INTERNATIONAL
HELLENIC
UNIVERSITY

Energy, growth, corruption and institution.

VASILEIOS BISKAS

SID: 3302120026

SCHOOL OF SCIENCE & TECHNOLOGY

A thesis submitted for the degree of
Master of Science (MSc) in Energy Systems

MARCH 2015
THESSALONIKI – GREECE

Energy, growth, corruption and institution.

VASILEIOS BISKAS

SID: 3302120026

Supervisor: Prof. Eftichios S. Sartzetakis

Supervising Committee Members: Assoc. Prof. Name Surname
Assist. Prof. Name Surname

SCHOOL OF SCIENCE & TECHNOLOGY

A thesis submitted for the degree of

Master of Science (MSc) in Energy Systems

MARCH 2015

THESSALONIKI – GREECE

Table of Contents

Abstract

This dissertation is written as a part of the MSc in Energy Systems. This study investigates if the presence of corruption or poor institutions has any effect on promoting the renewable energy. Alternative models including corruption and institutional estimates among the main drivers promoting renewable energy are estimated. A set of eighty countries with yearly data from 2001 to 2011 is being used. Panel data methodology of Fixed Effects and Random Effects is being applied. With the estimation of different models that include the corruption and institutional estimates we demonstrate the main drivers of the renewable energy. The main drivers of renewables are estimated to be the share of the common energy resources and the GDP per capita. The CO2 emission per capita, the energy use per capita, the growth of GDP and the share of energy imports are not estimated as significant drivers for the renewables. Regarding the corruptions and the institutional estimates, only the Government effectiveness was proven to have a significant negative link with the share of renewables. The links between the CPI, the Control of Corruption and the Government Effectiveness are presented but they are not found significant.

1. Introduction

The aim of this study is to investigate which are the main drivers in the increased penetration of renewable energy systems. The drivers that are considered are not only social or economical. The scope is to investigate if the presence of corruption or other estimates of poor quality of the institutions have an effect on the growth of renewable energy systems and applications. The analysis uses different estimation models in order to accumulate all the variables. The methodology is based on the most common techniques (OLS, Fixed Effects and Random Effects) in the estimations of panel data. The analysis is conducted for eighty countries with the time span from 2001 to 2011 using yearly data.

According to the definition of the International Energy Agency (IEA), renewable energy is the energy derived from natural resources that are replenished at a faster rate than they are consumed. Common sources of renewables are considered the solar, wind, hydro and some forms of biomass. The applications of renewables are many but the main is the electricity generation. Renewables are considered the main alternative in order to avoid and adheres the increasing global warming. Renewables are also considered a main contributor in the energy diversification of a country. The increase in energy diversification increases the energy security that is currently considered as an important section of the modern energy policy.

For those reasons it is important to investigate which are the main drivers of the growth of the renewable energy systems. But as it is obvious it is not only the different economical factors that affect the renewable energy systems. There are also certain political and social factors also effect the decision of implementing the different policies. But it is essentially the quality of institutions that control the policies, which is the unobserved main driver that affect the implementation of a certain policy.

The literature extensively examines the link between institutions and resource abundance. The evidence of the influence of resources policies under the presence of corruption are presented by many authors [Sachs and Warner (1995),Leite and Weidemann(1999) etc.]. However, only recently Gennaioli and Tavoni (2011) refered on the presence of a resource curse on renewable energy resources. They concluded that inefficient institutions can lead to adverse effect on policies.

The evaluation of renewable energy policy was investigated by many authors [Carley (2009), Marques and Fuinhas(2012) etc]. They all investigated which are the main drivers of the renewable energy policy using different variables. Marques,Fuinhas and Manso (2010) reviewed extensively the main drivers of the promotion of renewable energy.

This study is organized as following. Section 2 extensively reviews the literature of the drivers of the renewable energy. Section 3 presents the models and analytical framework used in the analysis. Section 4 described the data used in the analysis. Section 5 presents and describes the empirical findings. Section 6 provides the concluding remarks and the discussion of the findings.

2. Literature Review

Our scope is to investigate which are the main drivers in the penetration of renewable energy systems. The area of our concentration is the effect of the quality of the institutions or the presence corruption on the renewable energy. We also want to investigate what are the main socioeconomic factors that drive the growth of the renewable energy share in the total energy supply. Since the literature in this area is minimum, we start our review from the point of how the exploitation of natural resources and the environment is affected by institutions. Then we focus on the presence of corruption or low quality institutions in the formation of the environmental policy. Finally we review the literature in order to identify, which are the main factors that have effect on the implementation of the renewable energy systems.

The exploitation of natural resources and its economic impact has been an important area of discussion among economic literature. The main contributor is Auty (1993,1997,2001) who introduced the natural resource curse. Based on historical evidence he concludes that regions with abundant natural resources continue to have low income per capita and apparently low levels of economic growth. Although the low levels of economic growth can be interpretated by the presence of low quality institutions in the perception of corruption. Both Mauro (1995) and Mo (2000) using empirical methods conclude that corruption has an effect on economic growth using the corruption as a control for the institutions performance.

Sachs and Warner (1995) made a major contribution in the natural resource curse literature, by introducing the first econometric evidence that incorporates the institution's quality. They used some institutional index that incorporates corruption following Mauro's (1995) approach among other explanatory variables, finding a negative association between natural resource abundance and growth. Based on these findings Leite and Weidemann (1999) theoretically and empirically investigates the link between the natural resources and growth through the channel of corruption and institutional quality. They conclude that the level of corruption depends on the abundance of natural resources and the institution's operating regime .Their results further support the negative growth effect of natural resources, which is affected by the corruption and the institutional quality. Although a more resent study from Brunnschweiler (2006) has findings that contradict the previous resource curse literature. Her results indicate a positive relationship between natural resources (in this case mineral resources) and the GDP growth and between natural resources and the GDP growth and institutional quality.

Some other authors have implemented the use of the democracy index as an institution indicator. Bhattacharyya and Hodler (2009) investigate how natural resources effect corruption and if the democratic institutions have impact in this process. They conclude that resource rents increase corruption and this relationship depends on the quality of democratic institutions. Neumayer

(2002) investigates the link between democracies and environmental commitment. Although his findings support a positive link, his findings can have no implementation on the formation of policy.

Kolstad and Søreide (2009) have reviewed extensively the literature on natural resources and corruption. They conclude that corruption is the main contributor for the resource curse phenomenon. Rent-seeking and patronage are the main forms of corruption in countries that have abundant natural resources. Their suggestions focus on the implementation of policies that intercept and comprise those forms of corruption. Damania(2002) tried to investigate the presence of corruption in the environmental regulators, the institutions that are responsible for the synthesis and implementation of the environmental policy. He concludes that corruption can have an effect on the regulators, leading to diminishing enforcement of the perceived policy. Although these findings are based only on a theoretical and not an empirical model and further investigation is suggested.

Pellegrini and Gerlagh (2006) discuss the determinants of environmental policies' austerity in European Union, assessing the environmental regulators' performance. They conclude that corruption has a strong adverse effect on policy stringency, which is greater than the income's positive effect. Their suggestions for the environmental policy focus on the further control of corruption and the improvement of institutional quality in the low income countries. Lapatinas, Litina and Sartzetakis (2013) theoretically demonstrate an alternative perspective of the affect of corruption on environmental policy. It is argued that the environmental policy's effectiveness can be reduced by the presence of corruption, through the exploitation of the environment's public funds from policy makers.

Some authors investigated the link between policy formation, corruption and the political institutions. Fredriksson and Svensson (2002) developed a theoretical model of environmental policy formation considering the levels of corruption and political instability. Their empirical evidence supports their theoretical findings, suggesting that corruption has a negative effect on the performance of the environmental regulators and that the interaction of corruption and political instability is significant and important. However the political instability does not seem to have an effect on policy formation. Damania and Wilson (2004) construct a theoretical model to incorporate in the environmental policy and the environmental outcomes, the effects of the corruption and the political competition. Their results suggest that political competition leads to the adoption of tighter environmental policies and better environmental protection, although the effect of corruption on the policy formation cannot be eliminated. Fredriksson and Vollebergh (2009) investigate the effect of corruption on the environmental policy formation under the scope of different structures of political intuitions, and especially the presence of federalism. Their results suggest that government corruption diminish the energy policy measures. However this result is not valid when we take in to consideration the enforcement of the federal systems, where the effect of corruption is reduced.

In the literature it is extensively reviewed how the natural resource management policies are influenced by the presence of corruption. Based on this relationship some authors [Sachs and Warner (1995), Leite and Weidemann (1999) ,etc] find evidence of the existence of the resource curse. However until recently there was no reference on the presence of a resource curse in the renewable energy resources. This contribution comes from Gennaioli and Tavoni (2011), in their effort to assess the potential for resource curse in the renewable energy sector.

They establish both theoretical and empirical approach to analyze the relationship between the policy schemes for wind energy and the opportunity for rent-seeking and corruption. In their political economy approach the model of corruption allows the entrepreneur to decide whether to invest in the wind energy in a province and if he will make the bride to the politicians. The theoretical approach findings suggest that not only wind level but also the social and political institutions influence the expansion of the wind energy. These findings are consistent according to their empirical approach that estimates the level of criminal association. They concluded that poorly functioning institutions can lead to adverse effect of efficient policies.

However this approach needs to be criticized thoroughly. First of all the data originates only from Italy and in order to draw sufficient policy suggestions a larger sample of countries is required. Although their theoretical appears to take in to consideration the possible income of the investment decision, the empirical evidence does not use any explanatory variable for the level of income. So it is not possible to draw any assessment on resource curse, but only on the effects of corruption on the expansion of wind energy. In addition, the corruption is not estimated by a widely used index but by the violent crime index that is calculated for the specific country. Moreover their approach does not consider the other renewable energy resources that are available since the models are specifically oriented only on the wind energy.

In order to design and implement effective energy and environmental policy it is vital to understand the relationship between energy and economic growth. This has been investigated thoroughly in the energy economics literature. Many authors [Soytas and Sari(2003 and 2007), Lee and Chang (2005) and Payne (2008)] cannot find a clear and unified result, but only country specific results. However recent studies [Apergis and Payne(2009), Belke,Dreger and De Haan(2010) and Sharma(2010)] using advance econometric estimation methods and new empirical models find a positive strong bi-directional relationship between energy consumption and growth .

Recently there is a growing literature investigating the relationship between renewable energy and economic growth. Apergis and Payne (2009 and 2010) find empirical evidence on the presence of a positive bi-directional causality between renewable energy consumption and economic growth in the OECD and Eurasia countries respectively. Menegaki (2010) also estimates a positive relationship between renewable energy and GDP, although there are no evidence for the presence of a casual relationship between renewable energy and economic growth. Chien and Hu (2008) using a Structural Equation Modeling conclude that renewable energy has positive effect on GDP only through the channel of capital formation and not the channel of energy imports. Marques and Fuinhas (2012) find a negative relationship between economic growth and the share of renewable resources in energy supply.

In the scope of the global warming Menyah and Walde-Rufael (2010) examine the relationship between carbon dioxide emissions, renewable and nuclear energy production and GDP in US. Their empirical evidence suggests that nuclear energy consumption can reduce CO2 emissions, although renewable energy has no effect on emissions. The causality effect on renewable is positive from emissions, negative from GDP and insignificant from nuclear resources. Menyah and Walde-Rufael with Apergis and Payne (2010) have revised the previous article by using an error correction model for a group of 19 countries. In the long –run emissions are negatively affected by nuclear energy and positively by renewable energy. Although in the short-run the nuclear can reduce CO2 emissions, renewable have no effect on emissions. The renewable energy in the short-run have a negative association with nuclear and emissions and positive with economic growth.

The evaluation of the renewable energy policy is constant in the literature. Gan, Eskeland and Kolshus(2005) asses the different renewable energy policy instruments in electricity at the regions of Europe and US. They suggest the presence of more crystallized and sound policy objectives, increased focus on research and development, selection of the best mixture of policy instruments and improved capacity for effective policy implementation. Jenner (2010) evaluates the impact Feed-in Tariffs among different renewable energy technologies, through an extensive econometric model. The evidence suggests that Feed-in Tariffs were effective only in some forms of renewable energy and policy structure should be country-specific and technology-specific.

The evaluation of the renewable energy policy has been empirically investigated by many authors. Huang, Alavalapati, Carter and Langholtz (2007) investigate the different factors that affect the adoption of renewable portfolio standards (RPS) in individual states of United States (U.S). As explanatory variables are used the Gross state product (GSP), growth rate of population (GRP), political party dominancy, education level, natural resources expenditure, and share of coal in electricity generation. The empirical results suggest that education affects positively most the adoption of RPS, followed by the state product (GSP) and the growth of population (GRP). The political party domain and the natural resource expenditure have negative effect on the adoption of RPS. Yin and Power (2009) introduce a new measurement method for the RPS and investigate the impact on the renewable electricity. They conclude that the adoption of policy has a positive influence on the share of renewable and that only the energy import ratio from the socio-economic variables of energy has a significant positive effect on the renewable’ share. Carley (2009) also evaluates the effectiveness of RPS in the share of renewable energy. The empirical evidence suggests mixed results of the significance of the RPS policy. From the explanatory variables only the level of the state product seems to have a consistent positive effect on the share of renewable energy. Marques and Fuinhas(2012) investigate the impact of renewable policy in the European Union. They empirically test among other drives of the renewable, the effect of the policies on the share of renewable. They conclude that public policy supporting renewable have a consistent positive effect on the share of renewable. From the other explanatory variables only the available energy seems to positive relationship with the share of renewable. Emissions, energy imports and the other electricity production methods have negative relationship with the renewable energy.

Marques, Fuinhas and Manso(2010) investigate what are the main drivers for the promotion and growth of renewable energy systems. They use as explanatory variables for the political, socio-economical and the country specific factors. The empirical results are based on data for a panel of European countries. Their evidence suggests that traditional energy resources and CO2 emissions have negative effect on the deployment of renewable resources. The target of reducing energy dependency promotes the renewable, but the prices of the energy products do not seem to be statistically significant. The GDP seems to have significant effect on renewable's promotion only in the EU members.

From reviewing the literature some major conclusions can be drawn. As most of the authors agree that the exercise of environmental or energy policy can be affected by the presence of corruption in the different levels of the institutions. The presence of corruption also affects the renewable energy policies as Gennaioli and Tavoni (2011). The recent empirical studies that investigate the relationship between renewable energy and growth suggest the existence of a positive by-directional relationship. The attempts of policy evaluations in literature have highlighted the major drivers that affect the growth of renewable energy systems. The share of conventional energy methods, the energy imports and the level of emissions tend to be the most significant drivers. Our approach on investigating the drivers of renewable energy systems has the novelty of incorporating the quality of institutions and corruption closing the gap that exists in the literature.

3. Methodology

In this paragraph, we will analyze the panel equation using the fixed effects and random effects approach. In the random effects we will use all three approaches. Then we test the results under the two main hypothesis tests. The f-test and Haussmann test.

3.1 Panel estimation

A panel data model may specified according to the following model:

$$y_{it} = \alpha + X_{it}'\beta + u_{it} \qquad (1)$$

Where y_{it} is the dependent variable, X_{it} is a K-vector of regressors, and u_{it} are the error terms for $i = 1, 2, \ldots, M$ cross-sectional units observed for dated periods $t = 1, 2, \ldots, T$. The parameter α represents the overall constant of the model and β are coefficients $K \times n$, where n is the number of different regressors. The most recent panel data methodology utilizes a two – way error component model for the disturbances, with :

$$u_{it} = \mu_i + \lambda_t + \varepsilon_{it} \qquad (2)$$

Where μ_i denotes the unobserved individual (cross-section) effect, λ_t denotes the unobservable time effect and ε_{it} is the remainder stochastic disturbance term.

Expressing the above equations as a set of M cross-sectional equations with T observations stacked one over another we derive the following equation:

$$y_i = \alpha J_T + X_i{}'\beta_{it} + \mu_i J_T + I_T \lambda + \varepsilon_i \qquad (3)$$

for $i = 1, 2, ..., M$, where J_T is a T -element unit vector, I_T is the T -element identity matrix , and λ is a vector containing all the period effects, $\lambda' = (\lambda_1, \lambda_2, ..., \lambda_T)$.

Likewise, specifying the equations as a set of T period equations, with M observations stacked one over another for each equation we derive the following equation:

$$y_t = \alpha J_M + X_t{}'\beta_{it} + I_M \mu + J_M \lambda_t + \varepsilon_t \qquad (4)$$

for $t = 1, 2, ..., T$, where J_M is a M -element unit vector, I_M is the M -element identity matrix , and μ is a vector containing all the cross-section effects, $\mu' = (\mu_1, \mu_2, ..., \mu_M)$.

Imposing the stacked representation and specifying the equations as cross-sectional, we have:

$$y = \alpha J_{MT} + X\beta + (I_M \otimes J_T)\mu + (J_M \otimes I_T)\lambda + \varepsilon \qquad (5)$$

With error covariance matrix:

$$\Omega = E(\varepsilon\varepsilon') = E\begin{pmatrix} \varepsilon_1\varepsilon_1' & \varepsilon_2\varepsilon_1' & \varepsilon_M\varepsilon_1' \\ \varepsilon_2\varepsilon_1' & & \\ \vdots & \ddots & \vdots \\ \varepsilon_M\varepsilon_1' & \cdots & \varepsilon_M\varepsilon_M' \end{pmatrix} \qquad (6)$$

If we organize the equations as period specific, the representation is given by:

$$y = \alpha J_{MT} + X\beta + (I_M \otimes I_T)\mu + (I_M \otimes J_T)\lambda + \varepsilon \quad (7)$$

With error covariance matrix:

$$\Omega = E(\varepsilon\varepsilon') = E\begin{pmatrix} \varepsilon_1\varepsilon_1' & \varepsilon_2\varepsilon_1' & \varepsilon_T\varepsilon_1' \\ \varepsilon_2\varepsilon_1' & & \\ \vdots & \ddots & \vdots \\ \varepsilon_T\varepsilon_1' & \cdots & \varepsilon_T\varepsilon_T' \end{pmatrix} \quad (8)$$

3.2 Fixed and Random effects

We are able to incorporate the presence of cross-sectional and periodical terms μ and λ using the fixed or random effects.

3.3 Fixed Effects

If the μ_i and λ_t are assumed as fixed parameters and the remaining error term ε_{it} is assumed to be independent and identically distributed, then (2) represents a two-way fixed effects model. The following Q is the Within transformation operator of fixed effect:

$$\hat{\beta}_{OLS} = \left(\sum_i X_i' Q X_i\right)^{-1}\left(\sum_i X_i' Q y_i\right) \quad (9)$$

$$Q = I_M \otimes I_T - I_M \otimes \bar{J}_T - \bar{J}_M \otimes I_T + \bar{J}_M \otimes \bar{J}_T$$

Where (10)

3.4 Random Effects

If the μ_i ,λ_t and the error term ε_{it} are assumed to be independent and identically distributed, with mean zero and finite variance and assume also that they independent of each other, then this represents a two-way fixed effects model. From (2), we can estimate the covariance matrix to perform the first step of Generalized Least Squared(GLS) method :

$$\Omega = E(\varepsilon\varepsilon') = \sigma_\mu^2 \left(I_M \otimes J_T\right) + \sigma_\lambda^2 \left(J_M \otimes I_T\right) + \sigma_\varepsilon^2 \left(I_M \otimes I_T\right) \quad (11)$$

In the computation of the matrix we use one of the quadratic unbiased estimators (QUE) from Swamy-Arora, Wallace-Hussain, or Wansbeek- Kapteyn. The moment estimates of the component variances $\left(\sigma_\mu^2, \sigma_\lambda^2, \sigma_\varepsilon^2\right)$ are computed using the expected values from the quadratic forms in one or more sets of first-stage estimated residuals. The method of Swamy-Arora uses residuals from fixed effect and means regression. The Wallace-Hussain uses only OLS residuals. The Wansbeek-Kapteyn uses residuals from fixed effects estimator.

After estimating the component variances, we construct an estimator for the residual covariance, and perform the GLS transformation of the dependent and regressor. The cross-sectional GLS estimator is the according:

$$\hat{\beta}_{GLS} = \left(\sum_i X_i^{'} \hat{\Omega}_M^{-1} X_i\right)^{-1} \left(\sum_i X_i^{'} \hat{\Omega}_M^{-1} y_i\right) \quad (12)$$

3.5 Hypothesis Testing

Testing For Fixed Effects

We could test the joint significance of the dummy variables:

$$\mathrm{H}_0 : \mu_1 = \ldots = \mu_{M-1} = 0 \quad \text{and} \quad \lambda_1 = \ldots = \lambda_{\mathrm{T}-1} = 0$$

, by performing an F-test:

$$F = \frac{\left(RRSS - USSS\right) / \left(k\right)}{\left(USSS\right) / \left(d.f.\right)} \overset{H_0}{\sim} F_{(k),(d.f.)} \quad (13)$$

This is a simple Chow test with the restricted residual sums of squares (RRSS) and the unrestricted residual sum of squares (USSS).

The RRSS is that from the pooled OLS regression of (1):

$$y_{it} - \tilde{y}_{i.} = \beta(X_{it}' - \tilde{X}_{i.}') + \left(u_{it} - \tilde{u}_{it}\right) \quad (14)$$

The USSS is that from the Within regression in Fixed effects:

$$y_{it} - \tilde{y}_{i.} - \tilde{y}_{.t} - \tilde{y}_{..} = \beta(X_{it}' - \tilde{X}_{i.}' - \tilde{X}_{.t}' - \tilde{X}_{..}') + \left(u_{it} - \tilde{u}_{it} - \tilde{u}_{.t} - \tilde{u}_{..}\right) \quad (15)$$

With $F_1 \overset{H_0}{\sim} F_{(M+T-2),(M-1)(T-1)-K}$

Following we can test the existence of individual effects allowing for time effects

$\mathrm{H}_0 : \mu_1 = ... = \mu_{M-1} = 0$ allowing $\lambda_T \neq 0$ for $t = 1, 2, ..., T-1$

The RRSS is based on the regression with time-series dummies only:

$$y_{it} - \tilde{y}_{.t} = \beta(X_{it}' - \tilde{X}_{.t}') + \left(u_{it} - \tilde{u}_{.t}\right) \quad (15)$$

The USSS remains the same as (15). In this case F-statistic is $F_2 \overset{H_0}{\sim} F_{(M-1),(M-1)(T-1)-K}$

Correspondingly, we can test the significance of time effects allowing for individual effects

$\mathrm{H}_0 : \lambda_1 = ... = \lambda_{T-1} = 0$ allowing $\mu_i \neq 0$ for $i = 1, 2, ..., M-1$

The RRSS is given by regression (14) and the USSS by regression (15). In this case F-statistic is

$F_3 \overset{H_0}{\sim} F_{(T-1),(M-1)(T-1)-K}$.

Hausman's Specification Test

A central assumption in Random effects estimation is the assumption that the random effects are uncorrelated with the explanatory variables ($E\left(u_{it} / X_{it}\right)=0$). In the case $E\left(u_{it} / X_{it}\right)\neq 0$ the Random Effects estimator ($\hat{\beta}_{GLS}$) is biased. Hausman(1978) suggest comparing $\hat{\beta}_{GLS}$ and $\hat{\beta}_{OLS}$ under the null hypothesis $H_0 : E\left(u_{it} / X_{it}\right)=0$.

A test statistic would be based on

$$\hat{q}_1=\hat{\beta}_{GLS}-\hat{\beta}_{OLS} \quad (16)$$

and under H_0, $\hat{q}_1=0$ and $\operatorname{cov}\left(\hat{q}_1,\hat{\beta}_{GLS}\right)=0$.

4. Data

4.1 Sources

For the analysis yearly data are used from 80 countries. The panel ranges from 2001 to 2011. The countries chosen for the analysis are the ones with the widest possible time spam in yearly data necessary for accounting for all the control and institutional variables as they will be presented. The source of the data for the dependent variable and the control variables is the World Development Indicators from the World Bank. The sources of the data for the institutional variables are the Transparency International for the Corruption Perceptions Index and the World Bank's World Governance Indicators for the three Institutional estimators. The countries are presented in the Table .

Countries in Data Set		
Australia	France	Panama
Austria	Gabon	Peru
Belarus	Germany	Philippines
Belgium	Greece	Poland
Benin	Guatemala	Portugal
Bolivia	Haiti	Romania
Brazil	Honduras	Russia
Bulgaria	Hungary	Senegal
Cambodia	Iceland	Singapore
Cameroon	India	Slovakia
Canada	Indonesia	Slovenia
Chile	Ireland	South Africa
China	Israel	Spain
Colombia	Italy	Sweden
Costa Rica	Japan	Switzerland
Côte d´Ivoire	Kenya	Thailand
Croatia	Korea (South)	Togo
Cyprus	Latvia	Tunisia
Czech Republic	Lithuania	Turkey
Denmark	Luxembourg	Ukraine
Dominican Republic	Malaysia	United Kingdom
Ecuador	Malta	United States
Egypt	Mexico	Uruguay
El Salvador	Morocco	Vietnam
Eritrea	Netherlands	
Estonia	New Zealand	
Ethiopia	Nicaragua	
Finland	Norway	

Table 4.1 :Sample of Countries

4.2 Descriptive Statistics

For the analysis there is a wide range of variables that are used. We will represent their descriptive statistics in separate sets. This approach is based on the Marques et al. (2010) that uses political and socio-economical factors to determine the drivers of renewable energy.

Dependent Variable

The dependent variable is the share of the Renewable resources on the total electricity production. Although we use data from electricity production like Carley (2011) and Marques et al. (2010; 2011), we prefer not to use the natural logarithms of the share of renewable. This decision is based on the fact that it is crucial for the methodological approach of a two-way error component model to have balanced data. If we imply the natural logarithms we will have unbalanced data and we are able only to use the Fixed Effects from our panel methodology as described in the previous chapter. The descriptive statistics and the histogram of the dependent variable are presented on the following table.

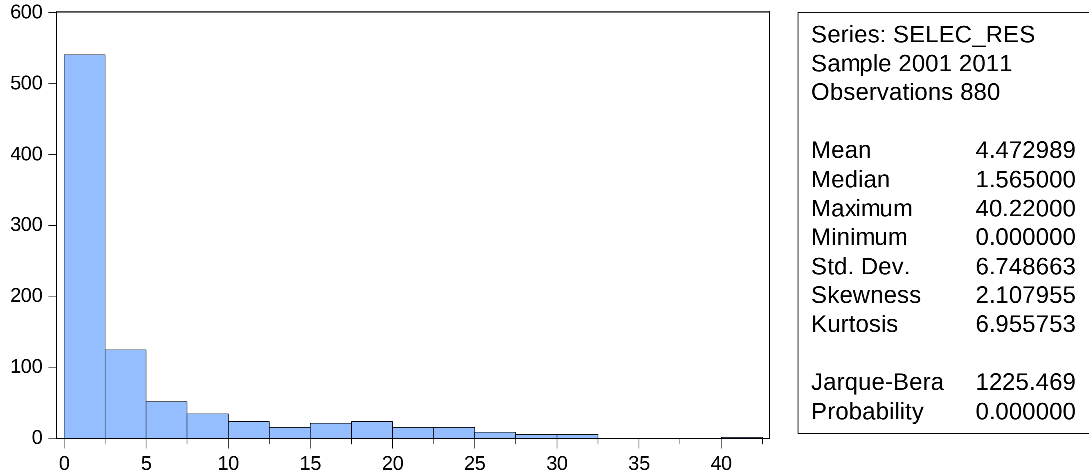

Table 4.2 : Histogram and Descriptive statistics of the share of Renewable resources

Independent Variables

The independent variables that we have selected can be separated in two large sets. The one set includes variables that represent the economic and social situation of each state. The other set include the variables that represent the corruption and institutional estimates of the state.

Socio-economic Factors

In order to incorporate the strength of the other energy sources that contribute in the electricity production we use as variables their share. We consider the shares of natural gas, coal, hydroelectric, nuclear and oil on the total electricity production. The descriptive statistics of the common energy sources are presented on the following table .

COMMON ENERGY SOURCES IN ELECTRICITY SUMMARY STATISTICS					
Variable	SELC_NG	SELEC_COAL	SELEC_HYDRO	SELEC_NUC	SELEC_OIL
Mean	20.98944	20.58257	26.64803	9.591773	17.83872
Median	13.115	12.68	14.185	0	3.79
Maximum	99.04	95.53	99.69	82.24	100
Minimum	0	0	0	0	0
St. Dev	24.93334	25.67439	28.07266	18.13091	27.6454
Skewness	1.356414	1.321834	0.94161	2.025283	1.901966
Kurtosis	4.058115	3.876701	2.721401	6.491629	5.529954
Jarque-Berra	310.8981	284.4449	132.8849	1048.613	765.2539
Prob	0	0	0	0	0

Table 4.3 COMMON ENERGY SOURCES IN ELECTRICITY

It can be seen from the data that common energy sources retain their large share in electricity production compared to the share of renewable resources. The hydroelectric production seems to have the largest share with the share of nuclear electric production to be the smallest. The fossil fueled electricity production seems to have marginally the same share.

It is also essential to consider the use of variables for the economic and social situation of the selected countries. Though, we consider as economic variables the natural logarithm of the available Gross Domestic Product per Capita and the share of the economic growth of the state. As a variable for the energy dependency of a country we use the data for the share of total energy imports over the total energy use. For the interpretation of the social apprehension of energy efficiency and the environmental concerns, we use the natural logarithms of the CO2 emission per capita and energy use per capita. The next Table presents the descriptive statistics of the socioeconomic variables.

SOCIO-ECONOMIC VARIABLES SUMMARY STATISTICS					
Variable	LCO2PC	LENERG_PC	LGDP_PC	ENERG_IM	GROWTH
Mean	1.150826	7.41549	8.7485	8.679409	3.465795
Median	1.609478	7.660267	8.749805	39.04	3.635
Maximum	3.211519	9.79615	11.38187	99.92	14.78
Minimum	-2.93549	4.834932	4.902382	-848.94	-17.95
St. Dev	1.296603	1.01775	1.544526	129.1618	3.684868
Skewness	-0.962	-0.27808	-0.323128	-4.44569	-0.8242
Kurtosis	3.252668	2.115913	2.121573	25.40954	6.44308
Jarque-Berra	138.0735	40.00043	43.60696	21312.28	534.3073
Prob	0	0	0	0	0

Table 4.4 SOCIO-ECONOMIC VARIABLES

Corruption and Institutional Estimates

For the scope of our analysis we use variables for the quality of the institutions. We use estimates for the control of corruption, the government effectiveness and the regulatory quality. We also use the Corruption Perception Index which is considered as the best estimate for the corruption of the institutions of a country The descriptive statistics of the corruption and the institutional estimates are presented on the following table.

CORRUPTION AND INSTITUTIONAL ESTIMATES SUMMARY STATISTICS				
Variable	CPI	CCor	GovEff	RegQ
Mean	49.6915	0.379347	0.478432	0.49717
Median	42	0.125	0.46	0.5275
Maximum	99	2.55	2.43	2.03
Minimum	14	-1.82	-1.68	-2.26
St. Dev	23.89915	1.098039	1.019939	0.918992
Skewness	0.551256	0.434204	0.024425	-0.290207
Kurtosis	1.932719	1.92404	1.86987	2.197886
Jarque-Berra	86.33611	70.10015	46.91792	35.94318
Prob	0	0	0	0

Table 4.5 CORRUPTION AND INSTITUTIONAL ESTIMATES

5. Results

In the literature so far, the institutional drivers of the renewable resources were not examined thoroughly and the Random Effects models were not used. In this study we employ a group of different models as described in the methodological approach. First we use models that do not include any estimate for the performance of institutions in order to evaluate the performance of the variables that are widely referenced as common drivers for the implementation of the renewable. The results are presented on the following Table.

Dependent Variable :SHAREOF RES		**OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS WITHOUT CORRUPTION ESTIMATE**						
Type of Model		**OLS**	**FE-FIXED PERIOD**	**FE-CROSSSECTION FIXED**	**FE-2WAY**	**RE Wansbeek-Kapteyn**	**RE Wallace - Hussain**	**RE Swamy - Arora**
SHARE OF OIL	Coefficient	**-0.54789*****	**-0.539294*****	**-0.896555*****	**-0.845053*****	**-0.842510*****	**-0.824394*****	**-0.824394****
	t-stat	**-31.16833**	**-30.54706**	**-67.99869**	**-60.97112**	**-63.87007**	**-60.72866**	**-60.72866**
SHARE OF NUCLEAR	Coefficient	**-0.509917*****	**-0.502653*****	**-0.678945*****	**-0.648962*****	**-0.650392*****	**-0.645510*****	**-0.645510*****
	t-stat	**-31.88041**	**-31.32871**	**-62.75951**	**-59.40602**	**-61.05172**	**-57.63196**	**-57.63196**
SHARE OF HYDROELECTRIC	Coefficient	**-0.513417*****	**-0.504419*****	**-0.895027*****	**-0.841778****	**-0.837872*****	**-0.817503*****	**-0.817503*****
	t-stat	**-29.68424**	**-28.98949**	**-70.75144**	**-62.50575**	**-65.12580**	**-61.54417**	**-61.54417**
SHARE OF COAL	Coefficient	**-0.547516*****	**-0.539795*****	**-0.917210*****	**-0.864831*****	**-0.864025*****	**-0.848024*****	**-0.848024*****
	t-stat	**-29.07068**	**-28.58450**	**-71.63261**	**-63.98530**	**-66.75099**	**-63.17899**	**-63.17899**
SHARE OF NG	Coefficient	**-0.549498*****	**-0.543474*****	**-0.899586*****	**-0.860195*****	**-0.856285*****	**-0.838133****	**-0.838133*****
	t-stat	**-31.45583**	**-31.07389**	**-67.75774**	**-63.77009**	**-65.89719**	**-62.18748**	**-62.18748**

LGDP PER CAPITA	Coefficient	0.256283	0.197678	0.356849	-2.113067***	-1.520784***	-1.250282***	-1.250282***
	t-stat	0.953619	0.729716	1.165379	-5.301194	-4.683159	-4.249188	-4.249188
LENERGY USE PER CAPITA	Coefficient	0.626456	0.626125	0.278117	0.423537	0.441638	0.453154	0.453154
	t-stat	1.37723	1.380456	0.703657	1.117756	1.202505	1.196453	1.196453
LCO2 EMISSIONS PER CAPITA	Coefficient	-0.883998**	-0.801137***	-0.189249	-0.077754	-0.085704	-0.079547	-0.079547
	t-stat	-2.362673	-2.143853	-0.995689	-0.427445	-0.478481	-0.418486	-0.418486
GDP GROWTH	Coefficient	-0.052748	-0.054321	-0.012595	0.000762	-0.002807	-0.004038	-0.004038
	t-stat	-1.284877	-1.113019	-1.469097	0.074006	-0.278719	-0.372467	-0.372467
SHARE OF ENERGY IMPORTS	Coefficient	0.005143***	0.005165***	0.000224	-0.002469	-0.002039	-0.001887	-0.001887
	t-stat	4.307515	4.338549	0.137233	-1.561905	-1.367823	-1.281779	-1.281779
CONSTANT	Coefficient	49.89009***	49.56699***	83.66496***	99.51324***	93.98079***	89.90167***	89.90167***
	t-stat	13.73109	13.66522	25.56196	27.85190	30.92958	32.31446	32.31446
EFFFECT SPECIFICATION	Cross-sectional	NO	NO	YES-FIXED	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
	Period	NO	YES-FIXED	NO	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
R-squared		0.623591	0.630719	0.988273	0.989509	0.866090	0.848162	0.889781
Adjusted-R^2		0.619259	0.622121	0.986951	0.988177	0.864549	0.846415	0.888641
Akaike info criterion		5.703351	5.706958	2.414150	2.325510	-	-	-
Schwarz criterion		5.7631	5.821024	2.903005	2.868683	-	-	-
Log-likehood		-2498.474	-2490.062	-972.2259	-923.2243	-	-	-
F-statistic		143.9656	73.35718	748.0160	743.0914	562.0437	485.4217	780.3751
ProbF-stat		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

* 10% level of significance ** 5% level of significance *** 1% level of significance

Table 5.1 : OLS, FIXED EFFECTS AND RANDOM EFFECTS MODELS WITHOUT CORRUPTION ESTIMATE

From the table we can conclude the following. First of all the application of the effects models increased the predictive ability. The Fixed Effects models that include the cross-sectional effects have the higher R-squared values than the respective models estimated with the Random Effects. The models estimated with the OLS and the Fixed Effects with period effects have the lower values.
Furthermore, in all the different models estimated the coefficients of all the common energy methods in the electricity power are negative and highly statistically significant. All the coefficients tend to increase in absolute numbers, when applying models that have higher predictive ability. In addition the constant term of the estimated model is also highly statistically significant, but positive with high values.

Although there are some mixed results when we observe the estimates of the different socio-economic variables that are considered in our models. The coefficient of the share of the GDP per capita in the OLS and the one way Fixed Effects models is positive, with no high value and not significant. However, when why apply the two-way Fixed Effects and the Random Effects models it is statistical significant with high negative value.

This is also the case in the coefficients of the share of energy imports. In the OLS and the one way Fixed Effects models the coefficient is positive, while in the remaining model is positive. The coefficients of the energy imports are highly significant only in the OLS and the model with the Fixed period Effects.

The coefficients of the energy use per capita are all non significant with positive value. The estimates for the CO2 emissions per capita are all negative, with statistical significant only those in the OLS and the model with the Fixed period Effects. The economic growth has mostly negative coefficients, expect of the two-way Fixed effect model, although they are all non significant.

A crucial question that arises is which methodology used performs better, by proving its results. For this reason we perform the hypothesis test as described in our methodology to examine the efficiency of our results.

FE-RE MODELS		FIXED EFFECTS-RANDOM EFFECTS MODELS HYPOTHESIS TESTS WITHOUT CORRUPTION ESTIMATE					
Type of Model		FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
Hypothesis Test		F-test	F-test	F-test	Hausman-test	Hausman-test	Hausman-test
Cross-section	Statistic	-	310.964926	337.652688	28.526859	0.000000	0.000000
	Probability	-	0.0000	0.0000	0.0015	1.0000	1.0000
Period	Statistic	1.658247	-	9.188829	7.349890	0.348710	0.000000
	Probability	0.0862	-	0.0000	0.6921	1.0000	1.0000
Cross-section and Period	Statistic	-	-	305.669167	26.979634	0.000000	0.000000
	Probability	-	-	0.0000	0.0026	1.0000	1.0000
						Cross-section test variance is invalid	Cross-section test variance is invalid
							Period test variance is invalid

Table 5.2: Hypothesis testing for the Fixed Effects and Random Effects Models without Corruption estimate

From the Hausman tests we can conclude that the Random effects estimators in all three different estimated models are not efficient and there is no presence of endogeneity. Especially in the Random Effects models that are estimated with the Wallace-Hussain and Swamy-Arora the test for the variance of the cross-section effect are invalid. From the F-test responsible for testing the heterogeneity of the models we can observe that they are all highly significant. So we should account for the observed heterogeneity.

Models with Corruption Perception Index (CPI)

In this section the estimations of the models that include the Corruption Perception Index (CPI) are presented. The results are summarized on the following Table.

Dependent Variable :SHAREOF RES		OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS WITH CORRUPTION PERCEPTION INDEX(CPI)						
Type of Model		OLS	FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
SHARE OF OIL	Coefficient	-0.547822***	-0.538625***	-0.895954***	-0.845071***	-0.842525***	-0.825224***	-0.879803***
	t-stat	-31.11927	-30.44764	-67.88667	-60.93146	-63.82041	-60.82699	-67.55527
SHARE OF NUCLEAR	Coefficient	-0.509713***	-0.501055***	-0.678836***	-0.649006***	-0.650404***	-0.645628***	-0.676698***
	t-stat	-31.55344	-30.86134	-62.74773	-59.34685	-60.96957	-57.67653	-63.12913
SHARE OF HYDROELECTRIC	Coefficient	-0.513330***	-0.503608***	-0.895145***	-0.841889***	-0.837892***	-0.818322***	-0.880443***
	t-stat	-29.61830	-28.85980	-70.75949	-62.36310	-64.94369	-61.51691	-70.85107
SHARE OF COAL	Coefficient	-0.547481***	-0.539385***	-0.916998***	-0.864895***	-0.864043***	-0.848673***	-0.904355***
	t-stat	-29.04643	-28.53738	-71.60836	-63.91149	-66.62947	-63.17838	-71.13708
SHARE OF NG	Coefficient	-0.549390***	-0.542584***	-0.899629***	-0.860277***	-0.856299***	-0.838876***	-0.883558***
	t-stat	-31.36234	-30.91900	-67.76224	-63.67509	-65.75311	-62.17670	-66.96791
LCO2 EMISSIONS PER CAPITA	Coefficient	-0.871152**	-0.708561*	-0.191084	-0.000709	-0.085783	-0.078332	-0.233179
	t-stat	-2.182695	-1.772120	-1.005326	-0.429381	-0.478537	-0.412933	-1.271258
LENERGY USE PER CAPITA	Coefficient	0.613250	0.532703	0.297028	0.426008	0.441670	0.448063	-
	t-stat	1.286085	1.119655	0.750694	1.122308	1.199703	1.181094	-
LGDP PER CAPITA	Coefficient	0.238352	0.069865	0.376428	-2.107473***	-1.519758***	-1.278088***	0.180973
	t-stat	0.719946	0.208939	1.226935	-5.256514	-4.602122	-4.188132	0.734480
GDP GROWTH	Coefficient	-0.052832	-0.054800	-0.012677	0.000709	-0.002814	-0.003863	-0.010812
	t-stat	-1.285876	-1.122344	-1.478610	0.068769	-0.279012	-0.356979	-1.241414
SHARE OF ENERGY IMPORTS	Coefficient	0.005128***	0.005059***	0.000160	-0.002474	-0.002038	-0.001899	-0.000374
	t-stat	4.253659	4.209202	0.098164	0.068769	-1.366533	-1.288078	-0.240930
CONSTANT	Coefficient	50.06259***	50.77804***	83.74097***	99.50476***	93.97553***	90.16728***	86.60376***
	t-stat	12.26217	12.45885	25.57915	27.82785	30.80951	31.98988	33.83726
CPI	Coefficient	0.001196*	0.008451	-0.007983	-0.001034	-4.54E-05	0.001614	-0.012039
	t-stat	0.092845	0.652444	-1.018717	-0.137361	-0.006146	0.206910	-1.553392
EFFFECT SPECIFICATION	Cross-sectional	NO	NO	YES-FIXED	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
	Period	NO	YES-FIXED	NO	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM

R-squared	0.623594	0.630902	0.988288	0.989509	0.866091	0.849088	0.890231
Adjusted-R^2	0.618824	0.621869	0.986952	0.988162	0.864394	0.847176	0.888968
Akaike info criterion	5.705614	5.708735	2.415108	2.327758	-	-	-
Schwarz criterion	5.770795	5.828233	2.909395	2.876363	-	-	-
Log-likehood	-2498.470	-2489.843	-971.6476	-923.2136	-	-	-
F-statistic	130.7293	69.83754	739.7516	734.7353	510.3649	443.9734	704.7640
ProbF-stat	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

* 10% level of significance ** 5% level of significance *** 1% level of significance

Table 5.3 : OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS WITH CORRUPTION PERCEPTION INDEX (CPI)

The estimations of the models with the CPI provide quite similar values with the previous models. There are only minor differences on the values of the estimates of the common energy methods and the constant, which remain highly significant with negative and positive effect respectively. The mixed coefficients of the socio-economic variables can also be observed in the various models. The share of energy imports and the economic growth have similar estimates with the previous models. The CO2 emissions per capita have negative values. Although only in the first two models the estimates are significant. On contrast the energy use per capita has positive values that are not significant.. The estimates of the GDP per capita are separated in the positive non significant and the negative highly significant.

We should note that the variable of the energy use per capita is not included to the estimation of the Random effects with the Swamy-Arora method. This is done to avoid the presence of more variables than the cross-section number, a constrain of this method. When the model was estimated with its presence, the estimate was not significant.

Regarding the estimates of the CPI that is the main addition to the estimations we can conclude the following. All the estimates have small value and they are mostly non significant. The only significant value is the one of the OLS model. There is also no clear evidence of the effect on the dependent variable because there are mixed results regarding of the signs of the estimates. Overall we can conclude that the CPI estimate is not a significant and consistent estimate for the quality of the institutions, when try to interpretate it as a variable for the growth of the renewable energy.
Regarding the efficiency of the results of the models estimated the Table 5.4 summarizes the required tests.

FE-RE MODELS	FIXED EFFECTS-RANDOM EFFECTS MODELS HYPOTHESIS TESTS WITH CORRUPTION PERCEPTION INDEX(CPI)

Type of Model		FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
Hypothesis Test		F-test	F-test	F-test	Hausman-test	Hausman-test	Hausman-test
Cross-section	Statistic	-	310.989748	337.056089	28.557810	0.000000	0.000000
	Probability	-	0.0000	0.0000	0.0027	1.0000	1.0000
Period	Statistic	1.698838	-	9.064771	7.417921	0.395775	0.000000
	Probability	0.0766	-	0.0000	0.7643	1.0000	1.0000
Cross-section and Period	Statistic	-	-	305.281771	28.240151	0.000000	0.000000
	Probability	-	-	0.0000	0.0030	1.0000	1.0000
						Cross-section test variance is invalid	Cross-section test variance is invalid
							Period test variance is invalid

Table 5.4: Hypothesis testing for the Fixed Effects and Random Effects Models with Corruption Perception Index (CPI)

From the Hausman test we can reject the null hypothesis of the efficiency of the Random Effects estimations. On the contrary the Fixed effects estimates prove to be highly significant.

Models with Control of Corruption Estimate

In this section the models that include the Control of Corruption are summarized. The estimations results are presented on the following Table.

Dependent Variable :SHAREOF RES		OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS WITH CONTROL OF CORRUPTION ESTIMATE						
Type of Model		OLS	FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
SHARE OF OIL	Coefficient	-0.548311***	-0.538554***	-0.896204***	-0.845971***	-0.843657***	-0.825901***	-0.880879***
	t-stat	-31.09098	-30.35047	-68.26901	-60.78892	-63.67164	-60.57801	-68.29451
SHARE OF NUCLEAR	Coefficient	-0.510751***	-0.501370***	-0.680967***	-0.650108***	-0.651649***	-0.646593***	-0.679396***
	t-stat	-31.50736	-30.72173	-63.08532	-58.93174	-63.67164	-57.15794	-63.98756

SHARE OF HYDROELECTRIC	Coefficient	-0.513861***	-0.503637***	-0.896131***	-0.843119***	-0.839409***	-0.819323***	-0.881894***
	t-stat	-29.60109	-28.77843	-71.11721	-62.05402	-60.55534	-61.15814	-71.55937
SHARE OF COAL	Coefficient	-0.547796***	-0.542466***	-0.916541***	-0.865707***	-0.865204***	-0.849576***	-0.904797***
	t-stat	-29.03986	-28.48442	-71.88395	-63.79916	-66.51316	-62.91962	-71.92340
SHARE OF NG	Coefficient	-0.550153***	-0.542466***	-0.901841***	-0.861592***	-0.857898***	-0.839970***	-0.887428***
	t-stat	-31.26729	-30.73436	-68.10351	-63.26748	-65.31951	-61.61194	-67.99622
LCO2 EMISSIONS PER CAPITA	Coefficient	-0.921966**	-0.747361*	-0.159425	-0.072055	-0.081337	-0.078425	-0.194607
	t-stat	-2.349606	-1.898234	-0.841173	-0.395668	-0.453713	-0.413215	-1.068217
LENERGY USE PER CAPITA	Coefficient	0.661495	0.578099	0.362624	0.441849	0.460947	0.466298	-
	t-stat	1.413844	1.237969	0.918866	1.163400	1.251325	1.227956	-
LGDP PER CAPITA	Coefficient	0.320370	0.108678	0.305273	-2.077268***	-1.469205***	-1.216904***	0.215642
	t-stat	0.958470	0.320218	0.999555	-5.173712	-4.441289	-3.973695	0.894567
GDP GROWTH	Coefficient	-0.052269	-0.054910	-0.010003	0.001369	-0.002318	-0.003726	-
	t-stat	-1.271715	-1.124126	-1.165172	0.132418	-0.229748	-0.343985	-
SHARE OF ENERGY IMPORTS	Coefficient	0.005210***	0.005073***	-0.000370	-0.002573	-0.002113	-0.001925	-0.000849
	t-stat	4.296734	4.193967	-0.226080	-1.620966	-1.413730	-1.304459	-0.548077
CONSTANT	Coefficient	49.19224***	50.51727***	83.72981***	99.22055***	93.56422***	89.70009***	86.04634***
	t-stat	11.63045	11.93146	25.69406	27.60142	30.29742	31.17938	33.73821
CON TROL CORRUPTION	Coefficient	-0.090552	0.124054	-0.533404***	-0.141267	-0.137874	-0.088777	-0.653231***
	t-stat	-0.322766	0.435689	-2.826623	-0.757199	-0.757727	-0.464523	-3.616367
EFFFECT SPECIFICATION	Cross-sectional	NO	NO	YES-FIXED	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
	Period	NO	YES-FIXED	NO	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
R-squared		0.623636	0.630801	0.988390	0.989516	0.866277	0.848968	0.848968
Adjusted-R^2		0.618866	0.621765	0.987066	0.988170	0.864582	0.847054	0.847054
Akaike info criterion		5.705504	5.709009	2.406347	2.327047	-	-	-
Schwarz criterion		5.770685	5.828508	2.900634	2.875651	-	-	-
Log-likehood		-2498.422	-2489.964	-967.7927	-922.9005	-	-	-
F-statistic		130.7524	69.80713	746.3383	735.2638	511.1847	443.5562	443.5562
ProbF-stat		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

* 10% level of significance ** 5% level of significance *** 1% level of significance

Table 5.5 : OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS with Control of Corruption Estimate

The estimators of the shares of the common energy sources in electricity production are negative and highly significant. That is consistent with our previous findings. The constant is also positive and highly significant in all models estimated.

The control of corruption is estimated to have negative values in the most of the models. Although only in two of the models the estimate is statistically significant.

The CO2 emissions per capita is estimated to have negative values that are mainly non significant. Energy use estimates are positive and non significant, while economic growth estimates are negative but mostly non significant. The estimates for the energy imports and the GDP per capita does not seem to have major variations from the ones estimated but when they are significant their values are positive and negative respectively.

The results of the hypothesis testing of the models are similar to the previous ones. The Random effects models' estimators are non efficient, while the Fixed effect estimators are efficient. The results are presented on the following Table.

FE-RE MODELS		FIXED EFFECTS-RANDOM EFFECTS MODELS HYPOTHESIS TESTS WITH CONTROL OF CORRUPTION ESTIMATE					
Type of Model		FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
Hypothesis Test		F-test	F-test	F-test	Hausman-test	Hausman-test	Hausman-test
Cross-section	Statistic	-	313.778574	337.398426	28.52029	0.000000	0.000000
	Probability	-	0.000000	0.000000	0.0027	1.0000	1.0000
Period	Statistic	1.665168	-	8.36755	7.427408	0.490999	0.000000
	Probability	0.0845	-	0.000000	0.7635	1.0000	1.0000
Cross-section and Period	Statistic	-	-	305.470699	29.253963	0.000000	0.000000
	Probability	-	-	0.000000	0.0021	1.0000	1.0000
						Cross-section test variance is invalid	Cross-section test variance is invalid
							Period test variance is invalid

Table 5.6 : FIXED EFFECTS-RANDOM EFFECTS MODELS Hypothesis Testing with Control of Corruption Estimate

Models with Government Effectiveness Estimate.

The estimations of the models that include the Government Effectiveness are presented on the following Table.

Dependent Variable :SHAREOF RES		OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS WITH GOVVERMENT EFFECTIVENESS ESTIMATE						
Type of Model		OLS	FE-FIXED PERIOD	FE-CROSSSECTI ON FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
SHARE OF OIL	Coefficient	-0.547749***	-0.538581***	-0.889102***	-0.843339***	-0.841231***	-0.823646***	-0.833035***
	t-stat	-31.14291	-30.49355	-67.34878	-60.88602	-63.85513	-60.81855	-62.70075
SHARE OF NUCLEAR	Coefficient	-0.509788***	-0.502044***	-0.675350***	-0.648297***	-0.649905***	-0.645028***	-0.644763***
	t-stat	-31.85462	-31.27958	-62.77182	-59.45796	-61.14837	-57.80282	-60.08749
SHARE OF HYDROELECTRIC	Coefficient	-0.513250***	-0.503603***	-0.886671***	-0.839763***	-0.836251***	-0.816413***	-0.828227***
	t-stat	-29.65640	-28.92394	-69.74216	-62.34763	-65.03597	-61.56377	-64.10453
SHARE OF COAL	Coefficient	-0.548059***	-0.540688***	-0.906368***	-0.861345***	-0.860846***	-0.845421***	-0.852366***
	t-stat	-29.03956	-28.61291	-69.81193	-63.41548	-66.23257	-62.86343	-64.85581
SHARE OF NG	Coefficient	-0.549289***	-0.542713***	-0.893722***	-0.858818***	-0.855304**	-0.837794***	-0.847161***
	t-stat	-31.42148	-31.01395	-67.50195	-63.74216	-65.93535	-62.35487	-64.62454
LCO2 EMISSIONS PER CAPITA	Coefficient	-0.841057**	-0.697048*	-0.195262	-0.086724	-0.096742	-0.090970	-0.020543
	t-stat	0.383906	-1.813141	-1.036697	-0.477726	-0.541322	-0.480536	-0.117107
LENERGY USE PER CAPITA	Coefficient	0.585285	0.532398	0.276323	0.403816	0.425201	0.447854	-
	t-stat	1.265889	1.155492	0.705519	1.067850	1.160360	1.186460	-
LGDP PER CAPITA	Coefficient	0.150595	-0.051604	0.557030*	-1.859646*	-1.224422***	-0.968961***	-1.063038***
	t-stat	0.441499	-0.148714	1.810580	-4.482482	-3.548208	-3.002521	-3.566062
GDP GROWTH	Coefficient	-0.054616	-0.060261	-0.010115	0.002495	-0.001148*	-0.002336	0.000325
	t-stat	-1.324426	-1.228088	-1.187384	0.8089	-0.114125	-0.215931	0.031451
SHARE OF ENERGY IMPORTS	Coefficient	0.005029***	0.004905***	-0.000303	-0.002614*	-0.002127	-0.001915	-0.002153
	t-stat	4.136150	4.048267	-0.187025	-1.655650	-1.429377	-1.303136	-1.458621
CONSTANT	Coefficient	50.99617***	52.12237***	81.60182***	97.47861***	91.60170***	87.61573***	92.47283***
	t-stat	12.00703	12.25269	24.83840	26.42547	28.73739	29.31441	30.72641
GOVERNMENT EFFECTIVNESS	Coefficient	0.168164	0.388080	-0.853375***	-0.463799**	-0.503152**	-0.493519**	-0.455693**
	t-stat	0.503495	1.149231	-3.941025	-2.144623	-2.373039	-2.203510	-2.109073
EFFFECT SPECIFICATION	Cross-sectional	NO	NO	YES-FIXED	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
	Period	NO	YES-FIXED	NO	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM

R-squared	0.623700	0.631287	0.988499	0.989570	0.867122	0.849614	0.860116
Adjusted-R^2	0.618932	0.622262	0.987187	0.988231	0.865438	0.847708	0.858506
Akaike info criterion	5.705332	5.707693	2.396929	2.321896	-	-	-
Schwarz criterion	5.770513	5.827191	2.891216	2.870500	-	-	-
Log-likehood	-2498.346	-2489.385	-963.6486	-920.6340	-	-	-
F-statistic	130.7884	69.95296	753.4838	739.1013	514.9365	445.8006	534.3294
ProbF-stat	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

* 10% level of significance ** 5% level of significance *** 1% level of significance

Table 5.7 : OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS with Government Effectiveness Estimate

The estimations of the government effectiveness have some interesting results. Only the OLS and the Fixed periods effects models have a positive value for the government effectiveness that is although not significant. All the remaining Fixed effects and all the Random effects models , have high significant estimators that are negative.

The common energy methods and the constant do not have any significant difference in their estimated values. The energy use per capita has positive but non significant values. The CO2 emissions per capita variable has estimated negative values that are significant only for the first two types of models. The estimators of energy imports do not have many variations from the ones estimated with other models previously. The GDP growth does not also have many major differences from the values that are formerly estimated. The estimator of the GDP per capita has some contradicting values, although those that are highly significant are consistent with our results so far.

In the Hypothesis testing of the models there is no breakthrough. The Random Effects estimates remain inefficient with the Fixed Effects estimates highly efficient. The results are summarized on the following Table

FE-RE MODELS		FIXED EFFECTS-RANDOM EFFECTS MODELS HYPOTHESIS TESTS WITH GOVVERMENT EFFECTIVENESS ESTIMATE					
Type of Model		FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
Hypothesis Test		F-test	F-test	F-test	Hausman-test	Hausman-test	Hausman-test
Cross-section	Statistic	-	316.786146	338.732455	28.037076	0.000000	0.000000
	Probability	-	0.0000	0.000000	0.0032	1.0000	1.0000
Period	Statistic	1.765365	-	8.000204	7.187106	0.341763	0.000000
	Probability	0.0629	-	0.000000	0.7837	0.000000	1.0000
Cross-section and Period	Statistic	-	-	307.039166	27.718796	0.000000	0.000000
	Probability	-	-	0.000000	0.0036	1.0000	1.0000

Cross-section test variance is invalid	Cross-section test variance is invalid
	Period test variance is invalid

Table 5.8 : FIXED EFFECTS-RANDOM EFFECTS MODELS Hypothesis Testing with Government Effectiveness Estimate

Models with Regulatory Quality Estimate

The models that include the estimate of the Regulatory Quality are presented on the following Table.

Dependent Variable :SHAREOF RES		OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS WITH REGULATORY QUALITY ESTIMATE						
Type of Model		OLS	FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
SHARE OF OIL	Coefficient	-0.549389***	-0.539780	-0.895161***	-0.845100***	-0.842516***	-0.822836***	-0.878601***
	t-stat	-31.67208	-31.08184	-67.66087	-60.92077	-63.81991	-60.48468	-67.24135
SHARE OF NUCLEAR	Coefficient	-0.510373***	-0.502232***	-0.677916***	-0.649023***	-0.650435***	-0.644931***	-0.676108***
	t-stat	-32.34055	-31.82186	-62.49437	-59.33292	-60.97510	-57.39910	-62.87458
SHARE OF HYDROELECTRIC	Coefficient	-0.516507***	-0.506518***	-0.893624***	-0.841820***	-0.837875**	-0.815773***	-0.877856***
	t-stat	-30.24722	-29.58599	-70.37298	-62.45665	-65.07249	-61.25717	-70.15341
SHARE OF COAL	Coefficient	-0.555574***	-0.547582***	-0.916274***	-0.864830***	-0.864004***	-0.846479***	-0.903208***
	t-stat	-29.78483	-29.39169	-71.45376	-63.94518	-66.70845	-62.90697	-70.83879
SHARE OF NG	Coefficient	-0.546710***	-0.539593***	-0.899000***	-0.860178***	-0.856236***	-0.836553***	-0.882419***
	t-stat	-31.70324	-31.33749	-67.69046	-63.72633	-65.84936	-61.92926	-66.76024
LCO2 EMISSIONS PER CAPITA	Coefficient	-0.639945*	-0.517493	-0.157223	-0.081367	-0.088926	-0.086665	-0.210440
	t-stat	-1.718413	-1.393938	-0.819682	-0.443198	-0.491813	-0.450867	-1.138959
LENERGY USE PER CAPITA	Coefficient	0.488979	0.478922	0.190661	0.434961	0.451501	0.488866	-
	t-stat	1.087487	1.071483	0.474802	1.124919	1.206281	1.267822	-
LGDP PER CAPITA	Coefficient	-0.856510**	-1.040508***	0.468451	-2.133416***	-1.538705***	-1.317579***	0.208107
	t-stat	-2.467912	-2.972669	1.466386	-5.066386	-4.395640	-4.060213	0.823781
GDP GROWTH	Coefficient	-0.059593	-0.066695	-0.012298	0.000691	-0.002867	-0.004121	-0.010567
	t-stat	-1.470414	-1.387707	-1.434350	0.066938	-0.284222	-0.377664	-1.210147
SHARE OF ENERGY IMPORTS	Coefficient	0.003357***	0.003214***	0.000169	-0.002469	-0.002041	-0.001917	-0.000339
	t-stat	2.725381	2.625297	0.103472	-1.560773	-1.368425	-1.302125	-0.218417
CONSTANT	Coefficient	59.68512***	60.33288***	83.32251***	99.59791***	94.05387***	90.04454***	85.75221***
	t-stat	14.58958	14.79710	25.37228	27.52035	30.43568	31.65176	32.43929

REGUALATORY QUALITY	Coefficient	1.888374***	2.073196***	-0.254365	0.030568	0.027441	0.091243	-0.311676
	t-stat	4.969546	5.455588	-1.221384	0.8803	0.137030	0.6699	-1.503691
EFFFECT SPECIFICATION	Cross-sectional	NO	NO	YES-FIXED	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
	Period	NO	YES-FIXED	NO	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
R-squared		0.634004	0.643100	0.988295	0.989509	0.866071	0.847043	0.889687
Adjusted-R^2		0.629366	0.634365	0.986959	0.988162	0.864374	0.845105	0.888417
Akaike info criterion		5.677569	5.675129	2.414534	2.327753	-	-	-
Schwarz criterion		5.742750	5.794628	2.908821	2.876358	-	-	-
Log-likehood		-2486.130	-2475.057	-971.3948	-923.2114	-	-	-
F-statistic		136.6918	73.62067	740.1817	734.7390	510.2786	436.9819	700.8565
ProbF-stat		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

* 10% level of significance ** 5% level of significance *** 1% level of significance

Table 5.9 : OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS with Regulatory Quality Estimate

The estimators of the constant and the common energy sources are consistent with our previous findings. The values of the estimates of the CO2 emissions and energy use per capita are positive and negative respectively, but with no significance level. The economic growth remains with negative estimators that are not significant. The estimators of the GDP per capita are highly significant with negative values. Only the two non significant estimators have positive values. The estimated values for the energy imports have only marginal differences from the estimators of the previous models.

The estimators of the Regulatory Quality seem to have some variations. Although the majority of them are positive some models provide negative values. Only the OLS and the Fixed periods effects models have values that are the higher of all and are highly significant. The remaining models have estimators that are not significant and with lesser value.

In the Hypothesis testing the Random effects models still remain inefficient. The Fixed Effects models are highly efficient. The summary of the test are presented on the Table below.

FE-RE MODELS		FIXED EFFECTS-RANDOM EFFECTS MODELS HYPOTHESIS TESTS WITH REGULATORY QUALITY ESTIMATE					
Type of Model		FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
Hypothesis Test		F-test	F-test	F-test	Hausman-test	Hausman-test	Hausman-test
Cross-section	Statistic	-	302.292384	325.593245	29.836182	0.000000	0.000000
	Probability	-	0.0000	0.000000	0.0017	1.0000	1.0000
Period	Statistic	2.186713	-	9.015254	7.401592	0.242728	0.000000
	Probability	0.0167	-	0.000000	0.7657	1.0000	1.0000
Cross-section and Period	Statistic	-	-	296.598561	27.015598	0.000000	0.000000
	Probability	-	-	0.000000	0.0046	1.0000	1.0000

Cross-section test variance is invalid	Cross-section test variance is invalid
	Period test variance is invalid

Table 5.10 : FIXED EFFECTS-RANDOM EFFECTS MODELS Hypothesis Testing with Regulatory Quality Estimate

Models with three different Institutional Estimates

In order to investigate more though roughly, how the institutions and their operations have effect on the share of the renewable resources, we estimate models that include the three different estimates for the institution's performance. Those three estimates are the Control of Corruption, the Government Effectiveness and the Regulatory Quality. We apply the same methodology of Fixed and Random Effects. In the Random Effects models with the Swamy-Arora method we exclude the non significant socio-economic variables to include the institutional estimates. The estimations can be summarized in the following Table.

Dependent Variable :SHAREOF RES		OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS WITH THREE INSTITUTIONAL ESTIMATES						
Type of Model		OLS	FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
SHARE OF OIL	Coefficient	-0.553599***	-0.543883***	-0.890404***	-0.843589***	-0.841202***	-0.822143***	-0.832592***
	t-stat	-31.99977	-31.26957	-67.30169	-60.43705	-63.31672	-60.07345	-62.09228
SHARE OF NUCLEAR	Coefficient	-0.515713***	-0.506533***	-0.677421***	-0.648867***	-0.650261***	-0.644672***	-0.644148***
	t-stat	-32.00758	-31.26120	-62.44626	-58.62296	-60.21594	-56.62586	-59.16993
SHARE OF HYDROELECTRIC	Coefficient	-0.522173***	-0.511955***	-0.888889***	-0.840007***	-0.836165***	-0.814649***	-0.826261***
	t-stat	-30.61682	-29.80413	-69.45156	-61.43357	-64.01715	-60.35606	-62.64642
SHARE OF COAL	Coefficient	-0.558391***	-0.550020***	-0.907558***	-0.860956***	-0.860235***	-0.843299***	-0.851848***
	t-stat	-29.86643	-29.34652	-69.71184	-62.72319	-65.35037	-61.60069	-63.99507
SHARE OF NG	Coefficient	-0.549497***	-0.541915***	-0.895892***	-0.858743***	-0.854882***	-0.835514***	-0.846125***
	t-stat	-31.72597	-31.22159	-67.22165	-62.83394	-64.86693	-60.96697	-63.58427
LCO2 EMISSIONS PER CAPITA	Coefficient	-0.987071**	-0.810442	-0.195866	-0.113372	-0.126245	-0.132007	-0.032636
	t-stat	-2.570158	-2.104585	-1.027247	-0.616957	-0.697716	-0.686536	-0.184685
LENERGY USE PER CAPITA	Coefficient	0.884556*	0.802950*	0.373698	0.487548	0.507593	0.533316	-
	t-stat	1.927560	1.753915	0.929641	1.254020	1.347141	1.372810	-
LGDP PER CAPITA	Coefficient	-0.510148	-0.731795**	0.445648	-1.960073***	-1.325265***	-1.078021***	-1.098440***
	t-stat	-1.430700	-2.021857	1.383126	-4.591685	-3.710336	-3.214806	-3.611446
GDP GROWTH	Coefficient	-0.047385	-0.052670	-0.009053	0.002372	-0.001329	-0.002785	-
	t-stat	-1.171937	-1.092261	-1.058874	0.229583	-0.131913	-0.256309	-

SHARE OF ENERGY IMPORTS	Coefficient	0.003302***	0.003163***	-0.000558	-0.002656*	-0.002164	-0.001934	-
	t-stat	2.699711	2.594660	-0.342192	-1.675672	-1.450121	-1.313478	-
CONSTANT	Coefficient	54.60182***	56.00768***	82.02968***	97.71014***	91.81545***	87.71869***	92.60491***
	t-stat	12.79595	13.10472	24.87729	26.42003	28.71683	29.21305	32.05772
CON TROL CORRUPTIO N	Coefficient	-0.432942	-0.242267	-0.302068	-0.028013	-0.005915	0.057752	0.108632
	t-stat	-0.964359	-0.536976	-1.444156	-0.137435	-0.029545	0.271174	0.537191
GOVERNME NT EFFECTIVNE SS	Coefficient	-1.334571**	-1.297029**	-0.771510***	-0.538473**	-0.593660**	-0.648059**	-0.575472**
	t-stat	-2.145460	-2.084517	-3.092706	-2.211050	-2.463141	-2.506541	-2.337904
REGUALATO RY QUALITY	Coefficient	3.24391***	3.242314***	0.143522	0.222819	0.235621	0.300958	0.184026
	t-stat	6.311086	6.332978	0.626969	1.009091	1.076856	1.281629	0.843234
EFFFECT SPECIFICATI ON	Cross-sectional	NO	NO	YES-FIXED	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
	Period	NO	YES-FIXED	NO	YES-FIXED	YES-RANDOM	YES-RANDOM	YES-RANDOM
R-squared		0.640823	0.648025	0.988531	0.989584	0.867257	0.848987	0.859371
Adjusted-R^2		0.635431	0.638568	0.987191	0.988216	0.865264	0.846720	0.857752
Akaike info criterion		5.663308	5.665779	2.398655	2.325129	-	-	-
Schwarz criterion		5.739352	5.796140	2.903806	2.884597	-	-	-
Log-likehood		-2477.855	-2468.943	-962.4083	-920.0568	-	-	-
F-statistic		118.8512	68.52140	737.3347	723.7075	435.2205	374.5070	531.0363
ProbF-stat		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

* 10% level of significance ** 5% level of significance *** 1% level of significance

Table 5.11 : OLS- FIXED EFFECTS-RANDOM EFFECTS MODELS with Institutional Estimates

From the three institutional estimates only one is highly statistical significant in all the models. Especially Government Effectiveness is highly significant in all models with negative values. Control of Corruption estimators are negative in the most of the models and only in some of the Random Effects models they have positive values. Despite the different signs they are not statistically significant. Regulatory Quality estimate has estimators that are positive in all models. Only the estimators of the OLS and the Fixed periods model are highly significant.

The estimators of the share of common energy sources and the constant are similar with the ones of the previous models that were estimated. The estimators of the CO_2 emissions are all non significant expect the OLS estimator and they all have negative values. The estimators of energy use have all positive values but only the one of the first two models are significant. The estimators of GDP per capita have negative values and are mostly highly significant. The economic growth has mostly negative values except the one of the two-way Fixed Effects model that is positive. However, they are all non significant. The share of energy imports has estimators that are positive and highly significant only in the first two models. The remaining estimators of the imports are negative and mostly non significant.

As it is concluded in the previous table the most predictive model remains the Fixed Effects model with both cross-sectional and period effects. That is consistent with all our results of the empirical method. The Fixed Effects models have highly efficient estimators, while the Random Effects estimators are inefficient. The summary of the Hypothesis Tests is present on the following Table.

FE-RE MODELS		FIXED EFFECTS-RANDOM EFFECTS MODELS HYPOTHESIS TESTS WITH THREE INSTITUTIONAL ESTIMATES					
Type of Model		FE-FIXED PERIOD	FE-CROSSSECTION FIXED	FE-2WAY	RE Wansbeek-Kapteyn	RE Wallace - Hussain	RE Swamy - Arora
Hypothesis Test		F-test	F-test	F-test	Hausman-test	Hausman-test	Hausman-test
Cross-section	Statistic	-	302.030263	322.514193	29.562647	0.000000	0.000000
	Probability	-	0.000000	0.000000	0.0054	1.0000	1.0000
Period	Statistic	1.751637	-	7.85066	7.309839	0.459354	0.000000
	Probability	0.0656	-	0.000000	0.8855	1.0000	1.0000
Cross-section and Period	Statistic	-	-	292.313386	30.139351	0.000000	0.000000
	Probability	-	-	0.000000	0.0045	1.0000	1.0000
						Cross-section test variance is invalid	Cross-section test variance is invalid
							Period test variance is invalid

Table 5.12 : FIXED EFFECTS-RANDOM EFFECTS MODELS Hypothesis Testing with Institutional Estimates

6. Conclusions

To sum up in this study, we investigate the drivers for the growth of renewable energy. The analysis includes not only socio-economic factors but also estimates for the corruption and the performance of the institutions. For this study eighty countries from all continents and types of economies were being examined with yearly data. The year range is from 2001 to 2011.

This study used additional estimates for socio-economic situation of the countries, as they were widely used in the literature. Based on the literature's evidence we applied also estimates for the corruption and the institutional performance to investigate their effect on the growth of the share of the renewable energy.

The analysis was based on the Fixed Effects and Random Effects models. The validity of the estimations was controlled by the special test that adequate for each model. Those are the F-test and the Hausman test respectively. First we estimate the different models not accounting for any institutional variable. Then we re-estimate the models taking in to consideration different types of estimates. Those were the Corruption Perception Index (CPI), the Control of Corruption estimate, the Government Effectiveness estimate and the Regulatory Quality estimate. From all the estimated models some major conclusions can be driven.

The shares of the common energy methods in electricity production are proven to be highly significant in all the models estimated. Especially their estimated values are all negative proving that they are the main factors for the diminishing penetration of the renewable energy methods in the electricity production. This also supports the theory of the lobbing pressure of those proven and widely used energy methods.

The emissions of CO2 per capita have mainly a negative effect on the growth of the renewable energy resources. That is consistent with the literature that states that countries with more emissions are less willing to implement Renewable Energy Policies. However the significance of the estimates is limited only to the OLS and the Fixed periods effects models. In all the other models the estimators are not significant.

The energy use per capita has a positive effect on the share of renewable energy. However, very few of the estimators were found significant with the overall number of the estimators to be non significant. Our results are consistent with the literature which states that countries with high energy use are the ones that first turn their attention towards renewable energy.

The GDP per capita has a majority of estimators that are proven to be highly significant in many models. Those estimates are negative with high values. On the contrary the estimators that are non significant have mainly positive values. Those results suggest that countries with higher GDP are more reluctant on enforcing renewable energy policies.

The Growth of GDP has mainly negative and non significant effect on the share of renewable in electricity. However, the estimators of the two-way Fixed Effects models are all positive but still not significant. This specific result is consistent with the latest advances in literature, where modern estimation methods prove a positive link between renewable energy and economic growth.

The estimators of the share of energy imports have the widest range. When they are estimated with the OLS and the one-way Fixed Effects models the coefficients are positive and highly significant. However, when estimated with the two-way Fixed Effects model and the Random effects models they are found negative and non significant. The high share of energy imports should lead a state to promote renewable energy for reducing its imports and having security of supply .Although this assumption is consistent with the positive values, the negative values possible reflect the power that conventional energy have.

Regarding the results of the models with the estimates of the corruption and the institutional performance the following conclusions can be made. For the CPI only one estimator is quite significant and is the estimator of the OLS model. All the other estimators are not significant. Moreover the signs of the coefficients are mixed with no clear indication for the link between renewable energy and corruption. The marginal majority of negative coefficients suggest that possibly there is a link between the higher level of corruption and the greater penetration of renewable energy.

Those finding are supported by the estimators of the Control of Corruption. In all models, except the one with Fixed period Effects, the values of the coefficients are negative and in some cases they are and significant also. We can conclude that the link between corruption and the growth of renewable energy sources seems to be present but it turns to be not significant.

The more robust results of the poor institutional performance and the growth of renewable are found with the Government Effectiveness estimate. In the OLS and the one-way Fixed Effects model it is positive and non significant. However in the remaining Fixed-Effects and Random Effects models it is negative and highly significant. This is the first significant estimation of the link between poor institutions in countries and the increase of renewable energy applications in their territory

The models that account for the Regulatory Quality are only the OLS and the one-way Fixed Effects model, where the estimates are positive and highly significant. In all the other models the estimates are not significant. That is essentially the case where a solid institutional framework leads to the advance of renewable energy.

The conclusions for the corruption and institutional estimates are presented in the model that considers all three institutional estimates. The only link that remains significant is the one with the poor Government Effectiveness and the increase on share of the renewable energy. The other two links are non-significant but they are present in all the models. So we could suggest the possible presence of a link between the increase of Corruption and the increase of the renewable resources. Also a positive link between effective Regulatory Institutions and the share of renewable energy can be established.

Regarding the methodology the estimates of the Random Effects models are tested and proven to be not efficient. On the contrast the estimates of the Fixed Effects models are highly efficient suggesting the presence of heterogeneity in the estimated models. Although the problem of endogenity is not present, the test applied does not account for serial-correlation or heteroscedasticity. The implementation of more advance methodological approach, like the Generalized Method of Moments, is essential to examine further the robustness of our results.

7. References

Marques, A. C., Fuinhas, J. A., & Pires Manso, J. R. (2010). Motivations driving renewable energy in European countries: a panel data approach. Energy Policy, 38(11), 6877-6885.

Gennaioli, C., & Tavoni, M. (2011) `Clean or" Dirty" Energy; Evidence on a Renewable Energy Resource Curse', Fondazione Eni Enrico Mattei: Energy Resources and Markets, 63, Available from: ECONSTOR <http://hdl.handle.net/10419/53279>

Mo, P. H. (2001). Corruption and economic growth. Journal of Comparative Economics, 29(1), 66-79.

Da Cunha Leite, C., & Weidmann, J. (2001). Does mother nature corrupt? Natural resources, corruption, and economic growth. Natural Resources, Corruption, and Economic Growth (June 1999). IMF Working Paper, (99/85).

Bhattacharyya, S., & Hodler, R. (2010). Natural resources, democracy and corruption. European Economic Review, 54(4), 608-621.

Neumayer, E. (2002). Do democracies exhibit stronger international environmental commitment? A cross-country analysis. Journal of peace research, 39(2), 139-164.

Damania, R. (2002). Environmental controls with corrupt bureaucrats.Environment and Development Economics, 7(3), 407-427.

Fredriksson, P. G., & Svensson, J. (2003). Political instability, corruption and policy formation: the case of environmental policy. Journal of Public Economics, 87(7), 1383-1405.

Fredriksson, P. G., & Vollebergh, H. R. (2009). Corruption, federalism, and policy formation in the OECD: the case of energy policy. Public Choice, 140(1-2), 205-221.

Kolstad, I., & Søreide, T. (2009). Corruption in natural resource management: Implications for policy makers. Resources Policy, 34(4), 214-226.

Pellegrini, L., & Gerlagh, R. (2006). Corruption and environmental policies: What are the implications for the enlarged EU?. European Environment, 16(3), 139-154.

Lapatinas, A., Litina, A., & Sartzetakis, E. S. (2011). Corruption and environmental policy: An alternative perspective (No. 23.2011). Nota di lavoro//Fondazione Eni Enrico Mattei: Sustainable development.

Wilson, J. K., & Damania, R. (2005). Corruption, political competition and environmental policy. Journal of Environmental Economics and Management,49(3), 516-535.

Soytas, U., & Sari, R. (2003). Energy consumption and GDP: causality relationship in G-7 countries and emerging markets. Energy economics, 25(1), 33-37.

Soytas, U., & Sari, R. (2009). Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member. Ecological economics, 68(6), 1667-1675.

Lee, C. C., & Chang, C. P. (2007). The impact of energy consumption on economic growth: evidence from linear and nonlinear models in Taiwan. Energy,32(12), 2282-2294.

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

Apergis, N., & Payne, J. E. (2009). Energy consumption and economic growth: Evidence from the Commonwealth of Independent States. Energy Economics,31(5), 641-647.

Belke, A., Dobnik, F., & Dreger, C. (2011). Energy consumption and economic growth: New insights into the cointegration relationship. Energy Economics,33(5), 782-789.

Sharma, S. S. (2010). The relationship between energy and economic growth: Empirical evidence from 66 countries. Applied energy, 87(11), 3565-3574.

Chien, T., & Hu, J. L. (2008). Renewable energy: An efficient mechanism to improve GDP. Energy policy, 36(8), 3045-3052.

Apergis, N., & Payne, J. E. (2010). Renewable energy consumption and economic growth: evidence from a panel of OECD countries. Energy Policy,38(1), 656-660.

Apergis, N., & Payne, J. E. (2010). Renewable energy consumption and growth in Eurasia. Energy Economics, 32(6), 1392-1397.

Menegaki, A. N. (2011). Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis. Energy Economics, 33(2), 257-263.

Marques, A. C., & Fuinhas, J. A. (2012). Are public policies towards renewables successful? Evidence from European countries. Renewable Energy,44, 109-118.

Menyah, K., & Wolde-Rufael, Y. (2010). CO< sub> 2</sub> emissions, nuclear energy, renewable energy and economic growth in the US. Energy Policy,38(6), 2911-2915.

Apergis, N., Payne, J. E., Menyah, K., & Wolde-Rufael, Y. (2010). On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. Ecological Economics, 69(11), 2255-2260.

Gan, L., Eskeland, G. S., & Kolshus, H. H. (2007). Green electricity market development: Lessons from Europe and the US. Energy Policy, 35(1), 144-155.
Jenner, S. (2012). Did Feed-In Tariffs Work? An Econometric Assessment. An Econometric Assessment (August 1, 2012).

Huang, M. Y., Alavalapati, J. R., Carter, D. R., & Langholtz, M. H. (2007). Is the choice of renewable portfolio standards random?. Energy Policy, 35(11), 5571-5575.

Yin, H., & Powers, N. (2010). Do state renewable portfolio standards promote in-state renewable generation . Energy Policy, 38(2), 1140-1149.

Carley, S. (2009). State renewable energy electricity policies: An empirical evaluation of effectiveness. Energy Policy, 37(8), 3071-3081.

Marques, A. C., & Fuinhas, J. A. (2012). Is renewable energy effective in promoting growth?. Energy Policy, 46, 434-442.

Auty, Richard(1993) Sustaining Development in Mineral Economies: The Resource Curse Thesis (Oxford University Press, New York).

Auty , Richard M. (1997), Natural resource endowment, the state and development strategy, Journal of International Development 9 (4), 651-63.

Auty , Richard M. (2001), The political economy of resource-driven growth, European Economic Review 45, 839-46.

Sachs , Jeffey D. and Andrew M. Warner (1995a), Natural resource abun- dance and economic growth, NBER Working Paper No. W5398.

Mauro, Paolo(1995), "Corruption and Growth." Quart. J. Econ. 110, 3:681–712, Aug. 1995

Davis, Peter (2002). "Estimating Multi-way Error Components Models with Unbalanced Data Structures," Journal of Econometrics, 106, 67-95

Wansbeek, Tom, and Arie Kapteyn (1989). "Estimation of the Error Components Model with Incomplete Panels," Journal of Econometrics, 41, 341-361

Swamy, P.A.V.B. and S.S. Arora(1972). The exact finite sample properties of the estimators of coefficientsin the error components regression models, Econometrica 40, 261‑275.

Baltagi, Badi H. (2005). Econometric Analysis of Panel Data, Third Edition, West Sussex, England: JohnWiley & Sons.

Wooldridge, Jeffrey M. (2002). Econometric Analysis of Cross Section and Panel Data, Cambridge, MA: TheMIT Press.

Hausman, Jerry A. (1978). "Specification Tests in Econometrics," Econometrica, 46, 1251–1272.

Wallace, T.D. and A. Hussain(1969). The use of error components models in combining cross-section and time-series data, Econometrica 37, 55‑72.