individual effects. It basically tests whether the unique errors are correlated or not with the regressors (the null hypothesis is they are not). The Hausman test was then performed on our sample. The results[15] concludes in favor of random effects panel estimation, which is in our data superior to the fixed effects

[15] See Appendix A.

model and has higher probability to generate consistent and efficient estimates. In this paper, random effects panel model is then used to explain the investment (the share) in renewable energy in MENA countries. Another argument supporting our choice is that, as shown in figure 1, the share of renewable energy to the total energy production varies very slightly from one country to another in our sample. In addition, many pertinent explanatory variables in our model, such as resources endowments or political variables, are time-invariant. In fact, fixed-effects model does not work well with data for which within-cluster variation is minimal or for slow changing variables over time.

Thus, the econometric model used in this paper is the following:

$$lnshareRE_{it} = \alpha + \beta X_{it} + \varepsilon_{it}, \quad (1)$$

where $\varepsilon_{it} = u_i + v_t + \omega_{it}$, X_{it} are a set of explanatory variables described above (in 4.1.), u_i is a country specific effects, v_t is a temporal effects; u_i and v_t must be orthogonal to ω_{it} and to the regressors, ω_{it} are the independent and identically distributed error terms, i represents the country index, and t represents the year.

5. Results and Discussion

The validity of the estimations is assessed by applying a set of tests. In order to check the relevance of the non-observed individual effects, the Hausman test was performed. This test is conclusive and indicates the random effect estimator is superior to the fixed effects. Consequently, we conclude that the random effects estimation processes will achieve robust estimates and will have a higher probability of generating consistent and efficient estimates, than the pooled OLS estimation. From the Wald test we reject the null hypothesis of non-significance, as a whole, of the parameters of the explanatory variables.

Table 2 presents the results from the estimation of model (1). The first column shows the results for the benchmark which is here the pooled OLS model; whereas the other columns present the results of the random effect model taking into account several measures of governance. To take into account various aspects of governance, we include as mentioned before six variables which are the most relevant for our work: *Corruption*, *Bureaucracy Quality*, *Government Stability*, *Internal Conflicts*, *Investment Profile* and *Law and Order*. These variables have been introduced successively in specifications (2) to (7), respectively.

In short, the results show:

- A negative and statistically significant relationship between CO2 emissions and ShareRE (effect not expected). This effect is robust and it is verified for all estimations.
- The parameter measuring the effect of elecOIL, is positive with random effect estimation and statistically significant.
- Larger energy imports have a positive effect on RE development. The effect is statistically significant, and presents the expected signs.
- Income effect on RE Is positive and statistically significant
- To be OPEC Members reveal a negative and statistically significant impact on RE investment.

- Parameter measuring effect of solar radiation on the RE is positive and statistically significant.
- Population growth has a positive and statistically positive impact on ShareRE.
- Trade openness has positive and statistically significant impact on RE investment.
- Corruption reveals a positive and significant effect on RE investment.
- Law and order reveal a positive and significant effect on RE investment.

In general, environmental concerns appear not encouraged the use of RE. We found that the larger CO2 emissions, the smaller are RE investment. This suggests that the greater the level of economic activity, the greater the pollutant activity will be and therefore the propensity to invest in renewable sources will be smaller. This former effect is unexpected.

This result is robust for all estimations. The opposed effect was verified for energy dependency, in accordance with the literature. The energy self-sufficiency aim, promotes the development of renewable sources.

The income effect is surprisingly unstable, despite being aligned with the lack of consensus in the literature. Indeed, some literature is inconclusive regarding the relationship between income and environmental concerns. The positive effect of wealth

In the promotion of RE, verified by Vachon and Menz (2006) and by Huang et al.(2007), is strongly confirmed in modesl (1) and (3). In assessing the income effect, we use GDP per capita (as Carley, 2009), although have tested several proxies of the income effect, namely GDP, the natural logarithm or both the contemporary and lagged growth rates. In general, this suggests that the major effect on renewables investment is the standard of living of its population and not the absolute economic size of a country.

An expected result is the negative effect of solar radiation on the (Carley, 2009). But in our sample the most solar radiation potential belong to GCC countries which are oil producer. Anyway, to be an OPEC Member is negative and significant to the RE investment. The result sheds light onto the lack of clarity present in the literature. This suggests that there could be an opaque relationship among players of traditional energy sources and environmental practices. In fact, literature argues that the larger the proportion of energy generated from fossil sources, the smaller the RE investment is. As noted by Sovacool (2009), the lobby effect delays the RE commitment. All the estimation for oil and coal confirms this (Marques 2010).

Table 2: RE investment determinant: Estimation results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Corruption	BureaucracyQuality	GovernmentStability	InternalConflict	InvestmentProfile	LawOrder
VARIABLES	OLS	RE Estimations	RE Estimations	RE Estimations	RE Estimations	RE Estimations	RE Estimations
elecoil	0.0444***	-0.0201***	0.0174	-0.0222***	-0.0220***	-0.0208***	-0.0213***
	[0.0115]	[0.00692]	[0.0111]	[0.00737]	[0.00710]	[0.00713]	[0.00714]
shareEimports	0.00572***	0.00168***	0.00391***	0.00157***	0.00156***	0.00176***	0.00180***
	[0.000964]	[0.000413]	[0.000860]	[0.000453]	[0.000428]	[0.000434]	[0.000434]
solar	-0.472***	-0.488**	-0.487***	-0.480**	-0.485**	-0.488**	-0.508**
	[0.0588]	[0.246]	[0.0680]	[0.194]	[0.241]	[0.247]	[0.204]
realgdpcap	0.000313***	-4.34e-05	0.000167**	-4.65e-05	-4.87e-05	-5.30e-05	-3.68e-05
	[6.02e-05]	[4.47e-05]	[6.85e-05]	[4.70e-05]	[4.59e-05]	[4.60e-05]	[4.65e-05]
CO2	-0.586***	-0.0403	-0.398***	-0.0477	-0.0411	-0.0454	-0.0595
	[0.0635]	[0.0469]	[0.0689]	[0.0494]	[0.0483]	[0.0483]	[0.0490]
popgrowth	-0.0629	-0.120***	-0.0285	-0.101**	-0.102**	-0.114**	-0.101**
	[0.127]	[0.0438]	[0.0835]	[0.0475]	[0.0456]	[0.0450]	[0.0456]
OPEC	-0.525	-3.620***	-1.577***	-3.562***	-3.597***	-3.487***	-3.508***
	[0.384]	[1.119]	[0.408]	[0.897]	[1.098]	[1.125]	[0.934]
TradeOp	0.0185***	0.00301	0.0125***	0.00507***	0.00531***	0.00491**	0.00515***
	[0.00337]	[0.00195]	[0.00305]	[0.00196]	[0.00194]	[0.00191]	[0.00193]
Corruption	-0.135	-0.163***					
	[0.159]	[0.0552]					
BureaucracyQuality			-0.0252				
			[0.213]				
GovernmentStability				-0.0184			
				[0.0219]			
InternalConflict					-0.0301		
					[0.0205]		
InvestmentProfile						0.0449	
						[0.0325]	
LawOrder							-0.178*
							[0.0932]
Constant	1.661	8.874*	4.478***	8.577**	8.712*	8.110*	9.521**
	[1.191]	[4.537]	[1.339]	[3.604]	[4.447]	[4.558]	[3.809]
Observations	132	132	132	132	132	132	132
R-squared	0.927						
Number of id		12	12	12	12	12	12
Standard errors in brackets							
*** p<0.01, ** p<0.05, * p<0.1							

Surprisingly, corruption has a positive and significant effect on RE investment. However this unexpected result can be explained by MENA region bad governance. In fact, literature on corruption considers, in the grease the wheels hypothesis, that corruption can grease the inefficiency of bureaucracy. The first bureaucratic inefficiency that can be compensated for through corruption is slowness. Leys (1965) therefore stressed that bribes could give bureaucrats an incentive to speed up the establishment of new firms in an otherwise sluggish administration. The same argument was later adopted by Lui (1985), who showed in a formal model that corruption could efficiently reduce time spent in queues. Some, such as Leff (1964) and Bailey (1966), also argue that graft may simply be a hedge against bad public policies. In these authors' view, this is particularly true if the bureaucrat is biased against entrepreneurship for ideological reasons or due to a prejudice against certain minority groups. Simply by impeding inefficient regulations, corruption may limit their adverse effects. The causality may in fact be subtler.

The grease the wheels hypothesis implies that the impact of corruption is conditional on the quality of the institutional framework. Corruption may contribute positively to the productivity of the factors of production and then increases investment in RE because it compensates investors for the consequences of a defective institutional framework, such as an inefficient administration, a weak rule of law, or political violence. One may nevertheless remark that graft also has its drawbacks. Indeed, although bribery may have its benefits, it may also impose additional costs in a weak institutional environment by increasing corruption incentives. Gennaioli & Tavoni (2016) study the link between public policy and corruption for the case of wind energy and show that in a publicly subsidized renewable energy sector, which attracts criminal appetites; more corruption between entrepreneurs and politicians increases investment in wind energy by influencing the licensing process. The insights of a simple model of political influence by interest groups are tested empirically using. Using Italian data for the years 1990–2007, they find robust evidence that construction of an average wind park is associated with an increase in corruption. The analysis is relevant for countries that are generally characterized by heavy bureaucracies, weak institutions and by large renewable potential.

In addition, our results indicate that Low level of law index may increases RE investment. This is specific to the environment problem. In fact natural resources preservation, CO2 reduction measures and globally environment protection jurisdictions are less stringent in developing countries and particularly in MENA region or even do not have these requirements or whose laws. Then national or foreign investors do not bear theses burdens which my motivate them to increase their investment in RE. Surprisingly, a more law specification may reduce their incentives.

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Appendix

Appendix A

	Coefficients (b) eq1	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
elecoils	-.0209845	-.0201155	-.000869	.000857
shareEimpo~s	.0016331	.0016815	-.0000483	.0000349
realgdpcap	-.0000469	-.0000434	-3.48e-06	5.97e-06
CO2m3cap	-.030786	-.0403162	.0095303	.006338
popgrowth	-.1224092	-.1199608	-.0024484	.0038461
TradeOp	.0027787	.0030143	-.0002355	.0002386
CorruptionF	-.1638683	-.1632959	-.0005724	.0037087

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 5.47
Prob>chi2 = 0.6026

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