FOSSIL & RENEWABLE ENERGY CONSUMPTION, GHGs AND ECONOMIC GROWTH: EVIDENCE FROM A RIDGE REGRESSION OF KYOTO ANNEX COUNTRIES

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ABSTRACT

This study has analyzed the relationship between energy consumption, GDP and CO_2 emissions of Annex-I countries in Kyoto Protocol for the period 2000-2010. In this paper, aggregate energy consumption has been split into renewable and non-renewable energy usage in EKC framework to discuss the potential effects of renewables on GHGs. Since there has been a multi-collinearity between the energy consumption and income variables, one of the biased statistical methods for fitting the multi-collinearity among the independent variables, namely Ridge regression method was used. Empirical results show that EKC hypothesis for Annex I countries of Kyoto Protocol has been rejected although they have been supposed to decrease the GHGs. Moreover, while some of the countries have potential to meet the Kyoto targets, especially countries in transition will have to endure environmental deterioration as a result of economic growth. Indeed, renewable energy has a potential to alleviate the GHGs. Since the elasticity between fossil energy consumption and emissions is mostly below unity, however, reducing fossil energy consumption and increased renewable energy usage will not be a solution by itself. Therefore, Ridge regression results indicate that policies seeking to promote renewable energy should be complemented with energy efficiency efforts to combat global change.

Keywords: Environmental Kuznets Curve, Renewable energy, Ridge regression, Carbon dioxide emissions, Sustainable economic growth.

1. INTRODUCTION

Global warming and climate change issues have raised concerns over the relationship between economic development and environmental protection since the 1990s. (Pao and Tsai, 2011). The subject of environmental deterioration versus economic development was first

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emphasized in detail in the World Development Report in 1992. It previously has been studied whether economic development causes problems for environmental protection or improves environmental quality has been studied through econometric methods during the three decades. The relationship between economic growth and environment is generally analyzed by the Environmental Kuznets Curve (EKC).

The Kuznets Curve (KC) hypothesis was first introduced by Simon Kuznets in 1955. Kuznets argued that economic development and inequality in income distribution might be explained by an inverted-U shape curve relationship that is justified both theoretically and empirically (Huang et al, 2008). KC, however, became a vehicle to identify the relationship between environmental quality and per capita income across the time in 1951 (Yandle et.al., 2003). The EKC hypothesis was first proposed and tested by the pioneering study of Grossman and Krueger (1991). EKC hypothesis states that, as per capita income increases, income inequality increases at first and then starts to decrease after a turning point. In other words, environmental pollution level increases as the countries' income grows, but begins to decrease beyond an income turning point (Granados and Carpintero, 2009, p.9). Early studies on EKC hypothesis have indicated that some important indicators of environmental quality such as sulfur dioxide and particulates in the air improve with increasing income. Empirical studies of EKC hypothesis have generally focused on two critical issues: whether a given indicator of environmental pollutant display an inverted U-shape relationship with levels of per capita income as well as the estimation of the threshold that environmental quality improves with increasing income per capita (See Yandlee et al., 2002). Since majority of world's GHG emissions results primarily from combustion of fossil fuels, energy policies that reduce fossil fuel usage take central place in climate change debates. According to the latest report of Joint Research Centre (EU-JRC), (see Oliver et al, 2012), fossil fuel combustion accounts for about 90% of total global CO_2 emissions. Moreover, according to the International Energy Outlook (2011), renewables are the fastest growing sources of world energy and the share of renewables in total energy use will increase from 10 % in 2008 to 14 % in 2035 (EIA, 2011). Considerable attention is given to renewable energy in many countries due to the concerns over the volatility of oil prices, the dependency on foreign energy sources (energy security problem) as well as the environmental consequences of GHGs. A large number of recent energy consumption-economic growth studies have focused on renewable energy consumption. Chien and Hu (2007), Chien and Hu (2008), Sadorsky (2009a), Sadorsky (2009b), Apergis and Payne (2010a), Apergis and Payne (2010b), Apergis and Payne (2011), Mahmodi and Mahmodi (2011) have examined the relationship between renewable energy consumption and economic growth. However, the general focus within the framework of EKC is on the relationship between emissions and economic development while omitting the energy aspects from the analysis. As pointed out Caviglia-Harris et al.(2009), energy is vital variable and is largely responsible for the lack of an EKC relationship. Therefore, energy as well as the splitting of aggregate energy consumption into renewable and non-renewable energy in EKC modeling helps policy makers' understand its possible effects on carbon emissions and sustainable development in the long term.

This paper aims to contribute to existing EKC researches in two aspects. First, to the best of our knowledge, no study has been carried out that tests the EKC hypothesis including renewable energy consumption as a variable that directly affects the environment. However, panel data analysis has been conducted for 24 EU countries as part of the research paper of Marrero (2010) and it was assumed that impacts of energy consumption on emissions had been dependent on the primary energy mix. Contrary to Marrero's (2010) paper, which included the energy mix in EKC hypothesis, we use the renewable energy consumption directly as an important variable on GHGs since characterization of the effects of energy and renewable energy on emissions is significant for the formulation of energy and environment policies. Secondly, since economic development is closely related to energy utilization, the potential of the multi-collinearity problem is expected to arise among independent variables in the empirical model. Previous EKC studies which take into account some additional variables such as energy consumption, trade, energy price, population etc., have generally ignored this issue. Therefore, EKC hypothesis has been tested by using ridge regression in our study. If there is a high multi-collinearity among independent variables, Ridge regression is an efficient technique for the analysis of multiple regression data that suffer from multi-collinearity. By adding a degree of bias to regression estimates, this technique reduces the standard errors and gives estimates that are more reliable (NCSS, 2014). In this study, we examine the relationship between economic growth, GHG emissions and energy consumption by taking into account the renewable energy for Annex-I countries of Kyoto Protocol. The rest of the paper is organized as follows; the next section presents a literature review regarding Kyoto Protocol and EKC studies. Section three describes the methodology and data for analysis. Section four discusses the empirical results and compares the results of the Ridge regression analysis with those of the previous studies. Concluding remarks are given in the final section.

2. LITERATURE REVIEW

The initial response of countries to the threat of global warming was the Framework Convention on Climate Change (FCCC) which was adopted in Kyoto, Japan on the 11th of December 1997. The stated objective of FCCC was to achieve stabilization of GHGs in the atmosphere. It was recognized that commitments set out in FCCC were not sufficient for achieving its ultimate objective and this led to the adoption of Kyoto Protocol in 1997 (UN, 2013). The Kyoto Protocol came into effect on February 16, 2005. Under Article 3 of Kyoto Protocol, 37 industrialized countries and the European Community (Annex I countries) have agreed to reduce their GHG emissions by an average of 5 % below 1990 levels during an initial commitment during the 2008-2012 period (Tucker, 2001). Although some countries such as China, India and Brazil are large emitters, these developing countries currently have no obligation for emission reductions. Instead, they suggest that they will take voluntary steps to control levels of GHG emissions. (CRF, 2013). The issues of developing country's commitments for emissions were contentious in the last three Conferences of the Parties to Climate Convention. It is stated that the continuity of Kyoto Protocol beyond 2012 may depend on Annex I as well as the attitude of developing countries to the agreement on this issue (Santilli, 2005). Kyoto Protocol contains a specific compromise assumed by industrialized and in transition economies to reduce their CO_2 emissions below their 1990's level along the period of 2008-2012. The Kyoto Protocol divides the member countries into different groups: Annex I with GHG emissions reduction obligations and non-Annex I without emission reduction obligations. Protocol covers the main GHGs such as CO_2, which represents the biggest share, and the other five GHGs. The goal of the protocol is to attain a cut of GHGs by 5.3 % until 2012 compared to the countries' CO_2 emission levels in 1990. Kyoto came into effect in 2005 and after Russia's ratification, 55 countries which emit at least 55 % of the global GHG emissions became parties to the Kyoto. To deal with the difficulty of integrating of the developing countries, Kyoto tries to enhance sustainable development for developing countries via flexible mechanisms such as Clean Development Mechanisms (Grunewald and Martinez, 2009).

Annex I countries are allowed to achieve some emissions reductions by investing in energy projects that cut GHG emissions in developing countries through Clean Development Mechanisms. It is recognized in Kyoto that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of their industrial activities. Hence, the Protocol brings heavier burden on developed countries under the principle of "common but differentiated responsibilities" (UN, 2013). After Kyoto Protocol, CO_2 emissions have become a focus of international attention and parties which have adopted internationally binding emissions reduction targets.

A key aim of international efforts to mitigate negative effects of global climate change is to alleviate global CO_2 emissions. Since the accomplishment of these efforts depends on commitments by the countries to reach global emission targets, it is important to understand the variables which have impact on CO2 emissions (Villanueva, 2012). Therefore, it has been questioned whether economic development leads GHG emissions or improves the environmental quality. It is expected that the understanding of this link will help in the development of emission reduction strategies.

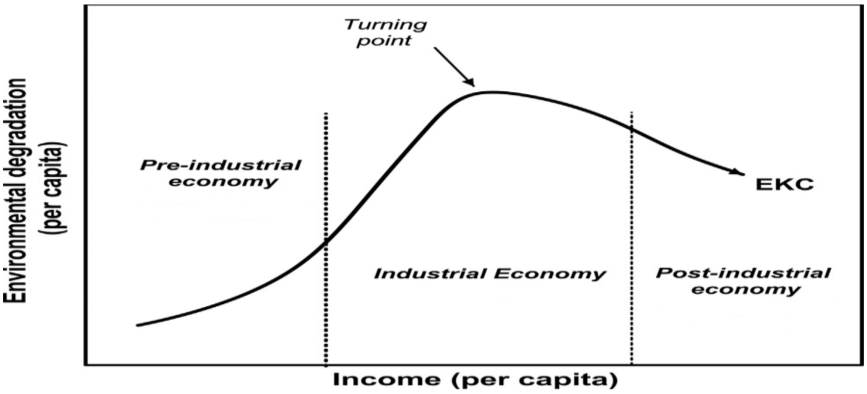

Figure 1: The environmental Kuznets curve: a development-environment relationship
Source: Panayotou, 2003.

According to the EKC, environmental pressure tends to rise faster than income growth in the early stages of economic development, then slows down, reaches a turning point and decreases with further economic growth, , in other words the environmental quality gets worse at first and then improves with economic growth (de Bruyn et al.,1998, p.162) (See Figure 1). The relationship between economic development and environmental degradation or quality can be considered to consist of three effects, which are the scale effect, the composition effect and the technical effect. While first effect provides an explanation for positive income-pollution relationship, the other two effects can explain both positive and negative relationships (Khanna and Plassmann, 2004 ,p.226). Environmental pressure increases as output growth increases (scale effect) but this pressure might be nullified by the other two effects. It is possible that economic development occurs mainly in sectors that pollute less (this is called composition effect) and technological progress can countervail the greater production level (technical effect) (Almeida and Sabadini, 2009). If EKC were true, this hypothesis would suggest that countries do not need to struggle to reduce CO_2 emissions as envisaged by the Kyoto Protocol since economic development would eventually lead to environmental improvement (Zhao, 2011).

There are mainly three research strands available in literature that examine the relationship between economic growth and environmental quality. The first strand focuses on the nexus of economic development and environmental pollutants (Zhang, 2009). This strand simply tests the validity of the so-called EKC hypothesis. EKC studies have gained an increasing research attention over the span of time since the pioneering works of Grossman and Krueger (1991), Grossman and Krueger (1995), Holtz-Eakin and Selden (1992) and Shafik (1994). Empirical results for EKC studies are controversial. The EKC hypothesis is being criticized for lack of feedback from environmental pollutants to economic output as income is assumed to be an exogenous variable (See Zhang (2009), Arrow et al.(1995), Stern (2004), Huang and Shaw (2002) etc). Stern (2004), Dinda (2004), Lieb (2003) and Bo (2011) provide a review survey of empirical EKC studies.

The second strand focuses on the link between economic output and energy consumption since GHG emissions are mainly caused by fossil fuels. Following the study of Kraft and Kraft (1978), an increasing number of studies have employed Granger causality and cointegration model, providing an empirical evidence between economic development and aggregate energy consumption.(See Akarca and Long (1980), Yu and Choi (1985), Erol and Yu (1987), Yu and Jin (1992), Masih and Masih (1996), Hondroyiannis et al.(2002), Soytas and Sari (2003), Lee and Lee (2010) etc. Payne (2010), provide an extensive review of the studies on empirical results for the relationship between energy consumption and economic growth relationship.

An assessment of the existing literature indicates that a large part of these studies focus on the nexus of energy-output or pollution-output. However, some recent studies "combined" approaches of these two strands and investigated the inter-temporal linkage in the energy-environment-income nexus (See Soytas et al. 2007, Soytas and Sari 2009, Halicioglu 2009, Ang 2007, Zhang and Cheng 2009, Apergis and Payne 2009, Marrero 2010, Almeida and Sabadini 2009, Grunewald and Martinez 2009, Richmond and Kaufman 2006, Zhao 2011, Araouri et al. 2012, Saboori and Sulaiman 2013, Pao and Tsai 2011, Sulaiman et al., 2013, Zeb et al. 2014, etc.).

Table 1. Selected papers on EKC using energy consumption

Author	Independent Variables	Data Period	Region	Method	Conclusion
Marrero, (2010)	Aggregate energy use, distribution of primary energy consumption, shares of the energy types and GDP	1990-2006	EU countries (EU 24)	Dynamic panel data analysis (GMM)	No EKC Kyoto Effect: There is no difference between pre and post Kyoto period.

Sulaiman et al., (2013)	Renewable electricity production, trade openness, GDP	1980-2009	Malaysia	ARDL	EKC yes Trade openness and renewable electricity production negatively effects the CO2 emissions
Zhang and Cheng, (2009)	Energy consumption, GDP	1960-2007	China	Granger causality	Unidirectional causality from GDP to energy consumption
Almeida and Carvalho, (2009)	Energy consumption, GDP	2000-2004	167 countries	Panel fixed effect	N-shaped EKC Kyoto Protocol has positive effect on CO2 reduction.
Gruneald and Martinez-Zarzoso, (2009)	GDP, dummies for Kyoto Protocol	1975-2004	123 countries	Static and dynamic panel data analysis	No EKC Kyoto Protocol has positive effects on CO2 reduction
Mazzanti and Musolesi, (2009)	GDP, Dummies for Kyoto, oil price shock	1960-2001	3 group countries	Panel cointegration	For north EU countries EKC yes; Kyoto Protocol has positive effects on CO2 reduction
Richmond and Kaufman, (2006)	fuel mix, GDP	1973-1997	36 OECD and non-OECD countries	Panel data analysis	No EKC for non-OECD countries
Zhao, (2011)	Energy consumption, GDP	1980-2004	23 OECD countries	Panel data analysis	Reverse EKC
Apergis and Payne, (2009)	Energy consumption, GDP	1971-2004	6 Central American countries	Panel cointegration	EKC yes, Energy consumption has positive effect on CO2 emissions reduction
He and Richard, (2010)	GDP, oil shock	1948-2004	Canada	Partially linear regression model	EKC yes, Oil shock has positive effect on EKC relationship
Arouri et al., (2012)	Energy consumption, GDP	1981-2005	12 Middle East and MENA countries	Panel cointegration	No EKC, Energy consumption has positive effect on CO2 emissions
Halicioglu, (2009)	Energy consumption, foreign trade, GDP	1960-2005	Turkey	ARDL, time series cointegration	EKC yes, Energy consumption has positive effect on CO2 emissions
Ang, (2007)	Energy consumption, GDP	1960-2000	Fransa	VECM, time series cointegration	EKC yes,

Caviglia-Harris et al.,(2009)	Energy efficiency, GDP	1961-2000	146 countries	Dynamic panel data analysis	No EKC, energy is important for EKC relationship
Saboori and Sulaiman, (2013)	Energy consumption, GDP	1980-2009	Malaysia	ARDL, time series cointegration	No EKC at aggregate level, EKC at disaggregate level
Zeb et al.(2014)	Renewable energy consumption, GDP	1975-2010	Bangladesh, India, Nepal, Pakistan, Sri-Lanka	Panel cointegration	Renewable energy has potential to reduce CO2 emissions.
Pao and Tsai, (2011)	Energy consumption, GDP	1980-2007	Brazil	Causality and ARIMA	EKC yes, Energy consumption has positive effect on CO2 emissions

Source: Authors' elaboration

Some selected papers on EKC which include energy consumption are listed in Table 1. It can be concluded from the survey of relevant literature that validity of EKC hypothesis is still controversial. Although there is overwhelming evidence linking economic growth and CO_2 and/or GHG emissions in the framework of EKC, economic development itself cannot be expected to control CO_2 emissions. Moreover, it appears that income-emission relationship has been affected by energy consumption and Kyoto Protocol elements. In other words, efforts for reducing GHG emissions by some mechanisms such as the use of less polluting technologies (renewables) have impact in the shaping of the long run emissions/GDP dynamics as well.

3. METHODOLOGY AND DATA OF ANALYSIS

The 1992 UNFCCC covers 41 countries including the EU. These countries have to fulfill their responsibilities to reduce GHG emissions. Kyoto countries that we included in the analysis can be seen in Table in Appendix 1. Following the Huang et al.(2009), these countries have been divided into three groups; "Annex II Countries", "Economies in Transition" and "Others". As mentioned before, Kyoto Protocol came into effect in 1997 and requires 38 Annex I countries and EU to reduce their emissions to 5.2% below the 1990 emissions level during the 2008-2012 period.

As GHG emission data and GDP for Liechtenstein are unavailable, this country has been excluded from the data set of the analysis which is consistent with the study of Huang et al. (2008). Although formally Canada withdrawn from Kyoto Protocol on December, 2011; we included this country in our research as well since our data period covers 2000-2010 excluding Monaco[4]. We selected the data period which is the same for all countries to be able to compare them with each other. Because of this purpose, we got the data set available for all countries for the period between 2000-2010. Furthermore we also included Turkey since Turkish Grand National Assembly approved a law to join the Kyoto Protocol in February, 2009. Being a party to Kyoto is important to comply with the EU environment targets. Annual time series data for the countries were taken from the World Development Indicators (WDI) online database for 39 Kyoto countries included Turkey. The variable CO2 is CO_2 gases emissions per capita (measured in metric tons per capita), the variable GDP is per capita Gross Domestic Product (at constant 2000 USD Dollar), the variable GDP2 is square of GDP, the variable REN is the renewable energy consumption quantity (measured in kt of oil equivalent) per capita and finally the variable FOS is fossil fuel energy consumption per capita (measured in kt of oil equivalent). The descriptive statistics of the variables for the countries can be seen in Appendix 2.

Three types of empirical specifications are typically used in the analysis of the EKC hypothesis: linear, a quadratic (inverted-U) and cubic specifications (N-shaped) or sideways-mirrored (S-shaped) (Friedl and Getzner, 2002). One general functional form includes other factors such as time, regional characteristics and technical factors which may be external variables in the following equations (Huang et al, 2008, p.242):

$$Q_t = a_0 + a_1 \ln Y_t + G_t + \varepsilon_t . \quad (1)$$

$$\begin{cases} Qt = a0 + a1\ Yt + a2Yt2 + Gt + \varepsilon t . \\ \ln Qt = a0 + a1 \ln Yt + a2\ (\ln Yt)2 + Gt + \varepsilon t . \end{cases} \quad (2)$$

$$\begin{cases} Qt = a0 + a1\ Yt + a2\ Yt2 + a3\ Yt3 + Gt + \varepsilon t . \\ \ln Qt = a0 + a1 \ln Yt + a2\ (\ln Yt)2 + a3\ (\ln Yt)3 + Gt + \varepsilon t . \end{cases} \quad (3)$$

In these specifications, Q is the per capita GHG emission, Y is the per capita annual GDP, t is time and G is the external variable, ε is the stochastic error and a_i are the coefficients of the EKC model (also it is called as marginal propensity to emit) (Huang, 2008, p.242). In the linear specifications, if $a_1 > 0$ and $a_2 = a_3$, the relationship between income and GHGs is linearly increasing. In this type specification, an increase in income level leads to a proportional increase in emissions. In the quadratic case, if $a_1 > 0$, $a_2 < 0$ and $a_3 = 0$, emissions exhibit an inverted-U relationship to per capita income. This means that the environmental quality (pollution releases) will first increase with increasing GDP then decrease (so-called EKC). In the

[4] For Monaco the data is not available for the year 2010, hence the data period for Monaco is 2000-2009.

cubic case, if $a_1>0$, $a_2<0$ and $a_3 > 0$, a N-shaped relationship between emissions and income can result. If the coefficients are reversed in terms of sign ($a_1<0$, a2>0 and $a_3 < 0$) a sideways-mirrored-S shape can be identified (Friedl and Getzner, 2002, p.5).

To test the EKC hypothesis, the relationship between GHG emissions per capita, energy consumption per capita, renewable energy consumption per capita, real Gross Domestic Product (GDP) per capita and squared of per capita real GDP was investigated. All variables have been taken in the natural logarithm form to obtain the elasticities in the model. Based on the conceptional model, the following equation has been employed to test the EKC relationship:

$$CO2_t = \alpha + \beta_1 GDP_t + \beta_2 GDP2_t + \beta_3 REN_t + \beta_4 FOS_t + \varepsilon_t$$

$$t= 2000,\dots, 2010 \qquad (4)$$

Since economic development is closely related to energy utilization we expect the multi-collinearity among independent variables in the equation 4. One of the problems frequently encountered in multiple regressions is multi-collinearity. Multi-collinearity means that there is a significant relationship between two or more independent variables in the model. Traditional regression method does not give correct results when multi-collinearity exists among the independent variables. Multi-collinearity causes serious problems in the estimation of regression coefficients. For example; the estimated coefficient values may be different from the actual values, the variance of the coefficients may be very high, the coefficient of determination R^2 of the model may be higher, the coefficients are insignificant and signs of the coefficients may be incorrect (Gujarati and Porter, 2008). Because of these effects, multi-collinearity is known as a serious problem for multiple regressions.

3.1. RIDGE REGRESSION

There are many statistical methods used in the case of multi-collinearity. One of them is a method known as Ridge regression which is one of the biased statistical methods. The method has first been proposed by Hoerl and Kennard in 1970. In this method, the regression coefficients will be closer to their correct values than the estimates obtained using ordinary least squares (OLS) if there is multi-collinearity (Ferreira and Sirmans, 1988). Although it is biased, it is a preferred method to decrease the variances of the estimates.

Ridge regression estimator which is biased estimator of β is given as:

$$\hat{\beta}^k = (X'X + kI)^{-1}X'Y \qquad (5)$$

where X is (nxp)- dimensional matrix of independent variables, $\hat{\beta}^k$ is $(px1)$ - dimensional vector of unknown parameters, Y is (nx1)- dimensional vector of dependent variable and k is bias parameter taking a value between 0 and 1 $(0 \leq k \leq 1)$ (Hoerl and Kennard, 1970). When $k = 0$, the ridge regression coefficients are equal to OLS regression coefficients. That is, it gives the same estimation with OLS method. The value of k increase, the ridge regression gives biased estimations. But these estimations have smaller variance than the OLS estimations. The most important point is to determine the correct value of k in Ridge regression. Various methods have been proposed for the determination of k in literature. Hoerl and Kennard (1970) have suggested the Ridge Trace for the selection of k. Marquardt and Snee (1975) have proposed variance inflation factor that is between 1 and 10. Hoerl, Kennard and Baldwin (1975) have suggested $k = p\hat{\sigma}^2 / \hat{\beta}'\hat{\beta}$ for the determination of k. In this study, VIF is used for the determination of k value. VIF is a very popular diagnostic tool for detecting multi-collinearity. VIF values that are lower than 10 indicate that multi-collinearity is not a serious issue. VIF values of the independent variables that corresponding to each value of k are calculated. k value that all VIFs are less than 10 is determined. The selection of k is optimal value. However, If any of VIF_j is higher than this value, multi-collinearity exists in model (Marquardt and Snee, 1975). It can be formulated as;

$$VIF_j = \frac{1}{1 - R_j^2} \qquad \text{for } j = 1, \dots, p \qquad (6)$$

R_j^2 is the coefficient of determination in a regression of the i −th independent variable on all other independent variables.

In ridge regression, t-test is used to test individual significance of the coefficients. Test statistic is;

$$t_k = \frac{\hat{\beta}_j^k}{s(\hat{\beta}_j^k)} \qquad (7)$$

where $\hat{\beta}_j^k$ is the estimation of j-th regression coefficients in the ridge regression model and $s(\hat{\beta}_j^k)$ is an estimation of the standard error under the null hypothesis $H_0: \hat{\beta}_j = 0$. To test this hypothesis, it is used degrees of freedom as $n - m$ when $m < n$ $(m = p + 1)$ where p is the number of independent variables and n is the number of observation (Cule et al., 2011).

4. EMPIRICAL RESULTS

The Ridge regression estimation results of equation 4 for each country have been given in Table 3. Besides the Ridge regression estimation method, we also estimated the models for each country by using ordinary least squared method to check the presence of multi-collinearity among independent variables and the calculated variance inflation factors of independent variables for each estimation methods have given in Table 2. As seen in Table 2, VIF values getting OLS estimation are very high which indicate serious multi-collinearity among the independent variables whereas the VIF values for each country from Ridge estimation are very small and acceptable levels.

Table 2. Variance Inflation Factors for the independent variables

	Least Squares Estimation				Ridge Regression Estimation			
Country	GDP	GDP2	REN	FOS	GDP	GDP2	REN	FOS
Australia	358213.17	359263.93	2.31	2.17	0.18	0.18	0.49	0.49
Austria	836946.81	833431.67	13.18	2.47	0.35	0.36	1.18	0.78
Belarus	20033.58	19147.81	45.16	12.13	0.09	0.09	0.15	0.40
Belgium	730299.12	729365.99	4.26	2.28	0.13	0.13	0.28	0.34
Bulgaria	29217.05	28448.77	10.10	1.96	0.19	0.20	0.50	0.60
Canada	632491.92	632523.32	2.20	2.19	0.22	0.22	0.95	0.94
Croatia	56985.73	56673.06	1.37	2.93	0.42	0.43	0.89	1.49
Czech Rep.	67023.12	66738.14	19.38	3.68	0.26	0.26	0.64	0.79
Denmark	1712454.72	1711324.70	3.65	2.13	0.34	0.34	1.92	1.43
Estonia	19038.66	18990.77	1.66	1.80	0.46	0.46	1.14	1.52
Finland	140900.98	140623.51	3.58	1.54	0.21	0.21	0.60	0.57
France	1460975.99	1460531.70	8.32	7.06	0.31	0.31	4.45	4.46
Germany	967960.11	964434.15	31.95	7.88	0.26	0.26	0.36	0.72
Greece	99298.50	99437.81	1.47	1.26	0.31	0.31	1.02	1.13
Hungary	68511.84	68928.23	19.24	7.91	0.19	0.19	0.48	0.58
Iceland	297438.81	298997.35	6.11	2.34	0.73	0.72	2.03	1.47
Ireland	117641.91	117560.42	9.87	9.87	0.23	0.23	0.53	0.54
Italy	1783626.08	1780110.10	2.60	7.16	0.60	0.60	2.00	3.84
Japan	878991.27	878695.52	3.04	1.29	0.47	0.48	1.81	0.99
Latvia	30195.76	29748.00	7.80	12.85	0.28	0.29	0.93	0.66
Lithuania	12300.47	12098.58	10.81	11.70	0.08	0.08	0.25	0.23
Luxemburg	1137024.26	1124551.40	26.93	13.39	1.15	1.18	3.50	1.53
Monaco	46270.45	47420.13	21.89	2.40	0.29	0.27	0.76	0.88
Netherland	1094008.07	1089559.50	11.40	1.24	0.09	0.09	0.15	0.28
New Zealand	252929.16	252889.43	1.82	5.30	0.15	0.15	0.15	0.15

Norway	650380.24	650180.81	2.15	2.49	0.11	0.11	0.20	0.20
Poland	73405.37	74592.31	16.12	3.49	0.32	0.31	0.92	1.04
Portugal	2231468.78	2231247.60	3.26	2.83	0.12	0.12	0.20	0.21
Romania	18404.77	18406.24	9.21	2.05	0.15	0.15	0.31	0.50
Russia	17916.25	18058.14	1.13	8.08	0.93	0.91	0.93	3.48
Slovakia	40501.44	41076.08	14.45	4.49	0.32	0.31	0.75	0.88
Slovenia	55078.86	54799.50	3.47	4.91	0.50	0.51	1.19	1.45
Spain	446239.88	444273.92	11.26	7.07	0.90	0.92	4.79	3.70
Sweden	223989.25	224144.23	4.32	1.89	0.70	0.70	3.81	1.75
Switzerland	1296430.46	1295159.40	8.43	2.40	1.29	1.29	4.47	1.73
Turkey	66963.38	67870.09	6.10	18.36	1.06	1.03	2.86	3.15
Ukraine	12137.72	12425.90	10.19	3.32	0.25	0.23	0.72	0.67
UK	512485.11	508297.51	43.25	14.55	0.47	0.49	2.96	1.85
USA	829568.24	829423.43	3.39	2.56	0.52	0.52	3.20	1.95

There is no evidence within the analyzed data period for EKC hypothesis regarding Kyoto countries as seen in Table 3. The curve shapes are given in the table and only France has an inverted-U shaped curve but the coefficients of GDP and GDP2 are insignificant. According to Table 4, the coefficients of GDP and GDP2 have either positive signs or negative signs. These results may be explained by the short data period. If longer data periods were used, the model could have caught the peak points on the curve. For Australia and Iceland, all coefficients in the models are insignificant and the coefficients of determination are small (R^2=0.47 for Australia, R^2=0.57 for Iceland). The coefficients of GDP and GDP2 are positive and significant for Belarus, Latvia, Lithuania and Monaco. In these countries, increasing economic growth causes CO_2 emissions to increase. However, GDP and GDP2 coefficients for Belgium and Greece are negative and significant which means that increasing economic growth decreases CO_2 emissions for the data period.

Table 3. The results of Ridge Regression estimations

Country	Curve shape	Cons.	GDP	GDP2	REN	FOS	R^2
Austria	Upwards	-5.116	0.0567	0.0027	-0.0582	0.8396***	0.86
			(-0.52)	(-0.52)	(-1.46)	(-5.99)	
Australia	Upwards	-4.039	0.1038	0.0049	0.0481	0.5856	0.47
			(-0.01)	(-0.01)	(-0.83)	(-0.58)	
Belarus	Upwards	-2.215	0.0697***	0.0043***	0.0771**	0.3554**	0.85
			(-4.62)	(-4.46)	(-2.98)	(-2.84)	
Belgium	Downwards	3.148	-0.3020**	-0.0144**	-0.0312	0.4922**	0.81
			(-2.93)	(-2.93)	(-1.94)	(-3.08)	
Bulgaria	Upwards	-4.000	0.0495	0.0030	0.0221	0.6784***	0.79
			(-1.49)	(-1.44)	(-0.40)	(-4.27)	
Canada	Downwards	-3.921	-0.0829	-0.0039	0.1304	0.8325***	0.86
			(-0.75)	(-0.73)	(-0.56)	(-5.30)	
Croatia	Downwards	-5.750	-0.0085	-0.0006	-0.0177	1.0211***	0.89
			(-0.17)	(-0.22)	(-0.22)	(-5.75)	
Czech Rep.	Downwards	-2.713	-0.0211	-0.0011	-0.0736*	0.7139***	0.87
			(-0.63)	(-0.59)	(-2.25)	(-4.77)	
Denmark	Upwards	-8.863	0.0986	0.0045	0.1031	1.1050***	0.90
			(-0.58)	(-0.57)	(-1.61)	(-6.92)	

Estonia	Upwards	-5.790	0.0081	0.0006	0.1078*	0.9250***	0.96
			(-0.31)	(-0.45)	(-2.05)	(-9.02)	
Finland	Downwards	-5.825	-0.0280	-0.0013	0.2484	0.8499***	0.76
			(-0.21)	(-0.21)	(-1.09)	(-4.54)	
France	inverted-U	-5.912	0.0034	-0.0001	0.0113	0.9912***	0.99
			(-0.07)	(-0.02)	(-0.25)	(-9.92)	
Germany	Downwards	-1.383	-0.0638	-0.0031	-0.0263**	0.5869***	0.87
			(-0.77)	(-0.76)	(-3.02)	(-4.38)	
Greece	Downwards	-5.030	-0.0510*	-0.0024*	0.0415	0.9911***	0.96
			(-2.35)	(-2.17)	(-0.60)	(-11.35)	
Hungary	Downwards	-2.586	-0.0209	-0.0010	-0.0559**	0.6343***	0.84
			(-0.48)	(-0.45)	(-3.05)	(-5.09)	
Iceland	Downwards	12.440	-0.2067	-0.0094	0.0863	-0.9127	0.57
			(-0.91)	(-0.91)	(-1.45)	(-1.48)	
Ireland	Upwards	-2.312	0.0149	0.0007	-0.1084***	0.5989***	0.86
			(-0.17)	(-0.17)	(-3.64)	(-4.45)	
Italy	Upwards	-7.443	0.1290	0.0062	-0.0260*	0.9616***	0.98
			(-1.09)	(-1.07)	(-2.05)	(-7.94)	
Japan	Upwards	-6.486	0.0435	0.0021	-0.0218	1.0058***	0.93
			(-0.53)	(-0.53)	(-0.64)	(-8.30)	
Latvia	Upwards	-3.447	0.0699*	0.0040*	0.0996	0.4275***	0.88
			(-2.32)	(-2.30)	(-0.91)	(-4.01)	
Lithuania	Upwards	-1.763	0.0807**	0.0046**	0.0101	0.2743**	0.73
			(-3.51)	(-3.54)	(-0.20)	(-3.56)	
Luxemburg	Upwards	-6.088	0.1073	0.0047	-0.0155	0.8347***	0.97
			(-0.98)	(-0.95)	(-0.47)	(-10.05)	
Monaco	Upwards	-5.285	0.2849**	0.0186**	0.4106**	-0.0121	0.89
			(-3.59)	(-3.62)	(-3.39)	(-1.56)	
Netherland	Downwards	-0.765	-0.0375	-0.0018	-0.0038	0.4445***	0.42
			(-0.80)	(-0.80)	(-0.34)	(-2.93)	
New Zealand	Downwards	-0.202	-0.1288	-0.0063	0.1913	0.4007**	0.69
			(-1.09)	(-1.09)	(-1.57)	(-3.64)	
Norway	Upwards	-7.722	0.3169	0.0143	0.3515*	0.3333**	0.62
			(-1.49)	(-1.48)	(-2.20)	(-2.96)	
Poland	Upwards	-2.707	0.0082	0.0004	-0.0186	0.6159***	0.79
			(-0.40)	(-0.40)	(-0.73)	(-4.36)	
Portugal	Downwards	4.503	-0.2860	-0.0145	-0.2836	0.4055**	0.61
			(-0.63)	(-0.63)	(-1.72)	(-3.43)	
Romania	Upwards	-3.409	0.0459	0.0027	-0.0519	0.6237***	0.65
			(-1.04)	(-1.04)	(-0.90)	(-3.89)	
Russia	Upwards	-4.985	0.0078	0.0006	0.0367	0.8597***	0.95
			(-0.34)	(-0.45)	(-0.48)	(-5.05)	
Slovakia	Upwards	-3.258	0.0049	0.0002	-0.0435*	0.6853***	0.86
			(-0.20)	(-0.17)	(-2.09)	(-4.52)	
Slovenia	Upwards	-4.279	0.0466	0.0024	-0.0832	0.7829***	0.92
			(-1.29)	(-1.27)	(-1.66)	(-5.22)	
Spain	Upwards	-6.657	0.0401	0.0021	-0.1666	1.1283***	0.98
			(-0.32)	(-0.33)	(-1.66)	(-8.86)	
Sweden	Downwards	-4.810	-0.0574	-0.0027	0.0441	0.9476***	0.99
			(-1.13)	(-1.15)	(-0.70)	(-16.30)	
Switzerland	Downwards	-5.449	-0.0204	-0.0010	0.0081	0.9853***	0.97
			(-0.21)	(-0.21)	(-0.06)	(-10.40)	
Turkey	Upwards	-4.693	0.1370	0.0079	-0.0197	0.6030***	0.95
			(-1.65)	(-1.70)	(-0.20)	(-4.14)	
Ukraine	Upwards	-4.255	0.0377	0.0027	-0.0083	0.7415***	0.80
			(-1.17)	(-1.25)	(-0.63)	(-5.09)	
UK	Upwards	-5.213	0.0783	0.0037	-0.0516	0.7885***	0.95

			(-1.14)	(-1.12)	(-1.71)	(-6.28)	
USA	Downwards	-6.124	-0.0093	-0.0004	0.0363	1.0271***	0.99
			(-0.37)	(-0.40)	(-1.19)	(-27.71)	

***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
-t statistics are given in parenthesis.

One of the main reasons for carbon emissions is fossil fuel energy consumption. In almost all Kyoto countries, the coefficients of the variable FOS as the proxy for fossil fuel energy consumption are positive and significant. Among the significant models, in the model for Monaco, the coefficient of FOS is insignificant. The highest elasticity is that of Spain (coefficient=1.1283) and in addition, the countries following Spain with highest elasticities greater than 1 are Croatia, Denmark, Japan and USA; also, the sole responsible of CO_2 emissions is fossil fuel energy consumption in these countries since the coefficients of the other variables are insignificant in the models. The lowest elasticity of the FOS is 27% in Lithuania. The other countries with low elasticities for the variable FOS are Norway (33%), Belarus (35%), Portugal (40%) and New Zealand (40%).

The renewable energy consumptions as an alternative for fossil fuel energy consumptions can be expected to cause less carbon emission than fossil fuel energy consumptions. In other words, greater renewable energy usage may decrease GHG emissions. The coefficients of the variable REN are negative and significant for Czech Republic, Germany, Hungary, Ireland, Italy and Monaco. Indeed, the usage of renewable energy lowers the air pollutants in terms of carbon emissions in these countries. The variable REN, however, is positive and statistically significant for Belarus, Estonia, Monaco and Norway. Therefore, non-fossil fuel energy consumption seems to have enhancing effects on carbon emissions of these countries. The elasticities of the variables REN and FOS are .08% and 35% for Belarus, 11% and 92% for Estonia, 35% and 33% for Norway respectively.

5. CONCLUSION

This paper proposed and estimated a ridge regression for 39 Kyoto countries for the 2000-2010 period that linked greenhouse emissions (CO2 equivalent) per capita with real per capita GDP and per capita energy consumption. The main contributions of this paper were two folds: on the one hand, it was aimed to examine the EKC hypothesis by separating total energy usage into renewable and fossil fuel energy components. On the other hand, another objective was to take into account multi-collinearity among the income and energy variables for the Kyoto countries which has been generally ignored in EKC studies.

The availability of the emissions data for the 2000-2010 period is a big limitation for this study. Despite the limited data period, remarks related to EKC hypothesis can still be provided. Based on our empirical study, there is no statistically meaningful evidence to support the EKC hypothesis for countries included in the Kyoto Protocol. Our results are consistent with those of the previous studies (See Huang et al, 2009). It is interesting to see that EKC hypothesis for countries that are parties to the Kyoto Protocol has been rejected, since they were supposed to decrease the GHG emissions. As can be seen from the results summarized in the tables, while some regression results fit a linear curve and show a decreasing trend, other countries show increasing trends. For example, Belgium, Canada, Croatia, Czech Republic, Finland, Germany, Hungary, Greece, Iceland, Netherland, New Zealand, Portugal, Sweden, Switzerland and USA show decreasing emission trends. These countries have a potential to meet the Kyoto targets. However, countries such as Austria, Australia, Belarus, Bulgaria, Denmark, Estonia, Ireland, Italy, Japan, Latvia, Lithuania, Luxemburg, Monaco, Norway, Poland, Romania, Russia, Slovakia, Slovenia, Spain, Turkey, Ukraine and UK will have some difficulties in complying with their Kyoto commitments. If we look at the country groups in terms of emission trend, generally economies in transition have increasing CO_2 emissions. This means that, these countries will have to endure environmental deterioration as a result of economic growth.

Another important result is related with the relationship between fossil energy and GHG emissions. The elasticity between fossil energy consumption and emissions are mostly below unity except for USA, Japan, Spain, Switzerland and Italy. This means that, reduction in fossil fuel by itself cannot be enough to lower the emissions. Moreover, renewable energy seems to lower GHG emissions for many countries like Germany, Czech Republic, Hungary, Ireland, Italy and Slovakia. In some countries, however, renewable energy consumption contributes to GHG emissions. One possible explanation for this relationship might be related to renewable energy type. Some renewable energy types such as biofuels may have negative energy balance, namely they may need much more energy than they can give.

Therefore, more improvement in energy efficiency and/or, a shift in the energy mix towards less polluting energies (renewable energy technologies) would be very important in order to achieve environmental targets. Moreover, Ridge regression results imply that, renewable energy polices on its own does not provide a solution to global warming and/or changing. Policies seeking to promote of renewable energy should be complemented by the energy efficiency efforts to ensure sustainable development.

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Appendix 1: Annex Countries and country groups

Annex II Parties	*Economics in Transition*	*Others*
Australia	Belarus	Turkey
Austria	Bulgaria	Monaco
Belgium	Croatia	
Canada	Czech Republic	
Denmark	Estonia	
Finland	Hungary	
France	Latvia	
Germany	Lithuania	
Greece	Poland	
Iceland	Romania	
Ireland	Russia	
Italy	Slovak Republic	
Japan	Slovenia	
Luxemburg	Ukraine	
Netherlands		
New Zealand		
Norway		
Portugal		
Spain		
Sweden		
Switzerland		
United Kingdom		
United States		

Source: Huang et al, 2008, p.241.

Appendix 2 : Descriptive Statistics of the variables for countries

Country	Variables	Mean	Median	St. Deviation	Min.	Max.
	CO2	8.34	8.31	0.47	7.44	9.02
Austria	GDP	37251.91	37067.32	1767.12	35027.30	39895.11
	REN	530.06	503.08	128.17	391.19	758.53
	FOS	2937.64	2913.96	159.75	2676.10	3163.76
	CO2	17.53	17.41	0.48	16.73	18.14
Australia	GDP	33775.83	34011.74	2005.00	30854.82	36202.84
	REN	247.54	256.82	29.41	189.12	275.50
	FOS	5266.44	5267.06	75.66	5106.50	5394.15
	CO2	5.98	6.11	0.52	5.30	6.59
Belarus	GDP	3208.23	3126.37	870.85	2102.27	4524.67
	REN	133.48	131.18	27.63	95.74	177.49
	FOS	2522.88	2557.44	176.07	2251.63	2736.71
	CO2	10.38	10.36	0.60	9.65	11.29
Belgium	GDP	35787.05	36011.47	1311.19	34008.54	37582.66
	REN	172.34	153.45	60.92	101.02	285.40
	FOS	4143.48	4127.63	157.10	3892.68	4341.48
	CO2	6.05	6.01	0.46	5.33	6.89
Bulgaria	GDP	3696.93	3733.26	658.66	2706.57	4561.33
	REN	93.69	96.95	16.28	67.80	123.87
	FOS	1817.43	1790.46	126.38	1658.49	2041.17
	CO2	16.65	16.91	0.93	14.63	17.46
Canada	GDP	34514.14	34583.43	1291.10	32497.23	36182.91
	REN	367.25	370.31	13.56	348.46	389.68
	FOS	6085.62	6207.82	323.66	5466.43	6398.06
	CO2	5.03	5.19	0.32	4.44	5.50
Croatia	GDP	9875.39	10090.37	1091.80	8141.48	11376.47
	REN	79.90	82.21	7.75	66.91	89.98

	FOS	1660.21	1697.30	98.08	1483.59	1820.37
Czech Rep.	CO2	11.63	11.95	0.63	10.31	12.15
	GDP	12578.86	12705.61	1557.70	10361.20	14554.94
	REN	181.00	170.56	37.78	132.99	252.08
	FOS	3575.32	3652.73	171.54	3190.46	3729.28
Denmark	CO2	9.08	9.15	0.70	8.06	10.34
	GDP	46888.36	46379.66	1584.80	45339.69	49554.91
	REN	475.69	487.63	97.70	326.89	644.22
	FOS	3002.09	3074.68	218.02	2649.71	3343.11
Estonia	CO2	12.29	12.47	1.07	10.99	14.05
	GDP	9785.30	10109.68	1675.40	7186.83	12265.80
	REN	445.11	432.31	66.23	374.10	601.58
	FOS	3366.55	3454.06	274.46	2953.16	3817.00
Finland	CO2	11.45	11.53	1.14	9.96	13.21
	GDP	36866.66	36995.04	2570.76	33217.07	40712.85
	REN	1379.63	1364.33	93.38	1238.51	1539.88
	FOS	3378.94	3322.46	275.93	3025.81	3826.59
France	CO2	5.99	6.01	0.27	5.52	6.29
	GDP	33604.90	33492.69	861.04	32392.11	34982.13
	REN	192.88	183.53	21.45	172.05	237.98
	FOS	2164.85	2183.83	100.39	1990.01	2267.45
Germany	CO2	9.76	9.82	0.44	8.94	10.37
	GDP	24049.58	23564.38	997.90	22945.71	25620.08
	REN	197.34	158.06	91.31	95.63	359.62
	FOS	3323.65	3369.58	139.62	3028.03	3518.29
Greece	CO2	8.56	8.68	0.33	7.67	8.89
	GDP	21142.24	21310.19	1833.28	18040.71	23431.47
	REN	92.73	92.12	4.86	87.41	105.53
	FOS	2444.56	2484.63	100.12	2206.53	2544.70
Hungary	CO2	5.51	5.60	0.29	4.86	5.83
	GDP	10456.14	10766.34	939.26	8810.08	11533.82
	REN	116.11	113.48	41.15	74.22	187.71
	FOS	2052.13	2051.06	111.63	1840.23	2198.34
Iceland	CO2	7.22	7.43	0.53	6.17	7.69
	GDP	52315.54	52001.27	4041.94	46985.73	58009.79
	REN	7.93	5.82	4.78	4.35	20.16
	FOS	2909.69	2861.19	118.58	2761.99	3147.79
Ireland	CO2	10.34	10.47	0.80	8.94	11.42
	GDP	46901.34	46732.80	3019.22	41695.66	51676.84
	REN	52.45	51.24	16.27	36.11	83.71
	FOS	3165.50	3144.22	204.96	2824.95	3455.73
Italy	CO2	7.70	7.92	0.53	6.67	8.13
	GDP	30246.06	30421.73	726.41	28807.54	31263.49
	REN	75.57	71.22	32.47	39.53	144.46
	FOS	2712.60	2760.80	157.86	2396.35	2855.42
Japan	CO2	9.50	9.61	0.34	8.63	9.86
	GDP	35390.71	35324.41	1205.01	33956.81	37185.30
	REN	53.23	51.73	9.43	43.80	77.74
	FOS	3259.41	3292.53	106.59	2997.66	3371.64
Latvia	CO2	3.11	3.08	0.26	2.63	3.48
	GDP	6599.29	6898.99	1370.48	4560.84	8699.39
	REN	498.22	513.93	51.53	399.47	577.00
	FOS	1219.30	1208.70	110.42	1023.56	1372.44
Lithuania	CO2	3.98	3.88	0.33	3.49	4.50
	GDP	7339.10	7603.97	1463.40	5097.93	9426.21
	REN	247.56	245.76	40.77	184.37	302.29
	FOS	1489.68	1458.22	157.61	1195.55	1711.27
Luxemburg	CO2	22.00	21.93	1.91	18.89	24.82
	GDP	79321.81	79295.53	4920.56	72394.19	87716.73

	REN	206.34	200.31	73.19	116.42	308.23
	FOS	7549.96	7491.72	704.99	6372.53	8586.29
Monaco	CO2	1.44	1.48	0.16	1.18	1.66
	GDP	1946.94	1929.20	225.71	1608.99	2293.30
	REN	405.80	404.92	50.75	341.42	482.59
	FOS	1120.49	15.30	3494.96	15.19	11067.32
Netherland	CO2	10.56	10.55	0.24	10.23	10.96
	GDP	39555.05	39122.29	1811.76	37546.80	42467.27
	REN	155.54	163.30	37.43	108.77	209.31
	FOS	4469.05	4471.51	109.03	4315.38	4711.46
New Zealand	CO2	8.15	8.21	0.48	7.22	8.89
	GDP	26815.55	27257.10	1176.31	24470.02	28352.41
	REN	289.46	290.95	20.62	246.81	316.21
	FOS	2839.59	2773.74	197.49	2551.33	3170.26
Norway	CO2	9.53	9.34	0.93	8.25	11.70
	GDP	64414.39	64589.98	2367.74	60726.25	67804.55
	REN	297.94	296.86	20.80	273.06	353.27
	FOS	3390.16	3291.17	321.53	2930.73	4046.33
Poland	CO2	8.05	7.98	0.22	7.77	8.39
	GDP	8213.03	7963.02	1191.10	6789.84	10035.85
	REN	135.65	124.24	28.80	105.70	198.92
	FOS	2324.06	2288.23	87.21	2218.51	2452.10
Portugal	CO2	5.81	5.87	0.44	4.92	6.44
	GDP	18309.33	18239.19	277.31	17952.89	18780.51
	REN	285.46	281.19	15.46	267.87	314.30
	FOS	1934.40	1968.40	147.20	1663.17	2123.55
Romania	CO2	4.28	4.40	0.35	3.67	4.75
	GDP	4557.37	4572.05	787.36	3339.64	5675.42
	REN	150.08	151.13	28.34	106.59	192.70
	FOS	1451.09	1500.67	122.00	1226.73	1579.06
Russia	CO2	11.31	11.14	0.56	10.65	12.23
	GDP	5318.36	5337.07	999.83	3878.10	6649.40
	REN	47.13	47.14	2.70	42.55	52.51
	FOS	4132.85	4110.11	208.09	3857.08	4474.36
Slovakia	CO2	7.02	7.20	0.35	6.25	7.34
	GDP	11660.82	11384.53	2039.37	8957.42	14360.42
	REN	97.04	83.82	33.78	61.96	164.34
	FOS	2415.41	2451.03	113.17	2162.81	2526.08
Slovenia	CO2	7.79	7.77	0.36	7.17	8.50
	GDP	17776.17	17854.63	1887.39	15033.47	20706.67
	REN	248.33	236.58	31.45	215.84	317.46
	FOS	2442.48	2415.50	107.42	2261.52	2659.27
Spain	CO2	7.39	7.61	0.73	5.85	8.14
	GDP	25652.69	25595.99	1018.44	23920.93	27136.09
	REN	118.09	115.34	13.99	102.04	143.12
	FOS	2502.89	2538.73	192.79	2110.22	2729.34
Sweden	CO2	5.64	5.61	0.47	4.70	6.43
	GDP	40301.98	40534.54	2570.96	36576.19	43649.95
	REN	1006.55	992.26	124.79	862.51	1268.88
	FOS	1894.24	1868.47	164.33	1561.84	2172.67
Switzerland	CO2	5.43	5.47	0.27	4.95	5.94
	GDP	52277.31	51734.30	2135.25	49843.38	55377.82
	REN	275.17	274.41	15.65	252.39	299.27
	FOS	1887.03	1905.51	92.06	1726.46	2058.23
Turkey	CO2	3.62	3.50	0.39	3.03	4.13
	GDP	6896.48	7129.59	803.56	5687.24	7833.53
	REN	80.80	79.07	13.28	63.19	103.09
	FOS	1132.02	1097.15	131.74	946.26	1302.27
	CO2	6.80	6.98	0.46	5.68	7.37

Ukraine	GDP	1755.81	1828.72	331.06	1210.69	2205.58
	REN	15.14	5.55	12.30	5.32	34.81
	FOS	2369.80	2371.18	163.73	1963.74	2564.71
	CO2	8.76	8.97	0.52	7.69	9.31
UK	GDP	37447.23	37559.73	2106.43	34058.66	40452.52
	REN	61.84	64.01	19.12	32.63	93.57
	FOS	3155.13	3226.95	188.47	2775.58	3346.78
	CO2	19.15	19.58	0.94	17.32	20.25
USA	GDP	43219.51	43273.71	1674.04	40946.37	45431.03
	REN	257.11	259.54	20.08	225.84	288.71
	FOS	6569.63	6724.68	323.01	5937.40	6919.26