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Mehrara, Mohsen; Razi, Davoud Hamidi; Rezaei, Sadeq

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Determinants of Renewable Energy Consumption among ECO countries; Based on Bayesian Model Averaging and Weighted-average Least Square

Mohsen Mehrara[1], Sadeq Rezaei[2], Davoud Hamidi Razi[3]

[1]Faculty of Economics, University of Tehran, Tehran, Iran

[2]PhD student in Economics, University of Tehran, Tehran, Iran

[3]M.A. in Economics, University of Urmia, Urmia, Iran

E-mail address: mmehrara@ut.ac.ir[1], sadeqrezaie@ut.ac.ir[2], davod.hamidi@yahoo.com[3]

ABSTRACT. Over recent years, renewable energy sources have emerged as an important component of world energy consumption. Increased concern over issues related to energy security and global warming suggests that in the future there will be a greater reliance on renewable energy sources. Given the role of renewable energy in the discussion of a reliable and sustainable energy future, it is important to understand its main determinants and to draw result implications for energy policy. This paper identifies the key determinants of renewable energy consumption among Economic Cooperation Organization (ECO) countries, over the period 1992-2011. There is a large literature on determinants of energy consumption and several studies have included a large number of explanatory variables. Empirical models of energy consumption are plagued by problems of model uncertainty concerning the choice of explanatory variables and model specification. We utilize Bayesian Model Averaging (BMA) and Weighted-Average Least Square (WALS) to resolve these model uncertainties. We have used not only conventional explanatory variables that have been used in last studies, but also institutional variables to consider the effect of socio-economic environment. The results of this study indicate that the institutional environment proxies, urban population, and human capital are the most important variables affecting renewable energy consumption in the ECO economies. Also the second and third effective variables are the renewables potential which lead to an increase in renewable energy consumption, and Co_2 emission which has revers effect respectively. Therefore improving of institutional circumstances and human capital can be useful to renewable energy growth and reducing of detrimental externalities of fossil energy consumption.

1. INTRODUCTION

Fossil fuel (e.g., coal, oil and natural gas) led economic growth, through its release of carbon dioxide (CO2) into the atmosphere, is considered to be the main driver behind global warming and climate change (Stern 2006, IPCC 2007). Many countries and international organizations now view renewables as important elements of energy security, dynamic economic development, environmental protection and greenhouse gas (GHG) emissions reduction efforts (Carley, 2009; Gan et al., 2007; Johnstone et al., 2010; Marques and Fuinhas, 2012). According to the IEA (2010), renewables deployment attained a 165.4% increase in power generation over the decade ending in 2009. However, evenly spread global participation is still limited. Coal still remains the main fuel source of power generation, accounting for 40.9% of total power output globally. The current trend shows a level of deployment asymmetry between developed and developing economies; however, countries from the same economic block and continent also show quite significant differences in deployment levels. Several studies have attributed these variations in renewables deployment to different factors. For example, Marques et al. (2010) identify some political, socioeconomic and country- specific factors as important determinants of renewables consumption. Given the above

discussions, a deeper understanding of the determinants of renewable energy consumption is of great importance, at least for the following reasons. Foremost, the increased concern over the issues related to energy security, climate change, and global warming suggests that there will be a greater reliance on the demand of renewable energy in the near future. According to the EIA report, renewable energy is projected to be the fastest growing energy source between now and 2030. It is estimated that world renewable energy consumption for electricity generation will grow by an average rate of 2.6% per year over the period 2007-2035. As a result, the renewable share of world electricity generation will grow by 5% during the same period, i.e., from 18% in 2007 to 23% in 2035.

Over the last two decades, hundreds of empirical studies have attempted to identify the determinants of energy consumption. There is a very large literature on determinants of energy consumption and several studies have included a large number of explanatory variables in so-called "kitchen sink" regressions. A problem is that theories of economic are often not mutually exclusive and the validity of one theory does not necessarily imply that another theory is false. This is not to say that theories are of no use for that purpose. Rather, the problem is that different theories are typically compatible with one another (Mehara & Rezaei, 2015). Sometimes theory can support choices of specific variables, but the inclusion or exclusion of most variables is typically arbitrary, a phenomenon labeled the "open-endedness" of theory (Brock and Durlauf, 2001). In addition, while theory may provide general qualitative variables (such as human capital), it does not tell us how these variables are to be specified or measured. We are thus faced with (at least) two types of uncertainty, each of which brings about model uncertainty. Since there exist a wide set of possible model specifications, we often obtain contradictory conclusions. To make matters worse, estimation results are often not robust to small changes in model specification, making credible interpretations of the results hazardous. A proper treatment of model uncertainty is clearly important. One such treatment is model averaging, where the aim of the investigator is not to find the best possible model, but rather to find the best possible estimates. Each model contributes information about the parameters of interest, and all these pieces of information are combined taking into account the trust we have in each model, based on our prior beliefs and on the data (Magnus et al, 2010).In order to combine model selection and estimation, the Bayesian method offers a natural framework.

This paper sets out a BMA and WALS approaches to assess how macroeconomic factors affect the renewable energy consumption among ECO countries during 1992-2012. Section 2 and section 3 presents a brief review of theoretical and empirical literature on renewable energy consumption respectively. We also present the empirical results of the paper in section 4, and section 5 concludes.

2. THEORETICAL LITERATURE; DETERMINANTS OF RENEWABLE ENERGY CONSUMPTION

2.1 ECO Countries

Economic Cooperation Organization (ECO) is an inter-governmental regional organization which was originally established as Regional Cooperation for Development (RCD) in 1964 by Iran, Pakistan and Turkey for promoting sustainable socio-economic development of the Member States. It was renamed ECO in 1985 and in 1992 the organization was expanded to include Afghanistan, Azerbaijan, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan. The ECO region is full of bright trading prospects. Despite its young age, ECO has developed into a thriving regional organization. Its international stature is growing. Nevertheless, the organization faces un-daunting challenges with respect to realization of its objectives and goals. Most importantly, the region is lacking in appropriate infrastructure and institutions which the Organization is seeking to develop, on priority basis, to make full use of the available resources in the region. General specifications these countries (except Afghanistan, because of lack of sufficient data) in 2012 are presented on Table 1.

Table 1: General Specification of ECO Countries

Country	Surface area (sq. km)	Population (annual %growth)	Energy Intensity[1]	Renewable Energy[2] Consumption (annual % growth)	GDP growth (annual %)
Azerbaijan	86600	1.36	19376.17	-31.9	2.2
I.R. Iran	1745150	1.33	39525.21	2.8	3.0
Kazakhstan	2724900	1.44	31744.05	-3.08	5.0
Kyrgyz Republic	199950	1.22	73080.15	0.28	-0.088
I.R. Pakistan	796100	1.7	18449.158	4.7	3.5
Tajikistan	142550	2.48	57301.3	4.3	7.5
Turkmenistan	488100	1.30	31061.62	0.0	11.1
Turkey	783560	1.28	7991.76	12.05	2.13
Uzbekistan	447400	1.48	99346.48	9.5	8.2

References: WDI & IEA (2014).

According to table 1 and this paper data it says that ECO countries economics, population and need for energy are growing. On the other side increased concern over issues related to energy security and global warming suggests that in the future there will be a greater reliance on renewable energy sources. Although MacKenzie (2003) seems to be convinced that the less developed countries (LCDs) should be permitted to burn fossil fuels for some time to allow them to industrialize, a number of developing economies have already started to commit substantially on non-fossil fuel energy sources.

2.2 Theoretical Literature

Similar to the classification presented by recent studies, we present the determinants of renewable energy growth that we use in three categories as political, socioeconomic and country- specific factors.

The first category is institutional circumstance, such as control of corruption, political stability, regulatory quality or government effectiveness, and rule of law. The second category includes income and energy consumption, as examples of socioeconomic factors. A third category, which includes renewable energy potential, is identified as consisting of country-specific drivers and macro-economic variables. The first category, institutional circumstance, is perhaps the most critical; this is mainly because renewables are currently more expensive options than fossil fuels. The instability of the economic system may unfortunately in fact be reflected in the parameters of the estimated models that, when used for inference or forecasting, can induce misleading results. In contrast to previous studies, our study considered that variables to analyze effect of economic environment.

2.2.1. Institutional Circumstance Variable

2.2.1.1. Control of Corruption:

Reflects 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.

The strand of the theoretical literature arguing that corruption can play a positive role in development process relies on static efficiency arguments, essentially viewing bribing as a type of

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[1] Total Primary Energy Consumption per Dollar of GDP (Btu per Year 2005 U.S. Dollars (Market Exchange Rates)
[2] Growth of Total Renewable Electricity Net Consumption (Billion Kilowatt-hours)

Coasean bargaining process. It is clearly proved in theoretical and experimental literatures that relationship between grow on renewable industry and the development level of economics is positive. In this context, Leff (1964) and Huntington (1968) suggest that corruption may allow entrepreneurs to work around extensive bureaucratic procedures, negating some of the deleterious effects of red tape; Liu (1985) uses an equilibrium queuing model to suggest that corruption allows the queue to be rearranged in a way that brings about an efficient allocation of time, giving those for whom time is most valuable the opportunity to move to the front of the line; and Beck and Maher (1986) and Lien (1986) suggest that corruption may serve to ensure that projects are awarded to the most efficient firms, who stand to gain the most from payment of bribes. A second strand of the theoretical literature suggests that corruption reduces both investment and growth. On investment, Murphy, Shleifer and Vishny (1993) suggest that the prevalence of increasing returns to rent-seeking may crowd out productive investment; Romer (1994) suggests that corruption, by imposing a tax on ex-post profits may in general reduce the flow of new goods and technology, particularly if an initial fixed cost investment is required (such as renewable energy industry); and the argument in Boycko, Shleifer and Vishny (1995) suggests that the added uncertainty may also serve to reduce investment flows. In order to we used Control of Corruption index that provided by WGI[1] of World Bank.

2.2.1.2. Rule of Law

Reflects 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. We used this variable to consider social stability and institutional characters of property rights for renewable projects. Social stability and improvement in property rights can promote incentives to extend renewable energy deployment and therefore, increases on renewable energy share in energy sector.

2.2.1.3. Regulatory Quality & Government Effectiveness

Regulatory Quality reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Government Effectiveness reflects 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.

The role of an effective regulatory regime in promoting economic growth and development has generated considerable interest among researchers and practitioners in recent years (e.g. World Bank, 2012). In particular, building effective regulatory structures in developing countries is not simply an issue of the technical design of the most appropriate regulatory instruments; it is also concerned with the quality of supporting regulatory institutions and capacity. Regulation can take many forms and the form of regulation policy adopted in developing countries has shifted over time (Minogue, 2005). From the 1960s to the 1980s, market failure was used to legitimize direct government involvement in productive activities in developing countries, by promoting industrialization through import substitution, investing directly in industry and agriculture, and by extending public ownership of enterprises (Jalilian & et al, 2006). Arguably, however, the performance of the new regulatory state remains under researched, especially in the context of developing countries with their own peculiar economic and social problems and institutional characteristics. These factors peroxided in our study by Regulatory Quality and Government Effectiveness countries ranks that provided by World Bank groups.

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[1] World Governance Indicators

2.2.1.4. Political Stability and Absence of Violence/Terrorism

Reflects perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. With regard to political factors, the quality and reliability of policies is of particular importance in uncertain technological field (Marcus 1981). If firms expect large changes in political stability and environmental regulation, the payoff function becomes volatile, hence augmenting the propensity to delay investments in new technologies or adopt existing end-of-pipe solutions (Frondel et al. 2004). Lack of political commitment for long-term targets is likely to be amplified in countries where public policies are perceived to be ineffective because frequent bribery and corruption (Lopez and Mitra, 2000) or simple lack of time consistency. An unstable policy environment is expected to have a negative effect on innovation (Johnstone et. al.2010). Overall, the several channels through which stability of policies, regulation in the energy sector and socio-political factors affect innovation (and then consumption) in renewable energy call for the inclusion of a broad set of potential interactions in the empirical specification. Prior to the presentation of our empirical strategy, we consider the political instability and existence of Violence/Terrorism ranks of ECO countries on WGI as political instability proxy.

2.2.2. Socioeconomic factors

2.2.2.1. Carbon dioxide emissions

Following Marques et al. (2010), we proxy environmental concerns by including CO_2 emission levels growth in our analysis. Because of environmental concerns drive renewables investment and consume is well held in literature (see for example Sadorsky, 2009). In the other hand, increases in CO_2 emission is result of increases in fossil fuels consumption and prefer it to renewable energy. In developing countries it is likely becomes negative. Given these significances, relationship between CO_2 emission and renewable energy consumption is not clear.

2.2.2.2. Prices (oil, natural gas & coal)

Van Ruijven and Van Vuuren (2009) examine the interaction of renewables and hydrocarbon prices in high and low GHG[1] emission mitigation scenarios. When strong policies are in place to reduce GHG emissions, an increase in hydrocarbon prices generate a shift from natural gas with carbon capture and storage (CCS), to coal with CCS, nuclear and wind power. Based on van Ruijven and van Vuuren (2009), we also include coal, natural gas and oil prices in our model. Marques et al. (2010) record erratic results for these variables; however, several studies (see as examples Awerbuch and Sauter, 2006; Changetal, 2009) report their relatedness to renewables, since renewables deployment could shield countries' oil and gas price volatility. Chang et al. (2009) find a significant and positive relationship between energy prices and the contribution of renewables to energy supply in regions with high economic growth, although there is no significance in lower economic growth nations. Since most of ECO countries have high fluctuated economic growth in period of study the effect of prices (oil, natural gas & coal) before of examine is not predictable.

2.2.3. Energy needs

Two variables representing the energy needs of a country are also employed: The urbanization index (ratio of urban population) and population growth. The effects of both variables are uncertain since large energy use and/ or growing energy needs due to population expansion could be supplied either by traditional energy sources or by renewable energy (see Carley, 2009; Marques et al, 2010).

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[1] Greene House Gas

2.2.4. Renewables potential

 As recently studies, previous literature employ an approximation for renewable energy potential in their analysis, i.e. 'Surface Area'. In this study, due to no data about the evolution of potential renewables through the years could be acquired; therefore we consider logarithm of Surface Area as proxy of renewable energy potential. In any case, such potentials are rarely changing given their nature. We expect that these variables will have a positive influence on renewables energy consumption growth.

2.2.5. Macro-economic variables

2.2.5.1. Industrialization

Industrialization is a term that usually refers to an increase in industrial activity and most authors assume that industrialization leads to higher energy usage because higher value added manufacturing uses more energy than does traditional agriculture or basic manufacturing (Sadorsky, 2013). For example, industries like petroleum refining, primary metals, chemicals, and paper and allied products tend to be more energy intensive than agriculture or textile industries (e.g. Jones, 1991 and Samouilidis and Mitropoulos, 1984). In empirical models, industrialization is usually measured by industry value added as a percent of GDP. Some authors like Parikh and Shukla (1995) use this indicator as a measure of structural change and the expectation is that larger shares of industrial activity in the economy create a demand for more energy. We considered industry value added as a % of GDP as industrialization of ECO countries proxy.

2.2.5.2. Economic growth

Relationship between renewable energy consumption and economic growth should be categorized into four hypotheses, each of which has important implications for energy policy (Al-mulali & et al, 2013). The growth hypothesis suggests that unidirectional causality runs from energy consumption to economic growth. It implies that increase in energy consumption have a positive impact on economic growth. Therefore, energy consumption has a vital role in economic growth in production process. If there is a unidirectional causality from economic growth to energy consumption, it is called conservation hypothesis. This hypothesis supports that the reduction in energy consumption will have little/ no effect on economic growth. Also, it is supported that an increase in real GDP causes an increase in energy consumption. The feedback hypothesis argues bidirectional causality between energy consumption and economic growth. This relationship implies that there is a joint effect between energy consumption and economic growth. In other words, energy conservation has negative effect on economic growth, and decreases in GDP have negative impact on energy consumption. No causality between energy consumption and economic growth is referred to as neutrality hypothesis. Under the neutrality hypothesis, energy consumption is not correlated with GDP, which means that the increase or decrease in energy consumption has no effect on economic growth and vice versa (Ocal & Aslan, 2013.

The 'growth hypothesis' suggests that energy consumption is a crucial component in growth, directly or indirectly as a complement to capital and labor as in put factors of production. Hence, a decrease in energy consumption causes a decrease in real GDP (Belke & et al, 2012). In this case, the ECO countries are called 'energy dependent' and energy conservation policies may be implemented with adverse effects on growth factors. since all of these countries are developing countries and almost half of ECO countries are exporter in fossil fuel commodities, by consider development theories and experimental studies, therefor energy intensity in these countries is high (see Table 1). In other side developing countries such as ECO countries in growth and development process the energy needs will be grow increasingly, then demand pressure to energy and cost-effectiveness of fossil fuels natures imposes the share of renewable sector decreases or even be

forgotten. According above, relationship between economic growth and renewable energy consumption in this case can be confusing.

2.2.5.3. Investment (domestic and foreign)

Domestic investment has crucial role on economic growth and new technologies usage in production. When domestic investment is growing and positive, it indicates that; first, business circumstance is appropriate and economic agents are hoping to prosperity in the future. Therefore renewable energy industry will be influenced by this space. Second, investment needs energy inevitably then; when investment increases energy consumption will be turn to increase automatically and it can make tendency to expand renewable energy usage. But increases on energy demand makes entrepreneurs are looking to find energy savings then renewable energies may be the next priority. However in our study, according to importance of investment in economy Gross capital formation growth is considered.

Recently, several studies on FDI literature have been focused on the spillover effects of FDI on the environment (energy consumption, pollution, dioxide carbon emission, clean energy usage, etc.). These studies show that FDI could threat the environment on the one hand as it could be a source of energy reduction on the other hand. They justified their results by the idea that foreign investors bring with them their own advanced technology while investing in developing economies to maximize the profits. As result, the domestic output rises with less energy consumption (see Mielnik and Goldemberg, 2002). In general, these studies show that foreign direct investments may have positive externalities as explained above but also lead to negative externalities. We used growth of FDI in flows to effect of foreign investment.

2.2.5.4. Financial development

Over the last three decades, the papers focusing the nexus between energy consumption and economic growth or financial development and economic growth have commonly found a significant relationship. It is therefore rational to anticipate a relationship running between financial development and energy consumption as well. Theoretically, Sadorsky (2011) explains how financial development affects energy consumption in three ways (see, for detailed discussion, Sadorsky (2011)). Nonetheless, Sadorsky (2010) points out that the theoretical relationship between the variables in question is unclear, and it could only be resolved through empirical analysis. In energy economics, the relationship between financial development and energy consumption has been attractive in recent years. Domestic credit provided by banking sector (% of GDP) for this purpose is used.

2.2.5.5. Human capital

Human capital can influence renewable energy consumption by three channels. Frist increases in human capital (and flows that increase on people knowledge) will be promote social tendency to green economy. In Other words human capital increases environmental concerns (such as air pollution, global warming, etc.). Second, just as accumulation of personal human capital produces individual economic (income) growth, so do the corresponding social or national aggregates. At the national level, human capital can be viewed as a factor of production coordinate with physical capital. The framework of an aggregate production function shows that growth of human capital is both a condition and a consequence of economic growth. Consequently, human capital can affect renewable energy consumption by economic growth. Third, an increase on human capital gives to industry sector this opportunity to deploy/ use new technologies. Since in renewable industry are used High-Tech imputes, then the skilled labor force is essential requirement. Therefore, it can be said that human capital will have a positive effect on renewable energy consumption.

3. EMPIRICAL STUDIES

The basic equations of BMA were first presented by Leamer (1978, Sections 4.4_4.6), who proposed Bayesian averaging of Bayesian estimates. BMA is flexible with respect to the size and exact specification of a model and it does not require the a priori selection of any model. Inference is based on a weighted average over all models. In econometrics, BMA has proved useful, and recent applications include León-González and Montolio (2004), Sala-i-Martin et al. (2004) and Masanjala and Papageorgiou (2007). Recently, interest is growing in different aspects of growth empirics, such as nonlinearities, parameter heterogeneity, and endogeneity. BMA is also applied in other areas of economics; see for example Tsangarides et al. (2004), Crespo-Cuaresma and Doppelhofer (2007), Eicher et al. (2007a,c), Masanjala and Papageorgiou (2008) and Prüfer and Tondl (2008).

Many studies have been conducted on issue of energy consumption and renewable energy consumption, which generally can be divided into two categories; studies that investigated on relationship between renewable energy and a few specific variables. Most of them studied causality relationship between energy consumption and one variable. Some of them such as; Sadorsky (2009 & 2010), Lee (2005), Apergis & Payne (2010a, b), Mehrara (2007), Pao & Tsai (2010 & 2011), Soytas & Sari (2006), Asafu-Adjaye (2000), Wankeun & Lee (2004), causality have examined.

Second case includes little numbers of studies that have investigated the determinants of renewable energy consumption. Also, most of these case studies have considered two or several type of variables and more of them have examined causality relationship between energy consumption and macro-economic variables. Although recently a number of these case studies have attempted to use various types of variables but, no one have applied BMA and WALS methods to consider model uncertainty in energy consumption field. Aguirr, M. and Ibikunle, G. (2014) have investigated factors influencing country-level renewable energy growth by applying FEVD and PCSE estimation methods in sample analysis. Rafiq & Alam (2010) have used ARDL and panel methods to identify renewable energy consumption among several country and analyzed causality relationship between renewable energy consumption and economic growth, and carbon dioxide emission. Omri & Nguyen (2014) have studied determinant of renewable energy consumption among 64 countries over the period 1990-2011 by using a dynamic system-GMM panel model. They mainly find that the increases in CO_2 emissions and trade openness are the major drivers of renewable energy consumption. Mudakkar & et al (2013) have investigated the multivariate energy consumption function for SAARC[1] countries. They used economic growth, FDI, financial development, and relative energy prices to determined energy consumption and causality relationship between them.

Our study takes a different approach and improves on the existing literature in several ways. The first improvement comes in terms of the sample of countries (ECO countries) and the period selected. Instead of focusing on the United States, the OECD or the European Union, we include ECO countries that all of them are developing countries. Second, some institutional features of the sample of countries have entered institutional features, along with other prevalent variables in the model. Third, we considered model uncertainty and used model averaging (includes BMA & WALS) to treat that problem, where in this approach the aim of the investigator is not to find the best possible model, but rather to find the best possible estimates. In this paper we confront BMA & WALS, and apply both techniques to shed further light on the determinants of renewable energy consumption.

4. DATA AND EMPIRICAL RESULTS

In both theoretical and empirical studies, many different kinds of variables have been considered as significant determinants of energy consumption. So in this research, by application of the methods

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[1] South Asian Association for Regional Cooperation

of Bayesian Model Averaging (BMA) and Weighted-Average Least Square (WALS), the effects of influential factors on renewable energy consumption which have been regarded in previous studies are investigated. We use STATA program to obtain the coefficient of BMA & WALS estimates.

4.1. Data

The variables used in the model are from time series data between1992-2012. The data is obtained from World Bank and U.S. Energy Information Administration (EIA). The variables are regarded based on growth rate and ratio, though all the variables are stationary. Each of variables of model has been presented briefly in Table (2).

4.2. Empirical Results

One of the most important privileges about BMA & WALS analyzing is the high level of trust in coefficients estimated in explanatory variables. Because these coefficients are not estimated based on just one model but they are derived from averaging model of estimated coefficients in every single variable with 524288 (=2^{19}) recapitulations or effective samplings. The coefficient for each of BMA & WALS estimates is calculated in this way:

$$\hat{\beta}_1 = \sum_{i=1}^{I} \lambda_i \hat{\beta}_{1i}$$

λ_i Is the possibility of "i" numbers of model and β_{1i} is an estimation of β_1 which is gained in case of M_i model being. Table (2) shows the t-ratio and the posterior inclusion probability (pip) for each of the BMA estimates which shed some light on the relative importance of each regressor. Table (3) shows standard error and t-ratio for each of the WALS estimates which shed some light on the relative importance of each regressor. Now we are going to analyze regarding to the results of tables (2 & 3):

Table (2): The results of BMA estimation

Variable	Variable symbol	Coefficient	t-ratio	Pip
Constant	cons	-1.017	-1.18	1.00
Domestic credit provided by banking sector (% of GDP)	gdbs	0.00076	0.01	0.05
US Central Appalachian coal spot price index Growth	gclp	-0.0007	-0.03	0.05
Gross capital formation (annual % growth)	ggcf	0.00002	0.01	0.05
Industry, value added (% of GDP)	ivad	-0.0037	-0.02	0.06
GDP growth (annual %)	ggdp	-0.0386	-0.18	0.08
Foreign direct investment, net inflows Growth	gfdi	0.0014	0.23	0.09
Natural Gas: Prices. OECD countries cif Growth	gngp	0.0187	0.25	0.10
Spot crude prices Growth(Brent US dollars per barrel	gsop	-0.0242	-0.24	0.10
Control of Corruption	ccrp	-0.0015	-0.35	0.16
Rule of Law	rolw	0.0030	0.40	0.19
Growth of Total Population	gpop	-9.0942	-0.83	0.49
Carbon dioxide emission growth	gcde	-0.6158	-0.99	0.57
Dummy variable of oil exporter countries	doex	0.6636	2.11	0.89
Logarithm of Surface area (sq. km)	lsac	0.5025	3.52	0.98
Regulatory Quality	regq	0.0234	3.61	0.99
Political instability and Violence	psav	-0.0453	-9.78	1.00
Government Effectiveness	goef	0.0308	4.06	1.00
Urban population (% of total)	urpop	-4.7634	-4.29	1.00
School enrollment, tertiary (% gross)	gset	1.631	5.53	1.00

Table (3): The results of WALS estimation

Variable	Variable symbol	Coefficient	Standard error	t-ratio
Constant	cons	-0.4668	0.7225	-0.65
Political instability and Violence	psav	-0.0387	0.0036	-10.66
School enrollment, tertiary (% gross)	gset	1.4665	0.2597	5.66
Urban population (% of total)	urpop	-4.7810	1.0558	-4.53
Government Effectiveness	goef	0.0302	0.0071	4.23
Regulatory Quality	regq	0.0170	0.0042	4.01
Logarithm of Surface area (sq. km)	lsac	0.4172	0.1177	3.54
Growth of Total Population	gpop	-16.2092	7.3398	-2.21
Dummy variable of oil exporter countries	doex	0.5245	0.2572	2.04
Control of Corruption	ccrp	-0.0101	0.0055	-1.96
Rule of Law	rolw	0.0174	0.0094	1.85
Natural Gas: Prices. OECD countries cif Growth	gngp	0.2849	0.1377	1.71
Spot crude prices Growth(Brent US dollars per barrel	gsop	-0.2849	0.1880	-1.52
Carbon dioxide emission growth	gcde	-0.5863	0.4135	-1.42
Foreign direct investment, net inflows Growth	gfdi	0.0127	0.0132	0.96
GDP growth (annual %)	ggdp	-0.4868	0.5381	-0.90
Domestic credit provided by banking sector (% of GDP)	gdbs	0.0710	0.3302	0.22
Industry, value added (% of GDP)	ivad	0.1010	0.5583	0.18
Gross capital formation (annual % growth)	ggcf	0.0015	0.0118	0.13
US Central Appalachian coal spot price index Growth	gclp	0.0083	0.0968	0.09

As a rough guideline for "robustness" of a regressor in BMA analysis, a value pip[1] = 0.5 is sometimes recommended (Raftery, 1995), corresponding approximately with an absolute t-ratio of |t | = 1 (Masanjala and Papageorgiou, 2008). Regarding pip ≥ 0.5 for robustness of a regressor, the results of the table (3) may be explained as follows:

We see that political instability and violence , government effectiveness, urban population (% of total) and school enrollment, tertiary (% gross) are by far the most robust auxiliary regressors with pip = 1.00. The coefficient of these variables has been obtained -0.045, 0.03, -4.76 and 1.63 respectively which indicates that averagely for each percent increase on political instability and violence rank's, and Urban population ratio, -0.045% & -4.76% will be decreased to renewable energy consumption in ECO countries respectively.

The second important variables include; regulatory quality, logarithm of surface area (sq. km), dummy variable of oil exporter countries and Carbon dioxide emission growth. These variables except Carbon dioxide emission growth, all these have a positive effect on the renewable energy consumption.

Other considered variables have not strong correlation with renewable energy consumption with pip less than 0.5. In fact it seems the other variables have affected the renewable energy consumption from main variables of institutional circumstance variable, human capital goods and others so that after controlling the above variables they have no important effect on renewable energy consumption.

In according of WALS analysis; statistical significance of a regressor is evaluated by t-ratio of respective coefficient. In the papers where WALS approach is used, the criterion of significance of

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[1] Posterior Inclusion Probability

explanatory variables is usually considered $t \geq 2$. Thus regarding $t \geq 2$ for robustness of a regressor, the results of the table (4) may be explained as follows:

Political instability and violence, urban population (% of total), population growth and control of corruption, have negative effect on renewable energy consumption in ECO countries. But school enrollment, tertiary (% gross), government effectiveness, regulatory quality, logarithm of surface area (sq. km) and dummy variable of oil exporter countries have positive effect on renewable energy consumption. Other considered variables have not strong correlation with renewable energy consumption with t-student less than 2.

These results implies that institutional circumstance variables are main determinant of renewable energy consumption in ECO countries and in contrast of last studies that have investigated the renewable energy consumption in developed countries, price of fossil energy, economic growth, FDI, carbon dioxide emission or financial development have not significant effect.

As previous studies we see that renewables potential, human capital and energy needs are from determining factor of renewable energy consumption. Interestingly, also we see that countries that export oil use renewable energy more than others. In fact oil revenues give them more facilities to apply renewable industries. These oil exporter countries by oil revenues are able to import new technology and renewable industry needs more and faster than other ECO countries.

4.3. Selection of Optimum Models

"STATA" program present vselect command in order to select variables after performing a linear regression. This command determine the best subsets of each predictor size by using leaps-and-bounds algorithm and provides the five information criteria[1] for each of these models in order to select the optimist model. The optimal model is the one model with these qualities: the smallest value of Akaike's information criterion (AIC), Akaike's corrected information criterion (AICc) and Bayesian information criterion (BIC); the largest value of R^2_{ADJ} (adjusted); and a value of Mallows's C_p that is close to the number of predictors in the models +1 or the smallest among the other Mallows's C_p values. These guidelines help avoid the controversy of which information criterion is the best. Sometimes there is no single model that optimizes all the criteria. There are no fixed guidelines for this situation. Generally, we can narrow the choices down to a few models that are close in optimization (Lindsey and Sheather, 2010). Then we make an arbitrary choice among them. We see the results of vselect command in Table (4):

Table (4): The results of vselect command

Number of regressor (models)	The regressors that constitute optimum model among different models with different numbers of regressors.
Best model by 1 regressor	psav
Best model by 2 regressor	psav goef
Best model by 3 regressor	psav gset regq
Best model by 4 regressor	psav gset regq lsac
Best model by 5 regressor	psav gset urpop goef gpop
Best model by 6 regressor	psav gset urpop goef regq lsac
Best model by 7 regressor	psav gset urpop goef regq lsac doex
Best model by 8 regressor	psav gset urpop goef regq lsac doex gcde
Best model by 9 regressor	psav gset urpop goef regq lsac doex gpop gcde
Best model by 10 regressor	psav gset urpop goef regq lsac doex gpop rolw gcde
Best model by 11 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde
Best model by 12 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gfdi
Best model by 13 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gngp gsop

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[1] An information criterion is a function of a regression model's explanatory power and complexity. The model's explanatory power (goodness of fit) increases the criterion in the desirable direction, while the complexity of the model counterbalances the explanatory power and moves the criterion in the undesirable direction (Sheather, 2009).

Best model by 14 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gngp gsop gfdi				
Best model by 15 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gngp gsop gfdi ggdp				
Best model by 16 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gngp gsop gfdi ggdp gdbs				
Best model by 17 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gngp gsop gfdi ggdp gdbs gclp				
Best model by 18 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gngp gsop gfdi ggdp gdbs gclp ivad				
Best model by 19 regressor	psav gset urpop goef regq lsac doex gpop rolw ccrp gcde gngp gsop gfdi ggdp gdbs gclp ivad ggcf				
Information criteria	**BIC**	**AICc**	**AIC**	**C**	**R^2ADJ**
Best model & Information criteria	359.2524 8_{th} **model**	863.1929 11_{th} **model**	324.7541 11_{th} **model**	8.411195 11_{th} **model**	0.7689578 13_{th} **model**

Results of selection of optimum model analysis indicate that the optimal model among one regressor models is model that just has political instability and violence as explanatory variable. Among four regressor models optimal model includes; political instability and violence, school enrollment, tertiary (% gross), regulatory quality, and logarithm of surface area (sq.km). Similarly, for each number of the explanatory variables the optimal model is presented (see table 5). We can see that most of determinant of renewable energy consumption in BMA and WALS analysis have appeared on all optimal models. Therefore, results of optimum model selection approve the conclusion of BMA and WALS. Best selection number of explanatory variables in the models, by information criteria AICc, AIC, and Mallows's C_p 11th model is optimal model. These variables includes; political instability and violence, school enrollment, tertiary (% gross), urban population (% of total), government effectiveness, regulatory quality, logarithm of surface area (sq. km), dummy variable of oil exporter countries, total population growth, rule of law, control of corruption, and carbon dioxide emission growth.

5. CONCLUSION

The economic theories on the energy consumption entail a vast array of potential factors by which renewable energy consumption can be influenced. To solve this problem, we employ Bayesian model averaging and weighted-average least square methods to allow us to partially control for model uncertainty in our analysis. The results indicate that the political instability and violence, government effectiveness, urban population (% of total) and human capital (school enrollment, tertiary (% gross)) are the most to robust auxiliary regressors affecting the renewable energy consumption among ECO countries. The second influential factors on renewable energy consumption are the regulatory quality, renewable potential (logarithm of surface area (sq. km)), dummy variable of oil exporter countries and carbon dioxide emission growth.

In fact, characteristics of the economic and institutional environment are main determinants of renewable energy consumption and price factors are insignificant. Remarkable result is existence negative relationship between controls of corruption and renewable energy consumption. As have stated in theatrical literature sector, usually at the early stage of developing, controls of corruption can be restrictive. Such that controls of corruption causes firms could not do rent seeking activities to alleviate high initial cost of renewable industry by acquiring governmental resources. Thus negative relationship is logical. Also carbon dioxide emission has negative effect on renewable energy consumption that it is against on common results in recent studies. Since the ECO countries have developing economy, first priority of them is growth and development rather than environmental concerns. Then they allocate investment resources in economy without consider environmental aspects. In this regard, growth of investment cannot boost renewable industry through them. On the other hand, since renewable crafts have high initial cost to apply, in develop process placed at lower priority. Also in against of physical capital, human capital is main determinants of renewable energy consumption in this study. Human capital by at least three canal

increases renewable energy consumption that includes providing skilled labor force and felicities of applying new technology like renewable crafts, promoting of knowledge of individuals and social (in relation to environmental concerns), and also by promoting of growth and development of these countries' economies. According to above it can be said that pay more attention to human capital and amend institutional environment of the ECO countries are appropriate proposition to extend renewable energy consumption.

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