Edgar J. Saucedo A.
University of Veracruz
Economics and Social Studies Institute, Mexico
E-mail: esaucedo@uv.mx

Jesús Díaz P.
Autonomous Metropolitan University, Iztapalapa
Economics Department, Mexico
E-mail: jdp@xanum.uam.mx

María del Pilar Parra O.
University of Veracruz
Economics Faculty, Mexico
E-mail: pilar.parra.ocampo@hotmail.com

ESTIMATING ENVIRONMENTAL KUZNETS CURVE: THE IMPACT OF ENVIRONMENTAL TAXES AND ENERGY CONSUMPTION IN CO2 EMISSIONS OF OECD COUNTRIES

Original scientific paper
UDK: 336.226.44:614.72
JEL classification: Q50, Q53, Q58, C23

Abstract

The objective of the paper is to estimate the relationship between CO2 emissions per capita, GDP per capita, energy consumption and environmental taxes for OECD countries in the period 1994-2014. To perform the above, we estimated a static and dynamic panel data models. The results show that the Environmental Kuznets Curve is verified for OECD countries, and environmental taxes have a negative impact on CO2 emissions (static model). On the other hand, the consumption of energy from fossil fuels has a positive impact on CO2 emissions. We conclude that while the Environmental Kuznets Curve is met, government plays an important role in improving the environment, because environmental taxes have a negative impact on CO2 emissions.

Keywords: Environmental taxes, trade, CO2 emissions, Environmental Kuznets Curve

1. INTRODUCTION

The aim of the paper is to estimate (quantitatively) the Environmental Kuznets Curve (EKC)[1] for OECD member countries. In addition, we estimate the effect of environmental taxes on CO2 emissions of OECD countries, in order to consider the possible effectiveness of these taxes in improving the environment.

There are several papers on the EKC estimation. The main feature of the most recent studies is that they focus on countries that emit more CO2 emissions into the environment and countries where environmental standards are almost non-existent. In addition, there are studies for developed countries that already have stricter environmental standards and that generate eco-innovation, but the focus is on the countries that will generate the most CO2 emissions if no measures are implemented. Regarding quantitative estimates, most of the studies focus on econometrically estimating the EKC, which has as its dependent variable emissions (mainly CO2) and as independent variables of GDP and some other variables. If several countries (or regions of a country) are used over time, the panel data methodology is used, whereas if it is only one country a co-integration analysis is performed.

We use the panel data methodology, with fixed effects and Driscoll-Kraay estimators. Additionally, we estimate a dynamic panel. We include as an instrumental variable the lag of the dependent variable (CO2 emissions).

The results show that the EKC is met for OECD countries (with an inverted U shape), and environmental taxes have a negative impact on CO2 emissions (static model). The consumption of energy from fossil fuels has a positive impact on CO2 emissions.

The findings show that if the income of OECD countries continues to increase, CO2 emissions will tend to decline (at some point in time). However, we can conclude that the design of public policies by the government, such as environmental taxes, is indispensable. At the international level it is essential that environmental taxes are harmonised, because CO2 emissions are a global externality.

2. LITERATURE REVIEW

In this section we review several papers that quantitatively estimate the EKC with different types of methodologies, ranging from the international to the local.

To study the EKC it is necessary to point out that this curve starts from the theoretical study of Kuznets (1955). Such author analysed the relationship between economic growth and inequality, and later environmental degradation was included it instead of inequality. Grossman and Krueger (1991) were the first to point out (empirically) that the relationship between environmental

[1] EKC shows the relationship between emission of various gases and GDP per capita, and other variables.

degradation and economic growth had an inverted U-shape. Later, other authors have modelled the relationship between economic growth and environmental degradation (Shafik and Bandyopadhyay (1992); Panayotou (1993)). Dasgupta, Laplante Wang and Wheeler (2002) show the different forms of EKC and the variables that determine height and slope of the inverted U-shape.

Duro, Teixidó Figueras and Padilla (2016) analysed inequities in the intensity of CO2 emissions with their explanatory factors to help policy design for countries. They used data for the whole world extracted from the International Energy Agency and used methodologies of grouping, addition and multiplication, as well as the technique of decomposition. They found that the reduction in the intensity of the emissions coincides with a clear reduction in their international dispersion; the main component of inequities is among the elements of the groups that were taken into account.

Pérez and López (2015) focused on the verification of the EKC hypothesis and the Logistics Environmental Curve (LEC) considering a sample of 175 countries comparing both methods. The empirical results showed significant evidence on the adequacy of EKC and LEC for the explanation of CO2 emissions in different countries. The authors show that for most of the countries of the sample there is a presence of N-shaped and also inverted N curves.

Poudel, Paudel and Bhattarai (2009) evaluated the relationship between CO2 and per capita income in Latin American and Caribbean countries through a fixed effects model of a panel data; finding through this analysis an N-shaped curve for the region. However, this form is sensitive if some countries are removed from the list. They rejected a square parametric regression in favour of a semi-parametric estimation.

Farhani, Meizak, Chaibi & Rault (2014) carried out an investigation to show that the EKC hypothesis is fulfilled for the countries of the Middle East and North Africa (Bahrain, Egypt, Jordan, Lebanon, Mauritania, Morocco, Tunisia, Algeria, Iran, Oman, Saudi Arabia, Syria and Tunisia). This paper is based on the hypothesis that there is an inverted U-relationship between environmental degradation and income, as well as between sustainability and human development. Using the panel data method, they established that factors such as energy, trade, value-added manufacturing and the role played by the law are related.

Apergis and Ozturk (2015) show how income and policies in 14 Asian countries (Bangladesh, Indonesia, Iran, Japan, Republic of Korea, Malaysia, China, Nepal, Oman, Pakistan, Saudi Arabia, Singapore and the Arab Emirates) are affecting the relationship between income and environmental emissions. Their objective was to test the EKC hypothesis for the 14 Asian countries through a panel data model. The multivariate model includes CO2 emissions per capita, GDP per capita, population density, land, industrial contribution to GDP and four indicators that measure the quality of institutions. In terms of the presence of an inverted U association between emissions and per capita income, results have the expected signs and are statistically significant, contributing to the theoretical support in the presence of the hypothesis of an EKC. Environmental degradation increases with GDP per capita during the early stages of economic growth and subsequently declines after reaching a certain level of GDP per capita.

Roca and Padilla (2003) consider the total flows for Spain of the 8 atmospheric pollutants for which historical series are available. Considering also the three main greenhouse gases, which are carbon dioxide (CO2), methane (CH4) and nitrous oxide. Through the development of an explanatory model for each of the pollutants, they present an overview of the relationship between per capita income and the various atmospheric pollutants; finding that there is a positive relationship between GDP and CO2 emissions. The elasticity between the two variables is greater than one. None of the pollutants studied unequivocally show EKC. In addition, they found that the ratio of emissions to GDP is significantly influenced by two factors acting in the opposite direction: the ratio of coal to total and primary energy, which, when increased, increases emissions; on the other hand, the relative importance of nuclear energy, which affects in the opposite direction. The evolution of greenhouse gas emissions in Spain and the lack of political will to fulfil the commitments deriving from the Kyoto Protocol explain that emissions have exploded (Roca & Padilla, 2003).

Esteve and Tamarit (2012) applied co-integration techniques and found that there is a linear relationship between CO2 emissions per capita and per capita income for the Spanish economy. With annual data from the National Institute of Statistics of Spain, they found the level of per capita income from which the hypothesis of the EKC for Spain is fulfilled. They determined that the EKC is fulfilled in the long term.

For Tutulmaz (2015) the economy of Turkey fulfils the hypothesis of the EKC for CO2 emissions, so it tests the hypothesis through a co-integration method using the EKC in a conventional way and later adds to its model variables such as energy and GDP per capita and non-structural econometric variables. The author believes that the generation of environmental policies should consider this type of analysis. He finds a lot of diversity in the estimation and the tests of co-integration, as well as diversity of results that is due to the restrictions of the model, this is the reason why he concludes that the verification of the EKC must be carried out in a non-restrictive way.

Another study for Turkey was conducted by Bölük and Mert (2015) in which they examined the potential of renewable energy sources in the impact of greenhouse gas emissions. The hypothesis of this work considers that the relationship between CO2 emissions, electricity using renewable sources and GDP can be explained through the EKC hypothesis. To verify the above, they performed an autoregressive lag distribution model and applied co-integration.

Yin, Zheng, & Chen (2015) found that there is an EKC for CO2 emissions in China. Environmental regulation had a moderating effect on EKC for CO2. The technological advance benefits the reduction of emissions, having a significant displacement effect. Energy efficiency, energy structure and industry structure have different impacts on CO_2 emissions. For all the evidence, the CO_2 emissions first present an increasing stage and later it decreases with the economic growth of China.

Al-Mulali, Saboori and Ozturk (2015) consider that when the income of a country increases, the public demand for better environmental quality will also increase. Therefore, government efforts will move towards improving environmental quality. In Vietnam, the government is continually working to reduce the country's environmental pressure, therefore, the authors wanted to verify the existence of the EKC hypothesis in Vietnam during the period 1982 to 2011 through a co-integration analysis with Autoregressive Distribution Lag Model. However, the results revealed that the EKC hypothesis does not occur in Vietnam because the relationship between GDP and pollution is positive, both short-term and long-term (Al-Mulali, Saboori, & Ozturk, 2015).

Wang, Zhou, Wang and Zha (2015) conducted an empirical study to test the EKC hypothesis for environmental quality in Gansu Province, China, through a co-integration analysis and a VAR autoregressive vector model. It was found that the scale effect and the composition effect have a weak contribution in the restoration of the environment, but the technology effect and environmental regulations play important roles.

He and Wang (2011) developed a multiplicative model of EKC where economic structure, development strategy and environmental regulation are considered as determining the height and slope of the EKC. They compare a model with the shape of the traditional EKC, one with a height adjustment and another with a slope adjustment. The model is estimated with panel data from 74 Chinese cities, considering the three most important pollutants in China: Total Suspended Particles (TSP), Sulphur Dioxide (SO_2) and Nitrous Oxide (NOX). From this study it was concluded that there is no single defined solution that fits all economies with structural differences, technical and institutional arrangements. This type of analysis can only be performed for some developed countries. And, finally, it is concluded that it is impossible to include all the important variables in a multiplicative model of EKC.

3. METHODOLOGY AND DATA

The panel data has a structure that contains a lot of information, due to counting observations of individual units over time. However, modelling relationships between variables with this type of database poses challenges, since it produces a variance-covariance matrix that depends on time and cross-section (Baltagi, 2005).

Using panel data reduces individual heterogeneity and co-linearity between variables because it is more reliable and with stable estimates of the parameters. However, there are certain limitations to the panel data method such as the problem of design and data collection, error measurement distortions and especially cross-section dependence, which is usually associated with macro data (Baltagi, 2005).

The general linear regression model with panel data can be presented as follows.

$$y_{it} = \alpha_{it} + \beta_{it} X_{it} + \varepsilon_{it} \quad (1)$$

$$i = 1,2, \dots, N;$$

$$t = 1,2, \dots, T$$

Where the variable is the dependent variable, is a vector of independent variables (Kx1), is the random element, i refers to individuals and there are N of them, and t refers to the time series that reaches the period T. The Greek letters represent the parameters of the model: collects the particular elements of the individuals presumed to change through time and , shows the slopes of the equation, which are distinct for each i and t. Hence, two types of models emerge: the fixed effects model (FE), where are assumed to be unobservable random variables that could be correlated to the X's, and the random effects model (RE) which assumes that are random variables that are not correlated with the regressors.

On the other hand, there are dynamic models which have been developed with the purpose of incorporating into the estimation the relations of causality that are generated within the model, as a way of dealing with problems of endogeneity. Endogeneity can be treated through different ways, however, one of the most common forms is through instrumental variables expressed as lags of the endogenous variable (Labra & Torrecillas, 2014).

Dynamic panels allow us to incorporate an endogenous structure into the model, by integrating past effects through instrumental variables (Labra & Torrecillas, 2014), and incorporating a relationship between the dependent and the independent variables in a bidirectional way. If lags are used as instruments of the endogenous variable, the regressor will correspond to the value in t-n (Levels) of the endogenous variable or the difference of these values) (Differences). Therefore, the larger the period of (t), the greater number of instruments we will have. One of the alternatives is the estimator of Arellano and Bond (1991) known as Difference GMM, since it uses as instruments the differences of lags.

The GMM System formulas are as follows:

$$Y_{(it)} = \alpha Y_{i,t-1} + \beta X'_{it} + \varepsilon_{t-1} \quad (2)$$

$$\varepsilon_{it} = \mu_i + \vartheta_{it}$$

$$E(U_i) = E(\vartheta_{it}) = E(\mu_i \vartheta_{it}) = 0$$

Where:

$Y_{(it)}$ = is the dependent variable of individual i at time t

X_{it} = is the independent variable of individual i at time t

Where the error term has two orthogonal components:

μ_i = fixed effects

ϑ_{it} = idiosyncratic shocks

For this study the panel data model is used because it has several advantages for a sample within the period from 1994 to 2014.

In order to examine the relationship between CO2 emissions and economic growth, model (3) includes, in addition to GDP per capita, other variables such as fossil fuel energy consumption and environmental taxes. The panel model is presented as follows:

$$CO2 = f(GDP, GDP2, FOSSIL,\ TAXRE) \ .. \quad (3)$$

Where CO2 is the total emissions of carbon dioxide measured in metric tons per capita; GDP denotes GDP per capita, GDP2 per capita GDP squared, FOSSIL to the fossil fuel energy consumption (as a percentage of the total energy consumption) and TAXRE to income from environmental (energy) taxes [2] (millions USD dollars).

Some variables were excluded even though they are considered of great importance in the explanation of the ecological impact, due to the scarce information on them it was decided they should be omitted, such as the index of eco-innovation, or the index of Rule of Law (World Justice Project, 2008).

The idea of using these variables as explanatory factors emerged from the analysis of previous studies, such as that of Egli and Steger (2007), whose specific model is used to understand when the maximum level of pollution occurs, derived from other factors that not only consider the income per capita, but also take into account the preference for a cleaner environment, increasing returns to scale by the use of new technologies and the magnitude of other external factors. This approach is based on a dynamic model that not only indicates an inverted U-relationship between pollution and income per capita, but is also compatible with economic growth and the sustained improvement of the environment over time.

The database was developed from a variety of sources and comes mainly from the World Bank (WB), the International Energy Agency (IEA) and the OECD. In this sense a set of ecological, environmental and economic variables are available. The following is a description of the variables used in this model: annual series of Gross Domestic Product (GDP) per capita, fossil fuel energy consumption (as a percentage of the total), and income through environmental (energy) taxes (millions of USD dollars), which together attempt to explain the behaviour of carbon dioxide (CO2) emissions from OECD member countries.

CO2 emissions: CO2 emissions represent the burning of fossil fuels and emissions from land use, such as deforestation (World Bank, 2015). They are measured in metric tons per capita

GDP Per Capita: GDP is the sum of the gross value added of all resident producers in the economy. These data are measured in constant dollars (World Bank, 2015).

[2] We include only environmental taxes applied to energy (air pollution).

Fossil Fuels Energy Consumption: Fossil fuel includes coal, oil, petroleum and natural gas products (OCDE (2015)). The data represents % total energy consumption.

Environmental Tax Revenue: The OECD, the IEA and the European Commission have agreed to define environmental taxes as “any (non-counterparty) payment obligatory to the Public Administrations applied on tax bases that are considered of special environmental relevance”. (OECD: 2016, 2014). According to OCDE, environmental taxes are classified in: energy, motor vehicles and transport and other. We use only energy environmental taxes. We include 1 variable: Environmental tax revenue in millions of USD dollar.

4. RESULTS AND DISCUSSION

Following the original EKC theory, we used data on GDP and GDP squared, as well as other additional variables, to explain CO2 emissions in OECD countries through a panel data for the period 1994 to 2014. A fixed-effects model was run using the Driscoll-Kraay estimator in which the following results were obtained:

Table 1

Results for the estimation of FE model with Driscoll- Kraay estimators

	FE	
CO2	Coef.	P<|t|
GDP	0.00010	0.001
GDP2	-6.71e-10	0.083
FOSSIL	0.11898	0.000
TAXRE	-0.00001	0.001
CONS	-6.59266	0.000
	within R-squared = 0.5023	

Source: own elaboration

Using Driscoll-Kraay estimators, most of the variables are all significant for explaining CO2 emissions. The negative sign of GDP per capita squared indicates that it is an inverted U-shaped curve and a maximum point can be found from which, as the EKC theory points out, increases in GDP per capita will no longer represent increases in levels of CO2 emissions, but, on the contrary, the increase in per capita income will tend to reduce CO2 emissions from a certain level of income.

In the estimated model, the relationship between CO2 emissions and the independent variables indicate that EKC is very likely to occur.

A dynamic model was estimated. For this case, the lag of the dependent variable was used as the instrumental variable, resulting in the following model.

Table 2.

Results of the estimation of the dynamic panel data model with instrumental variables

	Model	
CO2	Coef.	P<|z|
L(GDP)	0.20129	0.000
GDP	0.00007	0.000
GDP2	-3.16e-10	0.066
FOSSIL	0.12735	0.000
TAXRE	9.25e-06	0.123
CONS	-10.85357	0.000
Wald chi 2(S) =2096.71 Prob. >chi2 =0.00000		

Source: own elaboration

Then, we applied the Sargan test of over-identifying restrictions, but the null hypothesis was rejected, so we run the following robust model.

Table 3.

Results of the estimation of the dynamic panel data model with instrumental variables (robust model)

	Robust model	
CO2	Coef.	P<|t|
L(GDP)	0.20129	0.247
GDP	0.00007	0.001
GDP2	-3.16e-10	0.099
FOSSIL	0.12735	0.000
TAXRE	9.25e-06	0.279
CONS	-10.85357	0.000
Wald chi2(S) = 101.88 Prob. > chi2 = 0.0000		

Source: own elaboration

We applied the Arellano-Bond test for zero autocorrelation in first-differenced errors. The null hypothesis was no rejected; therefore the model has not autocorrelation.

Again, the results obtained with this autoregressive model of panel data show the fulfilment of the theory that supports the EKC between CO2 and income. That is, carbon dioxide emissions are favoured by the growth of economies although they reach a critical point and begin to decrease, as the theory points out. By increasing the consumption energy from fossil fuels increases, CO2 emissions tend to increase.

The dynamic model shows that environmental taxes have not impact in CO2 emissions, nevertheless in the static models there is negative and significant relation.

The results show that there is an EKC in the OECD countries, i.e. an inverted U-shaped relationship between GDP per capita and per capita CO2 emissions. However, in the static model environmental taxes negatively affect CO2 emissions, while in the dynamic model there is no relationship between these variables.

The financial crisis of 2008 brought with it a drop in production in almost all OECD countries, which caused CO2 emissions to decline. This situation was not taken into account in the modelling of the EKC, so the results would be affected if this event were included in the models, because the sample goes from 1994 to 2014, so results may vary.

The results are similar to those of Pérez and López (2015) and Poudel, Paudel and Bhattarai (2009), in the sense that the EKC is met, however for these authors the EKC form in N and inverted N (with other group of countries). However, the results of Farhani, Meizak, Chaibi & Rault (2014) and Apergis and Ozturk (2015), are more similar to those of us, since these authors find that the EKC is met with an inverted U-shape, but for countries of North Africa and the Midwest in the first case and Asian in the second case. Our results go in the opposite direction to those found by Al-Mulali, Saboori and Ozturk (2015), who point out that the EKC for Turkey is not met.

Finally, there are studies (Saucedo, Rullan, Hernandez (2016)) that show that eco-innovation can generate economic growth, as well as the environmental improvement already known, which would help countries have EKC with less height and slope.

5. CONCLUSIONS

We quantitatively estimate the EKC for the OECD countries and find that this curve has the form of an inverted U, which is in accordance with what the theory proposes. In this way, the OECD countries would have a tendency to reduce CO2 emissions as their income reaches a certain level. However, not all countries are close to that maximum level of emissions yet, there will be some that have already passed that level and others that are far from reaching the maximum level.

One of the findings is that in order to reach that maximum level of contamination, and from there start to lower it, government intervention is necessary. Environmental taxes have a negative impact on CO2 emissions, so the role of governments in OECD countries is key to reducing CO2 emissions. The consumption of energy from fossil fuels has, as expected, a positive impact on CO2 emissions, so that alternative sources of energy should be considered.

Based on what we found, public policies could be designed to establish environmental taxes that would reduce the negative impact of economic activity on the environment. At the OECD level, there could be some harmonisation of environmental taxes among its member states.

REFERENCES

Al-Mulali, U., Saboori, B., & Ozturk, I. (2015). Investigating the environmental Kuznets curve hypothesis in Vietnam. *Energy Policy 76*, pp. 123-131.

Apergis, N., & Ozturk, I. (2015). Testing Environmental Kuznets Curve hypothesis in Asian countries. *Ecological Indicators 52*, pp. 16-22.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment. *The Review of Economic Studies, 2(58)*, pp. 277-297.

Baltagi, B. (2005). *Econometric analysis of panel data*. New Jersey: John Willey & Sons.

Bölük, G., & Mert, M. (2015). The renewable energy, growth and environmental Kuznets curve in Turkey: An ARDL approach. Renewable and Sustainable. *Energy Reviews, 52*,pp. 587-595.

Dasgupta, S., Laplante, B., Wang, H. and Wheeler, D. (2002). Confronting the Environmental Kuznets Curve, *Journal of Economic Perspectives*, 16 (1), pp. 147-168.

Duro, J. A., Teixidó Figueras, J., & Padilla, E. (2016). Empirics of the international inequality in CO2 emissions intensity: explanatory factors according to complementary decomposition methodologies. *Environmental and Resource Economics* 63 (1), pp. 57-77.

Egli, H., & Steger, T. (2007). A dynamic model of the environmental Kuznets curve: turning point and public policy. *Environmental & Resource Economics*, 36(1), pp. 15-34.

Esteve, V., & Tamarit, C. (2012). Threshold cointegration and nonlinear adjustment between CO2 and income: The Environmental Kuznets Curve in Spain, 1857-2007. *Energy Economics 34*, pp. 2148-2156.

Farhani, S., Meizak, S., Chaibi, A., & Rault, C. (2014). The environmental Kuznets curve and sustainability: A panel data analysis. *Energy Policy 71*, pp. 189-198.

Grossman, G.M., Krueger, A.B., (1991). Environmental impacts of the North American Free Trade Agreement. *NBER working paper 3914.*

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review* 45 , pp. 1-28

Labra, R., & Torrecillas , C. (2014). Guía CERO para datos de panel. Un enfoque práctico. *UAM-Accenture Working Papers* (2014/16).

OECD. (2014). Environmental taxes. http://www.oecd.org/env/tools-evaluation/environmental-taxes.htm [accessed 9.08.2016].

OECD. (2016). Las leyes ambientales más estrictas no afecta la competitividad de las exportaciones - estudio de la OCDE https://www.oecd.

org/centrodemexico/medios/las-leyes-ambientales-mas-estrictas-no-afectan-la-competitividad-de-las-exportacionesocde.htm [accessed 8.08.2016].

Panayotou, T., (1993). Empirical tests and policy analysis of environmental degradation at different stages of economic development, ILO. Technology and Employment Programme, Geneva

Pérez, R., & López , A. J. (2015). Growing green? Forecasting CO2 emissions with Environmental Kuznets Curves and Logistic Growth Models. *Environmental Science & Policy, 54*, pp. 428-437.

Poudel, B. N., Paudel, K. P., & Bhattarai, K. (2009). Searching for an Environmental Kuznets Curve in Carbon Dioxide Pollutant in Latin American Countries. *Journal of Agricultural and Applied Economics, 41(1)*, pp. 13-27.

Roca, J., & Padilla, E. (2003). Emisiones atmosféricas y crecimiento económico en España. La curva de Kuznets ambiental y el protocolo de Kyoto. *Economía Industrial, III (351),* pp. 73-86.

Saucedo, E., Rullán, S. y Hernández, E. (2016):Crecimiento económico y ecoinnovación en la Unión Europea, Cuadernos económicos de ICE, 91, pp. 55-72.

Shafik, N. and Bandyopadhyay, S. (1992). Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence. Background Paper for the World Development Report. The World Bank, Washington, DC.

Tutulmaz, O. (2015). Environmental Kuznets Curve time series application for Turkey: Why controversial results exist for similar models? *Renewable and Sustainable Energy Reviews, 50*, pp. 73-81.

Wang, L., Zhou, D., Wang, Y., & Zha, D. (2015). An empirical study of the environmental Kuznets curve for environmental quality in Gansu province. *Ecological Indicators, 56*, pp. 96-105.

World Bank. (2015). World Development Indicators, http://wdi.worldbank.org/table/3.6, [accessed 7.12.2016].

World Justice Project. (2008). World Justice Project. http://worldjusticeproject.org/what-rule-law [accessed 7.06.2016].

Yin, J., Zheng, M., & Chen, J. (2015). The effects of environmental regulation and technical progress on CO2 Kuznets Curve: An evidence from China. *Energy Policy (77)*, pp. 97-108.