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Governance and renewable energy investment in MENA countries: How trade matters?

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ABSTRACT

Middle East and North Africa (MENA) countries have recently developed their renewable energy markets. However, their rate of investment in renewable energy remains small as compared to other regions in the world, despite their relative abundant endowments, particularly in wind and solar. While literature identifies some barriers to investment in renewable energy, we assume that the investment of MENA countries could be impeded by specific governance factors. Furthermore, we consider recent literature showing that trade openness reduces the negative effects of weak governance. In this paper, we empirically investigate the link between governance, openness and renewable energy investment in MENA region using a panel data for 15 MENA countries over the period 1996-2013. Our results confirm that governance issues largely determine investments in renewable energy in MENA region. In addition, this effect seems to be conditional on trade regime. Our results are robust to several alternative measures of governance and confirm that bad governance and distorted trade policy are complements in the explanation of the low level of investment of MENA countries in renewable energy.

Keywords: Renewable energy investment, governance, trade openness, interaction effect, random effect panel

JEL Classification: Q28, D73, F18, C23

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1. Introduction

During the previous years, renewable energy (RE) sector has known growing interest. Policy makers have recognized the need to develop this sector, regarding its benefits to the economy and the environment. Number of researchers has in fact documented the benign effects of alternative energy (nuclear and renewable energy) on driving down the degree of CO_2 emissions and reducing the effects of climate change (Alfarra and Abu Hijleh, 2012; Apergis et al., 2010; Lee, 2014; Menyah and Wolde-Rufael, 2010). Moreover, Pao et al. (2014) proposed that developing clean energy is a viable solution for addressing energy security and climate change issues in MIST.[1] Another important feature of RE is that it consolidates sustainable development. Glorioso et al. (2007) prove in this case that clean energy strengthens sustainable development in the Mediterranean.

In this context, Middle East and North Africa (MENA) region is considered as one of the most promising markets for RE over the next 10-20 years with its natural resources in sunshine, wind, biomass and geothermal (Komendantova et al., 2012).[2] Kahia et al. (2017) confirm in addition that RE plays a crucial role for economic growth in MENA countries, which economies still have an intense dependence on traditional energy sources to satisfy the continuous increase in demand. The RE resources constitute a big opportunity for many countries of this region to increase their economic development and improve their environment quality. However, the actual MENA rate of investment in RE remains small compared to other regions in the world, especially regarding it fast rising electricity demand and urgent need for new generation capacity.

The late and small investment in RE in MENA region can be explained by traditional arguments often used to explain the weak RE investment in developing countries. It is, in fact, argued that renewables costs and benefits cannot adequately be captured in 'hard currency', implying that many of the benefits of renewables turn into a non-tangible luxury that only high-income countries, and therefore with easy access to capital, can afford to develop (El-Katiri, 2014). However, many MENA economies are middle-income economies facing endemic crises related to public debt and foreign currency reserves. This is the case for Morocco, Tunisia, Egypt, Syria, Lebanon and Jordan. Nevertheless, since the early 2000s, changing economics of technologies such as photovoltaic and wind have occurred, and gradual uptake of the renewables technology is observed in the MENA region. Then, the traditional argument against RE in developing countries as a 'luxury' source of energy holds true less and less. However, the rate of investment in RE varies considerably between MENA countries, independently of their endowment in traditional energy. While many governments support the diffusion of RE and have been developing RE markets with an increasing amount of investment, and an expanding project pipeline[3], some other MENA countries continue largely to use traditional energy.

Komendantova et al. (2012) study the RE investment in MENA region. They highlight the importance of the illegal environment and the government ineffectiveness, areas where North Africa countries fall short. They identified the existence of risks which are of particular concern to investors, and that could influence the deployment of renewable sources in the region. They argue that investors' decision is impacted by "regulatory risk" (including corruption and

[1]Mexico, Indonesia, South Korea, and Turkey.

[2]Recent studies suggest also that North Africa region is faced a large electricity demand of EU to meet its 2020 targets. Egypt and Morocco established national entities such as NREA in Egypt and CDER in Morocco whose role are, among others, to export the clean electricity to Europe.

[3]United Arab Emirates (UAE) developed the one of the largest Concentration of Solar Power plants in the world, shams, and Morocco and Turkey investment beat the $ 1 billion barrier considered as the biggest projects in 2015 (Global Trends in Renewable Energy Investment 2016, Frankfurt School-UNEP Centre/BNEF).

complex bureaucratic procedures), "political risk" (including general political instability if it is a country) and "force majeure risks" (including terrorism). In many MENA countries, investment often does not happen at all because of complex and lengthy bureaucratic procedures and unpredictable investment volumes due to corruption. In fact, most MENA countries present an investment climate strongly influenced by ineffective bureaucracies and corruption.[4] According to the World Bank report (2008), MENA region has significant regulatory problems regarding the index for the ease of doing business for many countries in the region. It showed that corruption is the most significant problem for investment for Egypt and Algeria followed by the political instability and violence issues.

While many papers study the determinants of RE investment in developed and some emerging countries (Bird et al., 2005; Carley, 2009; Marques et al., 2010; Marques and Fuinhas, 2011), nothing has been done so far in the context of MENA countries, especially in investigating the relationship between governance and RE investment. Our paper tries to fill this gap by analyzing the development of RE in MENA, taking into account the governance issue characterizing this region.

In reality, literature has long invoked weak quality of institutions in MENA region (Elbadawi and Makdisi, 2011; Foley, 2010; Gray, 2010; Schwarz, 2008). However, this issue has unfortunately largely been neglected in previous research studying RE policy in this region. Accordingly, Smith (2004) 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, Fuinhas and Marques (2013) show that the corruption is one of the most difficult problem for electricity sector. Bouoiyour et al. (2014) add that energy policies cannot be designed without considering political factors. Iyer et al. (2015) find that investment risks are higher in regions with inferior institutions. The authors suggest that institutional reforms leading lower investment risks could be an important component of cost-effective climate alleviation strategies. At the opposite, Verdolini and Vona (2015) show that decreasing entry barriers results in a growth of investment in RE but do not find evidence of institutional quality influencing investment in RE. Masini and Menichetti (2013), examining the impact of non-financial factors in RE investment, including behavioral and institutional factors, find that only the behavioral context plays an important role at affecting the incentives to invest in RE.

While many studies make evidence of negative effect of weak governance on RE investment, some papers show that trade openness might reduce this negative effect, suggesting that countries which do not favor institutional improvements can establish a policy of open market (Ades and Di Tella, 1999; Blake and Martin, 2002). Particularly, Damania et al. (2003) found that trade liberalization attenuates the impact of corruption on environmental policy formation. Mukherjee and Chakraborty (2013) recognized that government systems might influence pollution haven hypothesis effects, principally in countries where there is no democracy and freedom. It seems then important to take into account the interaction effect between trade and governance when studying RE investment.

The effect of trade liberalization on environment policy in general has been widely studied in the literature. In fact, some studies found that trade openness reduced pollution and declined the use of energy (Brack, 1998; Sbia et al., 2014; Vona and Nicolli, 2013), while other studies consider the pollution haven hypothesis and recognize that more exporters have lower environmental regulations (Mongelli et al., 2006; Mukherjee and Chakraborty, 2013) and that importing countries have contrary positive impacts (Almeida and García-Sánchez, 2017).

[4]Note that, the study of Komendantova et al. (2012) was conducted before the Arab Spring started to unfold in the region in 2011 and was based on qualitative expert interviews.

However, this literature doesn't consider, to the best of our knowledge, the relationship between trade, institutions and RE investment, even less in MENA countries.

By combining different strands of literature, this paper aims to explain MENA region differences in RE investment taking into account the relationship between these three factors. Our aim is twofold: to study the impact of governance on RE investment in the MENA region, and examine how trade openness may affect this relationship. We explore whether governance and trade have a joint influence on RE investment in addition to their individual effect. The paper addresses these issues by using a panel data approach in a sample of 15 MENA countries over the period 1996-2013. We analyze the investments in renewable energy in these countries depending on institutional indicators, trade openness as well as different economic factors. Our results first prove that weak institutional qualities decrease RE investment in MENA countries, and second give evidence of the complementarity of trade openness and governance in promoting the development of RE sector in MENA countries.

The remainder of the paper is organized as follows: a theoretical framework of the relationship between governance, trade openness and RE investment is discussed in Section 2. The empirical strategy and the data are described in Section 3; while in Section 4 we report and discuss the empirical results of our main model as well as robustness checks. Finally, our main conclusions and the policy recommendations are given in Section 5.

2. Theoretical background

Globally, the benign effects of RE investment is helping countries in driving down their degree of CO_2 emissions (Alfarra and Abu Hijleh, 2012; Apergis et al., 2010; Lee, 2014; Menyah and Wolde-Rufael, 2010) and in curbing the issues of global warming, energy insecurity and economic susceptibility to volatile energy prices. However, literature identifies different risks for RE investments. We first distinguish "regulatory risk" defined as "the risks related to 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" (Bunn and Mustafaoglu, 1978; De la Torre and Neckar, 1988; Fitzpatrick, 1983; Smith, 1997).[5] Secondly, literature identifies "political risk" defined as "the risks rising from the expropriation, currency convertibility and transferability and to political violence, such as war, riots or corruption that may influence the political stability of a government and its regulation" (Alesina and Perotti, 1996; Bunn and Mustafaoglu, 1978; Fitzpatrick, 1983; Smith, 1997). Brink (2004) analyzes political risks and argues that political risk presents different drivers depending on economic, political and social factors.[6]

Regulatory risks are considered as one of the major barriers for RE investment (Gatzert and Kosub, 2014; Gatzert and Kosub, 2015; Micale et al., 2013). Empirical study of particular aspects of regulatory risks as well as risk drivers can be found in Alesina and Perotti (1996), Hitzeroth and Megerle (2013), Holburn (2012) and Lüthi and Wüstenhagen (2012). For illustration, Lüthi and Wüstenhagen (2012) 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.

[5]In the literature, there are several definitions of policy or regulatory risks, which often considerably differ (Brink, 2004; Fitzpatrick, 1983; Smith, 1997).

[6]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).

In reality, a large number of studies focus principally on one aspect of governance, namely corruption. Results designate corruption as one of the major causes of environmental degradation. Damania et al. (2003) find that corruption is a significant negative determinant of environmental protection and Lopez and Mitra (2000) argue that corruption and environmental policy stringency are characterized by a monotonic (negative) relationship. On the other hand, it has also been argued that corruption can be somewhat beneficial by creating opportunities for illicit private gains for firms, such that paying "cash for contract" (Asiedu and Freeman, 2009). This result is the effect of "grease the wheels" mechanism. According to Bellos and Subasat (2012), corruption can compensate for poor governance and speed up inefficient bureaucratic processes in order to attract FDI (Bellos and Subasat, 2012; Kaufmann and Weim, 1999; Méon and Sekkat, 2005). In the context of green investment, Gennaioli and Tavoni (2016) study the link between public support schemes for RE and corruption and find that the number of green energy projects in Italian provinces increased with corruption. Specifically, an increase in criminal activity results in an increase in the number of green projects.

Additionally, theoretical and empirical studies on the determinants of environmental policy agree on the visible role of private and public interest in impacting policy outcomes (Peltzman, 1976). Based on the seminal paper of Grossman and Helpman (1994), Fredriksson (1997) and Aidt (1998) consider multiple lobbies, which try to capture sector-specific policies by proposing perspective bribes to politicians. They conclude 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. This difference depends on the weights the politician gives 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.[7]

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 office holders are less able to credibly commit to a policy. This prediction is confirmed in their empirical analysis of the stringency of environmental regulation. Using a sample of 54 developed and developing countries, Pellegrini and Gerlagh (2006) found that corruption stands out as a substantial and significant determinant of environmental policies, while democracy have insignificant impact.

While, the link between governance and environment policies is confirmed in the literature, some papers argue that we cannot study governance and RE investment nexus without considering trade openness effect. Damania et al. (2003) conclude in this case that the effect of corruption greatly depends on the degree of trade openness. Ades and Di Tella (1999) and Blake and Martin (2002) show that trade openness reduces the negative effects of weak governance.

The effect of trade liberalization on environment policy in general has been widely studied in the literature. Mongelli et al. (2006) and Antweiler et al. (2001) observe that the relationship between international trade and the environment should be interpreted through three aspects: (i) scale, (ii) technology, and (iii) the effects caused by the specialization of the products. The scale effect argues that trade openness is supposed to stimulate the domestic consumption and the level of production and thus accelerate the economic activity. The second effect implies that trade openness offers the opportunities of the transfer of advanced technology generally less polluting and strengthens the environmental regulation. The third effect is the composition effect; it appears when trade is seemed to have an impact on the modification of the economic structure of the host-country. Besides, Liu and Liang (2013) stressed China's leadership in

[7]Although the negative effect of corruption on environmental policy is a consolidated result, using a sectorial measure of the brown lobby appears more interesting when the policy of interest is also sector specific, as in the case of RE policies.

commercializing clean energy technology could eventually help lower its costs and promote its commercialization globally.

Some studies found that trade openness reduced pollution and decreased the use of energy. For example, the study by Sbia et al. (2014) found that trade increased the flows of new technology which replaced the old technology heavily consuming of energy. Brack (1998) shows that trade opened the doors to international companies specializing in green and clean energy and concludes that trade openness benefits the environment. Similarly, the study by Vona and Nicolli (2013) investigated the effect of energy market liberalizations on policies that support RE in OECD countries. They found that energy trade has a positive and perhaps unintended impact on RE policies and that energy liberalization increases the public support to RE. In this case, literature shows that trade openness promoted green energy.

Finally, some studies examine the relationship between governance, trade and environment. Damania et al. (2003) tested the relationship between trade, corruption and environment quality for a mix of developed and developing countries. Authors test a random effect model and their results indicate that the impact of corruption on environmental policy couldn't be considered without taking into account trade policy regime. They argue that countries with freer trade have stricter environmental regulations. Mukherjee and Chakraborty (2013) recognized that government systems might influence pollution haven hypothesis effects, principally in countries where there is no democracy and freedom; if the government is not sensitive to environmental issues, the pollution haven hypothesis effects can be intensified.

3. Empirical strategy

3.1. Methodology

This paper investigates the link between governance, trade openness and RE investment in MENA countries. We study the impact of governance on RE investment and how trade openness can affect this relationship. As discussed in the introduction, governance is identified as the major barrier for investment in RE in MENA countries and should greatly influence the development of this sector. Nevertheless, some studies show that trade openness can reduce the negative effects of weak governance. The effect of governance seems then to depend on the level of trade openness. Two fundamental questions are studied in our paper; first, is bad governance harmful to investment in RE in MENA countries? Second, are there interaction effects between governance and trade openness regarding the development of RE?

We test these theoretical predictions using a panel estimation strategy, which presents many advantages compared to a standard cross-sectional model. In fact, panel data contains more information, greater variability of data and less colinearity between the variables. In another hand, it allows us to exploit the time-series dimension of the data and control for possible heterogeneity and omitted variables pertaining to cross-sectional estimation.

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.[8] While fixed effects panel is generally preferable in practice because it allows 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 concludes for most

[8]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.

specifications in favor of random effects panel estimation, which is in our data superior to the fixed effects model and has higher probability to generate consistent and efficient estimates. Another argument supporting our choice is that, some pertinent explanatory variables in our model 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.
Finally, we use the random effects panel model specified as follows:

$$\text{lnshareRE}_{it} = c + \delta \text{gov}_{it} + \gamma \text{gov}_{it} \times \text{open}_{it} + \alpha \text{open}_{it} + \beta X_{it} + \varepsilon_{it}, \quad (1)$$

where for country 'i' at time t, lnshareRE_{it} is the logged share of renewable energy in total primary energy produced, gov_{it} is an indicator of governance, open_{it} is a measure of trade openness, X_{it} are a set of explanatory variables traditionally used as main determinants of renewable energy and ε_{it} represents the error term, which is $\varepsilon_{it} = u_i + \nu_t + \omega_{it}$ where u_i is a country specific effects which capture important heterogeneity across countries, ν_t is a temporal effects which capture any factors that are dynamic but affect renewable energy development; u_i and ν_t must be orthogonal to ω_{it} and to the regressors, ω_{it} are the independent and identically distributed error terms. $\text{gov}_{it} \times \text{open}_{it}$ is an interaction term between the governance index and trade openness variable.

The key parameters that address our questions are δ and γ; they illustrate whether RE investment is affected by governance and, if this effect depends on trade openness. Differentiating equation (1) with respect to governance shows how our model tests these links:

$$\frac{\partial \ln shareRE_{it}}{\partial gov_{it}} = \delta + \gamma \times open_{it} \quad (2)$$

If γ is significant, then we can say that the impact of governance on renewable energy investment depends on trade openness. In addition, the hypotheses tested in this paper is that $\delta > 0$ and $\gamma < 0$. In other words, weak governance is harmful to RE investment but trade openness can reduce this negative effect. The effect of weak governance on RE investment is then significantly smaller in relatively opened countries.

3.2 Data

Given that environmental issues and especially renewable 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, whose some of them do not yet begin investment in renewable energy, they have been deleted from the study. In final, our sample is composed of 15 MENA countries including: Algeria, Egypt, Iran, Iraq, Israel, Jordan, Lebanon, Libya, Morocco, Saudi Arabia, Syria, Tunisia, Turkey, United Arab Emirates and Yemen for period 1996-2013. We restrict our sample to this period because governance data are only available as of that date.

The dependant variable corresponds normally to the amount of RE investment. However, data on RE investment are not available for MENA. In general two proxies are often used in literature, RE production and RE consumption. We follow Marques et al. (2010) and use as a proxy the share of renewable energy in total primary energy produced (ln*shareRE)*. 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 (net biomass geothermal, wind and solar) and the total primary 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 primary energy produced.

In addition, to estimate equation (1), we use three sets of explanatory variables: measures of the quality of governance, trade openness, and a set of control variables. These variables are described in turn below and all summary statistics are presented in Table 1.[9]

(a) Governance data

The primary variable of interest is governance, since it should greatly influence the use of RE sources in MENA countries. We take into account governance by using different measures provided by the Worldwide Governance Indicators (WGI) database and developed by Kaufmann et al. (2010). This database constructs aggregate indicators of six broad dimensions of governance for 212 countries since 1996, namely *Control of corruption*, *Regulatory quality*, *Rule of law*, *Government effectiveness*, *Political stability* and *Voice and accountability*. The six indicators are defined in the appendix (Table A1).
Each WGI indicator represents a different facet of governance and ranges from -2.5, the weaker governance, to +2.5, the better governance. However, In order to properly compare their estimates, we follow Ebeke et al. (2015) and Méon and Weill (2010) and rescale them so that they range between 0 and 1, where 1 corresponds to the best level of governance. In addition, this methodology will enable us to better compare results between estimations of our basic model and robustness checks estimations run in next section with other measures of governance.

(b) Trade Openness

In addition to governance indicators described above we introduce in the specification trade openness *(openness)*, which is used to control for a potential positive effect of the degree of openness on developing RE but also to detect a potential interaction with governance.
Large part of the literature found that trade openness reduced pollution and declined the use of energy (Brack, 1998; Sbia et al., 2014; Vona and Nicolli, 2013) while other studies consider the pollution haven hypothesis and recognize that more exporters have lower environmental regulations (Mongelli et al., 2006; Mukherjee and Chakraborty, 2013) and that importing countries have contrary positive impacts (Almeida and García-Sánchez, 2017).
A basic measure of trade openness is the share of exports and imports in GDP which is available in the UNCTAD database.

(c) Control variables

Due to the limited size of our sample, we introduce in our model a small number of control variables. We use four variables, which are commonly used in the literature as main determinants of RE development, and are weakly correlated.[10]

The first 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*.

The second major variable is the income, measured by the real GDP per capita. There is an important literature on the relationship between energy use and income (see for example, Apergis and Payne, 2009; Asafu-Adjaye, 2000; Ramazan and Soytas, 2007; Wolde-Rufael, 2006, 2009). In general richer countries are supposed to have more financial capacity to implement stricter environmental policies and encourage the use of renewable energy.

[9]The definition and the sources of all variables are given in the appendix (Table A1).
[10]We aimed to introduce a control for renewable energy endowments. However, for statistical constraints due to the small size of our sample, and given that countries in the sample have similar renewable energy endowments, especially solar energy, we finally prefer to focus here on most decisive determinants.

Furthermore, population of rich countries should be sensitive to environmental issues and put pressure on governments for developing cleaner energy sources. Therefore, we expect a positive sign for variable *Gdppc*.

The third control variable is pollution emissions. Indeed, 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 CO_2 emissions being a main greenhouse gas effect stemming from the combustion of fossil fuels and causing the climate change, we introduce in our model the CO_2 emissions per capita. We expect a positive sign for *CO_2 emissions* 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 and Scandurra, 2014).).

Finally, due to the specificity of our sample, the vector of explanatory variables includes a dummy OPEC to distinguish between oil exporting countries and oil importing ones. The formers are likely to continue promoting oil energy source, while the latter have a strong incentive to rely on their own renewable energy sources.

4. Results and Discussion

This section presents the main results of our estimation followed by robustness checks.

4.1. Main results

Tables 2 and 3 present the results from the estimation of model (1). Table 2 gives the results for the benchmark, which is here the pooled OLS model and Table 3 presents the random effects model estimates. Columns 1–6 of Tables 2 and 3 contain estimates from the regression model based on which aspect of governance was included. We consider as mentioned in section 3.2, *Control of corruption*, *Regulatory quality*, *Rule of law*, *Government effectiveness*, *Political stability* and *Voice and accountability*. These variables have been introduced successively in specifications (1) to (6), respectively.

Our results indicate at first glance, that random effects estimation process (Table 3) gives robust estimates and have higher probability of generating efficient estimates than the pooled OLS estimation. In fact, LM statistics indicate that, in every specification (from (1) to (6)), the null hypothesis of homogeneity of unmeasured country and time specific effects is rejected (at the 1% level). We conclude that the pooled OLS estimator is not a good estimator and that OLS estimation is not the appropriate estimation process in our study. Therefore, we will focus in the remainder of this paper on the results provided by the random effects estimation (Table 3). However, we could note that globally, the presence of random effects does not result in inconsistency of the OLS estimator. In addition, from the Wald test we reject at the 1% level the null hypothesis of non significance, as a whole, of the coefficients of the explanatory variables.

Regarding the estimation results, we can see that parameters and significances are very similar and stable across estimations and are in line with the theory. Most of control variables are intuitively signed. In fact, results show that, as expected, larger energy imports have a significant and positive effect on RE development. The positive effect for energy dependency is verified, in accordance with the literature, which argues that energy self-sufficiency aim promotes the development of renewable sources.

The income effect on RE investment is negative and statistically significant. This result is unexpected, despite being aligned with the lack of consensus in the literature. Indeed, literature is inconclusive regarding the relationship between income and environmental concerns. Our result is similar to Marques et al. (2010) who find a negative effect of income on the promotion

of RE in non-UE Members, and argue that this negative effect is explained by the low level of the GDP, suggesting scarcity of wealth to cope with RE costs. Some other studies also give evidence of a nonlinear relationship between a measure of incomes and environmental quality (Damania et al., 2003).

Regarding environmental concerns, CO_2 emissions have no significant impact on promoting RE investment in MENA countries. In the case of European countries, Marques et al. (2010) find that lobbies of traditional energy sources and CO_2 emissions rather restrain renewable deployment.

Finally, being an OPEC Member has a significant negative impact on RE investment. This is consistent with the literature which 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 et al., 2010). In addition, 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).

An important result of our study concerns the effect of governance on RE investment. Table 3 shows that, among the different indicators of governance that were introduced, control of corruption, regulatory quality, rule of law and voice and accountability statistically explain RE investment in MENA countries. Government effectiveness and political stability do not seem to matter in this context. In addition, most governance aspects reveal a positive effect on RE investment, indicating that RE investment rises with the quality of governance. Accordingly, better governance tends to be associated with more RE investment and inversely, weaker governance (with its different facets) is associated with smaller investment in clean energy in MENA region. This result is in line with previous results on the impact of governance on environmental policies (Bouoiyour et al., 2014; Damania et al., 2003; Iyer et al., 2015; Komendantova et al., 2012; Lopez and Mitra, 2000).

However, the most important result, which is central to the question studied in the present paper, is the existence of an interaction effect between governance quality and trade openness. The coefficients associated with the interaction term ($gov_{it}\times open_{it}$) are significant at 1% level regarding five of the six governance indicators (except for political stability), which implies that the effect of governance quality on RE investment depends on trade regimes.

The interaction coefficient estimates provide a sense of the effect of governance quality under different trade regimes. In the different specifications, the coefficient of the interaction term is negative. This indicates that the greater the level of trade openness, the lower will be the effect of governance on RE investment. The effect of governance on RE investment is then significantly smaller for open economies than for closed economies.

To better illustrate our results, we consider the parameters estimates from the control of corruption regression model (Table 3, column (1)). The coefficient associated to control of corruption variable corresponds in our model to the effect of the control of corruption in countries with lowest level of trade openness (openness=0). The positive sign of this coefficient simply implies that a one unit increase of control of corruption would increase RE investment in a country which level of openness is exactly zero, by 6.308. This particular observation offers a benchmark against which the other countries can be compared. Given the negative sign of the coefficient of the interaction term ($gov_{it}\times open_{it}$) in this specification, a higher trade openness level, generates a smaller effect of control of corruption on RE investment. In other words, the control of corruption has a smaller effect on RE investment in relatively open economies. To be more precise, we seek the value of openness that makes the global effect of control of corruption negative. This turning point is found at a trade openness level equal to 101.74.

Hence, the results indicate that governance quality increases RE investment in countries with an openness level below 101.74.[11]

To better assess the role of trade openness on the relationship between governance and RE investment, we turn now to the results related to trade openness variable in our model. Table 3 shows first that, in most specifications (except for specification (5)), trade openness has a positive and statistically significant impact on RE investment. This positive effect implies that more trade openness is associated with increases in RE investment, and is in line with most literature on the effect of trade openness on environmental policies. However, the negative sign of the coefficient associated with the interaction term indicates that the better the institution qualities, the smaller the effect of trade openness on RE investment. Then, trade openness has a stronger effect on RE investment among countries with poor institutions.

Consider again estimates from the control of corruption specification, a one unit increase of trade openness would increase RE investment in a highly corrupted country (control of corruption=0), by 0.028. This effect is smaller when the level of control of corruption is better, and becomes negative if observed values of control of corruption are high (best control of corruption). More precisely, we find that the turning point is 0.451, which means that trade openness increases RE investment in countries with a control of corruption level below 0.451. The development of RE in those countries is thus largely due to their openness which compensate the negative effect of their weak governance. This finding highlights the role played by the trade in mitigating the negative impact of weak institutions of some MENA countries on RE investment.

Our results are best compared to recent studies on the effect of governance on environmental policies that have considered the possibility of interaction effect with trade policies. Our findings point in the same direction of the studies of Ades and Di Tella (1999), Blake and Martin (2002) and Damania et al. (2003) who show that trade openness might balance the negative effect of bad governance and suggest that countries which do not favor institutional improvements can establish a policy of open market.

In the case of MENA region, it seems that bad governance and protectionism (distorted trade policy) are complements in the explanation of low level of investment in RE in MENA region. Bad governance increases investment costs, in addition to those of distorted trade policy, and then discourages investment in RE.

4.2. Robustness checks

In order to assess the robustness of our results, we run additional estimations using an alternative governance indicators database, i.e. the International Country Risk Guide (ICRG) database to investigate whether the results are robust to the use of other measures of governance. This database provides longitudinal rating for more than 140 countries based on 22 variables classified into three categories of risks: political, financial and economic risks.

We first include in our estimation the political risk rating, comprising 12 components covering both political and social attributes.[12] This indicator can be considered as an alternative measure of overall quality of governance and political stability. Secondly, we distinguish only six

[11]All turning points are given in Tables 3, only for significant coefficients.

[12]Each component is assigned a maximum numerical value (risk points), with the highest number of points indicating the lowest potential risk for that component and the lowest number (0) indicating the highest potential risk. The maximum points able to be awarded to any particular risk component is pre-set within the system and depends on the importance (weighting) of that component to the overall risk of a country (PRS Group, ICRG methodology).

components of this index, as alternative institutional variables to WGI governance indicators. More precisely, to take into account various aspects of governance, suitable for comparison with WGI governance indicators used in Section 3.2, we include the components which seem the most relevant: *Corruption*, *Bureaucracy quality*, *Law and order*, *Investment profile*, *Government stability* and *Democratic accountability*.[13] These variables as well as their interaction with trade openness have been introduced successively in specifications (1) to (7), respectively. For comparative purposes, all governance indicators have also been rescaled to range between 0 and 1, where 1 corresponds to the best level of governance.

Globally, the results are qualitatively similar to those obtained in Section 4.1 (based on WGI governance indicators). Estimates of Table 4 support the general results of Table 3. Coefficients signs and significances of the control variables are largely consonant and are still in line with the theory. For example, in both tables we find that larger energy imports, weaker income and being not OPEC member are factors which increase RE investment in MENA countries.

Regarding our key variables, Table 4 shows that governance quality remains of the theoretically correct sign. Considering its individual significance, the positive statistically significant effect of governance is confirmed for two aspects i.e. bureaucracy quality and democratic accountability. More specifically, bureaucracy quality appears as the most important component impacting MENA region investment in RE. Countries where the administration is efficient and tends to be somewhat autonomous from political pressure are more likely to promote clean investment. Indeed, developing RE should result from a long-term strategy which is only possible in countries with some strength and expertise and which do not to proceed to drastic revisions when governments change.

Regarding trade openness, Table 4 shows that the coefficient on this variable is positive and statistically significant at conventional levels in specifications which consider political risk index, bureaucracy quality and democratic accountability as governance indicators. This confirms that more open economies tend to have more RE investment.

Finally, results of Table 4 still point to the existence of governance effect that is conditional on the level of trade openness. The interaction effect is negative and statistically significant at conventional levels, for political risk index, corruption, bureaucracy quality, and democratic accountability. The negative sign of the interaction term confirms that the greater the level of openness, the lower the effect of governance quality on RE investment. Similarly, we can say that the conditional effect of trade openness depending on governance stringency is confirmed in these robustness estimations. The greater the governance quality, the lower the effect of trade openness on RE investment.

5. Conclusions and policy implications

This paper investigates the main determinants of RE investment in MENA countries who have a great potential of renewable energy production. In addition to traditional factors commonly used to explain RE investment, we particularly focus on the role of governance quality, which is considered as a major issue in the region. We also explore the interaction effect between governance and trade openness on RE investment. In fact, recent literature shows that the effect of governance on environmental policies is conditional on the trade regime. Our paper tries in this context to fill the gap of the apparent lack of literature considering the link between governance, trade openness and RE investment in MENA region.

The empirical findings of our paper show that governance has globally a positive impact on RE investment in MENA countries. However, this effect seems to be conditional on trade

[13]See definition and summary statistics in the appendix (Table A2).

regime. In fact, results show that a bad governance is less detrimental to RE investment in relatively open economies. In opposite, distorted trade policies increase the effect of bad governance on clean investment. Similarly, trade has a stronger positive effect on RE investment among countries with poor institutions than among countries with good institutions. Thus, protectionism and bad governance appear to be complements in the explanation of the low level of RE investment in MENA region. Our findings are robust to several measures of governance quality.

Several policy implications emerge from our study. The identification of this governance and openness effects may be an important input for policy-makers by indicating the areas where efforts and reforms are necessary in order to promote RE investment in MENA region. In this case efforts have to be made in improving administration quality in closed economies and in enhancing liberalization in countries with weak governance to overcome these issues.

For relatively less open economies, authorities have to guarantee good governance to encourage RE investment. Our research identifies the aspects of governance where the action of national political community is the most beneficial to RE investment. In this case, efforts have to be made on implementing a better regulatory and bureaucracy quality in addition to a more democratic system. Second, as recommended by international organizations, MENA governments have to promote international trade. In addition, countries plagued with very inefficient institutions may benefit from letting globalization grow. Then, MENA countries should promote greater partnerships with other regions of the world in order to promote research and technology transfer. More specifically, MENA region should promote regionally integrated markets for renewable energy technologies in order to realize economies of scale that attract private sector investments.

Our paper suggests that in countries who do not favor institutional improvements, or in which these improvements could take time, openness constitutes a good alternative to raise their investment in renewable energy. This seems as a necessity for the region to enhance growth, to reduce its dependence on non-renewable energy sources as well as for environment purpose. Furthermore, developing renewables could be important to generate employment, which constitutes another main issue in MENA region in addition to fighting bad governance. An interesting future research could then examine the effect of renewable energy on employment in MENA countries.

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Table 1. Summary statistics

Variable	Mean	Standard déviation	Minimum	Maximum
lnshareRE	-4.084	3.755	-11.838	3.520
Control of corruption	0.430	0.134	0.184	0.794
Regulatory quality	0.422	0.164	0.066	0.764
Rule of law	0.439	0.139	0.115	0.749
Government effectiveness	0.448	0.146	0.110	0.773
Political stabiliy	0.390	0.157	0.0008	0.713
Voice and accountability	0.318	0.128	0.091	0.652
Openness	79.171	30.511	30.383	180.605
Share imports	-107.236	190.541	-559.061	97.193
Gdppc	7537.384	9993.269	698.967	46856.84
CO_2 emissions	6.121	6.371	0.724	36.904
OPEC	0.4	0.490	0	1

Table 2. Trade openness, governance and renewable energy investment: OLS regression estimates

Dependent variable: lnshareRE						
	(1)	(2)	(3)	(4)	(5)	(6)
Control of corruption	15.501***					
	(5.26)					
Regulatory quality		6.935***				
		(3.04)				
Rule of law			6.838**			
			(2.31)			
Government effectiveness				12.587***		
				(3.89)		
Political stabiliy					1.162	
					(0.56)	
Voice and accountability						19.665***
						(5.83)
Control of cor* openness	-0.139***					
	(-5.08)					
Regulatory qua* openness		-0.123***				
		(-4.13)				
Rule of law* openness			-0.111***			
			(-3.56)			
Government eff* openness				-0.143***		
				(-4.53)		
Political sta* openness					-0.022	
					(-1.01)	
Voice and acc*openness						-0.152***
						(-3.82)
Openness	0.071***	0.066***	0.058***	0.076***	0.015*	0.063***
	(5.49)	(4.54)	(3.88)	(4.89)	(1.80)	(4.33)
Share imports	0.011***	0.014***	0.013***	0.012***	0.013***	0.010***
	(12.00)	(15.64)	(13.63)	(11.87)	(14.56)	(11.21)
Gdppc	0.1E-3***	0.2E-3***	0.1E-3***	0.1E-3***	0.1E-3***	0.5E-4*
	(5.31)	(7.19)	(7.31)	(5.45)	(6.99)	(1.82)
CO_2 emissions	-0.377***	-0.390***	-0.375***	-0.374***	-0.392***	-0.261***
	(-8.21)	(-8.39)	(-7.84)	(-7.99)	(-7.58)	(-5.09)
OPEC	-0.580	-0.638	-0.788*	-0.697*	-0.771*	-0.590
	(-1.50)	(-1.48)	(-1.94)	(-1.78)	(-1.83)	(-1.59)
Intercept	-8.855***	-5.226***	-5.044***	-7.875***	-2.346***	-8.979***
	(-6.53)	(-4.85)	(-3.59)	(-5.08)	(-2.95)	(-7.29)
N	217	217	217	217	217	217
R^2	0.864	0.858	0.857	0.859	0.847	0.874

Notes: t-statistics are displayed in parentheses under the coefficient estimates; *** denotes significant at the 1% level, ** denotes significant at the 5% level, * denotes significant at the 10% level. All models are significant at the 1% level.

Table 3. Trade openness, governance and renewable energy investment: Random Effect Panel estimates

Dependent variable : lnshareRE						
	(1)	(2)	(3)	(4)	(5)	(6)
Control of corruption	6.308***					
	(4.12)					
Regulatory quality		4.143**				
		(2.50)				
Rule of law			5.220***			
			(2.90)			
Government effectiveness				3.302		
				(1.52)		
Political stabiliy					0.124	
					(0.10)	
Voice and accountability						4.537**
						(2.27)
Control of cor* openness	-0.062***					
	(-3.86)					
Regulatory qua* openness		-0.049***				
		(-2.92)				
Rule of law* openness			-0.060***			
			(-3.16)			
Government eff* openness				-0.065***		
				(-3.46)		
Political sta* openness					-0.012	
					(-1.04)	
Voice and acc* openness						-0.071***
						(-3.20)
Openness	0.028***	0.020***	0.026***	0.029***	0.004	0.021***
	(3.60)	(2.64)	(3.00)	(3.33)	(0.82)	(2.84)
Share imports	0.002***	0.002***	0.002***	0.002***	0.002**	0.002***
	(2.81)	(3.13)	(2.76)	(3.20)	(2.08)	(2.75)
Gdppc	-0.9E-4***	-0.7E-4***	-0.8E-4***	-0.9E-4***	-0.7E-4***	-0.5E-4***
	(-4.38)	(-3.69)	(-4.11)	(-4.63)	(-3.43)	(-3.01)
CO_2 emissions	0.016	0.016	0.022	0.020	0.025	0.009
	(0.64)	(0.63)	(0.91)	(0.85)	(1.00)	(0.38)
OPEC	-4.710***	-4.814***	-4.924***	-4.928***	-5.193***	-5.250***
	(-5.70)	(-5.80)	(-5.80)	(-5.81)	(-6.37)	(-6.22)
Intercept	-4.079***	-3.039***	-3.638***	-2.644**	-1.434**	-2.608***
	(-4.78)	(-3.58)	(-3.73)	(-2.41)	(-2.06)	(-3.01)
N	217	217	217	217	217	217
Wald (χ^2)	106.61***	102.22***	95.90***	104.88***	93.47***	98.07***
LM (χ^2)	480.27***	386.95***	451.73***	471.45***	478.26***	509.33***
Openness turning point	101.741	90.061	87			63.901
Governance turning point	0.451	0.408	0.433	0.446		0.295

Notes: Robust t-statistics are displayed in parentheses under the coefficient estimates; *** denotes significant at the 1% level, ** denotes significant at the 5% level, * denotes significant at the 10% level; the Wald test tests the null hypothesis of non-significance of all coefficients of explanatory variables; the LM test tests the null hypothesis of non-relevance of individual effects.

Table 4. Robustness checks: Testing alternative measures of governance

Dependent variable : lnshareRE							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Political risk rating	0.848						
	(0.48)						
Corruption		1.080					
		(1.11)					
Bureaucracy quality			4.226***				
			(3.73)				
Law and order				1.016			
				(0.83)			
Investment profile					0.812		
					(0.70)		
Government stability						1.492	
						(1.43)	
Democratic accountability							1.719**
							(2.39)
Political ris* openness	-0.039*						
	(-1.77)						
Corruption* openness		-0.026**					
		(-1.97)					
Bureaucracy qua*openness			-0.056***				
			(-4.93)				
Law and ord*openness				-0.024			
				(-1.30)			
Investment pro*openness					-0.021		
					(-1.52)		
Government sta*openness						-0.007	
						(-0.57)	
Democratic acc*openness							-0.021**
							(-2.23)
Openness	0.026*	0.009	0.017	0.016	0.026***	0.006	0.010*
	(1.81)	(1.51)	(1.59)	(1.26)	(4.39)	(0.59)	(1.75)
Share imports	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002**
	(2.60)	(2.74)	(2.75)	(2.72)	(3.34)	(2.95)	(2.34)
Gdppc	-0.7E-4***	-0.7E-4***	-0.7^{E}-4***	-0.5E-4***	-0.9E-4***	-0.5E-4***	-0.6E-4***
	(-3.70)	(-3.77)	(-3.70)	(-3.01)	(-5.06)	(-2.77)	(-3.37)
CO_2 emissions	0.031	0.024	0.035	0.023	0.029	0.018	0.019
	(1.26)	(0.98)	(1.41)	(0.90)	(1.24)	(0.74)	(0.76)
OPEC	-5.225***	-5.144***	-5.096***	-5.296***	-4.884***	-5.062***	-5.256***
	(-6.59)	(-6.62)	(-6.20)	(-6.68)	(-5.92)	(-5.87)	(-6.07)
Intercept	-2.000*	-1.673**	-2.102**	-2.082**	-3.239***	-2.639***	-2.139***
	(-1.66)	(-2.47)	(-2.25)	(-2.09)	(-4.27)	(-2.63)	(-3.27)
N	217	217	217	217	217	217	217
Wald (χ^2)	100.43***	101.66***	115.22***	96.63***	94.09***	86.84***	87.33***
LM (χ^2)	487.5***	392.79***	545.06***	443.46***	429.28***	465.73***	527.68***
Openness turning point			75.464				81.857
Governance turning point	0.666						0.476

Notes: Robust t-statistics are displayed in parentheses under the coefficient estimates; *** denotes significant at the 1% level, ** denotes significant at the 5% level, * denotes significant at the 10% level; the Wald test tests the null hypothesis of non-significance of all coefficients of explanatory variables; the LM test tests the null hypothesis of non-relevance of individual effects.

Appendix

Table A1. Data sources and variables definitions

Variable	Definition	Source
Share_RE	Percentage of renewable energy in total primary energy production	OECD and EIA
Control of corruption	Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests	WGI Database
Regulatory quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	WGI Database
Rule of law	Perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence	WGI Database
Government effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	WGI Database
Political stability	Perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism	WGI Database
Voice and Accountability	Perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association	WGI Database
Openness	Exports +imports (% GDP)	UNCTAD
Share imports	Energy imports (% energy use)	World Development Indicators
Gdppc	GDP per capita (constant 2005 US$)	World Development Indicators
CO_2 emissions	CO2 emissions (metric tons per capita)	World Development Indicators
OPEC	Dummy variable taking 1 for OPEC countries, 0 otherwise	Authors

Table A2. Definition and summary statistics of ICRG governance indicators

Variable	Definition	Mean	Standard deviation	Minimum	Maximum
Political risk rating	Political and social attributes of a country	0.616	0.100	0.319	0.793
Corruption	Assessment of corruption within the political system	0.380	0.134	0.166	0.833
Bureaucracy Quality	Institutional strength and quality of the bureaucracy	0.483	0.205	0	1
Law and Order	Strength and impartiality of the legal system and its popular observance	0.666	0.180	0.250	1
Investment Profile	Risks to investment	0.660	0.153	0.250	0.958
Government Stability	Government's ability to carry out its declared program(s), and its ability to stay in office	0.753	0.135	0.430	0.916
Democratic accountability	How responsive government is to its people	0.490	0.278	0	1