Rule of law and its implications for the environmental taxation-income path across European Countries

Concetta Castiglione, Department of Economics, Trinity College Dublin

Davide Infante and **Janna Smirnova**, Department of Economics and Statistics, University of Calabria

Abstract

Research has clearly demonstrated that economic development is closely related to environmental quality. In last two decades this relationship has been described by the Environmental Kuznets Curve, that postulates an inverse U-shaped relationship between pollution and income. However, while theoretical and empirical research has focused on the polluting effects of economic development, few have identified the policy instruments which can be introduced to counteract such negative effects. This paper concentrates on one of these instruments, such as environmental taxation. Estimations of data from 28 European countries confirm the existence of an inverse U-shaped relationship between environmental taxation and per capita income, that we denominate Environmental Taxation Kuznets Curve (ETKC). The empirical results clearly demonstrate that the environmental taxation-income relationship is strongly influenced by the rule of law which, when strong, ensures that environmental policies are implemented effectively. A strong rule of law thus contributes to achieving a turning point at lower levels of per capita income. Our analysis also made it possible to identify differences in ETKC among European countries, showing that post-transition economies may have not yet reached the turning point of the curve due to the presence of a weaker rule of law.

Keywords: Environmental taxation, Environmental Kuznets Curve, Rule of law

JEL Classification: H23, O43, O44, P28, Q58

Introduction

Extensive theoretical and empirical research has discussed the impact of public policy on efforts to improve environmental quality. This improvement is usually measured with relation to the Environmental Kuznets Curve (EKC) that defines the relationship between environmental degradation and economic development. Models that investigate the existence of EKC propose an inverse U-shaped curve whereby, starting from lower levels of per capita income, pollution increases gradually to reach a peak before decreasing at a turning point found at higher levels of per capita income.

Since improvements in environmental quality with the rise of income per capita could reflect how successfully environmental protection policies are implemented, we propose to analyse the links between environmental protection and income. To do this we analyse the environmental taxation – income relationship and confirm the hypothesis on the existence of inverse U-shaped curve that describes environmental taxation as a function of income per capita. This relationship, that we denominate "Environmental Taxation Kuznets Curve", being the result of successfully implemented policy of environmental protection, is found to be strongly influenced by institutions.

The evidence of the classical EKC is usually based on three widely used theories regarding how socioeconomic progress relates to environmental protection (Galeotti et al. 2006, Galeotti 2007). The first theory proposes that, as an economy undergoes three stages of *economic growth,* it passes from an agricultural and therefore non-polluting economy to a high-polluting industry-based economy and, finally to a low polluting service-based economy. As Galeotti et al. (2006) have shown, such a vision emphasizes how policies governing economic growth may, *per se*, become a crucial instrument for environmental

improvements. The second theory is based on the *role of technology* which states that increased socioeconomic well-being enables an economy to adopt more efficient production technologies which are themselves less environmentally harmful. This implies that environmental policies in a rapidly developing economy may prompt technical change in an effort to decrease existing pollution, thereby improving environmental conditions. The last theory of how economic development influences environmental progress considers environmental quality as a luxury good. This theory suggests that, as economic growth and social well-being increase, stronger institutions call for environmental awareness, thus opting for environmental protection as active policy and not simply the consequence of economic development. The quality of environmental governance suggesting that institutional factors strongly affect the functioning of environmental policies (Bhattarai and Hammig 2004, Dasgupta et al. 2001, Leitão 2010, Magnani 2000). These theories point towards compatibility between economic growth and a clean environment that can be achieved through application of effective environmental policies. The introduction and application of these policies, in turn, strongly depend on the strength of institutional context. Therefore, we analyse the relationship between environmental protection policies and economic growth, investigating the role that institutional factors play in this relationship.

While the results of environmental protection policies are well documented in empirical studies, environmental protection itself is left in the shade. Few studies make an effort to measure environmental protection and analyse factors crucial for its efficacy. As we argue, one of these factors should be institutional enforcement. Among others, institutions such as the protection of property rights, legal origins, democracy and governance quality have been shown to have an important impact on the quality of the environment (Cole 2007, Leitão 2010, Weisbuch 2000). However, among the institutions studied from an environmental perspective, that of rule of law has not yet received its deserved attention. Given that implementation of environmental policies rarely occurs without state intervention, the strength of the rule of law, which is an institution of governance, is expected to play an important role in environmental protection.

In particular, our empirical investigation aims to analyse the impact of the rule of law on the environmental taxation–income relationship across European countries. Two hypotheses are advanced. The first evaluates the existence of "Environmental Taxation Kuznets Curve", i.e. an environmental taxation–income per capita path. In particular, we show that the relationship between environmental taxation and per capita income is an inverse U-shaped curve. The second tested hypothesis is whether the turning point of environmental taxation - income path is influenced by the rule of law. We demonstrate that the enforcement of the rule of law shifts the turning point to lower levels of per capita income, accelerating the improvement of environmental quality.

Background

An increasing body of empirical research has confirmed the existence of the EKC for various polluters in different countries (for reviews see Dasgupta et al. 2002; Dinda 2004; Stern 2004), with different polluting emissions accounting for the presence of the EKC in various European countries over the last two decades. The presence of this curve clearly indicates progress in environmental protection policies in European countries. Various studies indicate that a wide range of factors contribute to this progress, indicating that factors such as an increase in welfare and economic openness, shift to green technologies, switch in preferences

verso clean products, which, among others, contribute to environmental improvement. Not surprisingly, underlying such progress, environmental policy plays a decisive role in determining how these factors positively influence environmental protection.

In turn, some studies have demonstrated that the successful implementation of environmental policies is determined by the institutional environment. For example, corruption has been shown to have a negative effect on environmental quality, undermining the effectiveness of environmental policies (Cole 2007, Damania et al. 2003, Leitão 2010). In contrast, strong institutions in the form of political liberties, civil rights and democracy have been shown to positively contribute to environmental issues (Bhattarai and Hammig 2001, Frankel and Rose 2002, Torras and Boyce 1998) as have secure property rights (Culas 2007) and legal protection (Di Vita 2009).

Among institutions, one of the most important components which determine the successful implementation of policies in general is the rule of law. It is necessary to underline the importance of the rule of law as one of the important components for the successful implementation of environmental policies (Galeotti 2007). Kaufmann et al. (2010) define the rule of law as the "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". Environmental policies are therefore clearly dependent on the quality of this institution as it determines the functionality and applicability of these policies. Although this link between the quality of rule of law and effective environmental policies is not surprising, only very few empirical studies have actually shown that a reinforced rule of law reduces the degree of environmental damage (Panayotou 1997, Bhattarai and Hammig 2001).

In turn, among environmental protection policies, environmental taxation has a very important role (see Ekins 1999). Here, we evaluate the extent to which the European environmental taxation is determined by the strength of the rule of law and how its enforcement contributes to reversing the gradual increase in industrial polluters. Most policies aimed at environmental improvement and preservation were introduced in Europe at the end of eighties and beginning of nineties. The emergence of these policies was initially instigated by increasing public awareness to environmental damage and the widespread realisation of its detrimental effect to the long-term goals of economic development (EEA 1995).

Since then, the taxation system in European countries has passed through complex evolution processes that witnessed the introduction of different forms of taxes designed to perform different functions. The gradual but accelerated introduction of environmental taxes was a necessary response to the rapid global decline in environmental quality. A large part of these environmental taxes have proven to be effective. Some notable examples are Germany's introduction of taxation on leaded petrol which led to the rapid substitution of this polluting fuel with an environmentally less damaging one; the decrease in the amount of waste delivered to landfill sites in Denmark after the introduction of a tax on waste treatment; the reduction of traffic in urban centres after a traffic congestion charge was introduced in various European cities (Ekins 1999). These are a few of the many examples which demonstrate that when environmental taxes successfully reduce polluting factors, less taxation is subsequently required. Therefore, in conditions where the rule of laws is strong and policies are properly reinforced, the volume of environmental taxation may actually first increase and then decrease as a consequence of the effectiveness of environmental policies.

However, it is important to note that decreasing trends in environmental policies which involve taxation may be attributed not only to its effectiveness, but sometimes, on the contrary, to its ineffectiveness. In fact, a progressive increase in environmental taxation may undermine economic activities (Leiter et al., 2011) since a limitless increase in environmental taxation would have negative effects on international trade, employment, competitiveness and

consumption (Wier et al. 2005). Such negative economic effects caused by unreasonably high taxes would eventually render environmental policies unsustainable, at which point, taxation would be gradually abandoned. While factors contributing to this aforementioned scenario remain to be investigated, we demonstrate that economic growth and successful enforcement of institutions within a strong rule of law play a determining role in the implementation of effective taxation policies.

In light of progress achieved in environmental policies and the fact that European countries exhibit an EKC for many polluters, here, we advance the hypothesis that the relationship between environmental taxation and income per capita should exhibit an inverse U-shaped profile. Therefore, we evaluated the existence of what we term an Environmental Taxation Kuznets Curve (ETKC), where the increasing slope of the curve is found in conditions where income and institutions are growing, and environmental taxes are introduced. When these taxes achieve major efficacy, the ETKC curve reaches a turning point when the pollution levels stop increasing and start declining. We argue that this turning point reflects a moment when relatively high level of income per capita is achieved and institutional quality is improved[1]. At the ETKC turning point, no increase in taxation is necessary to reinforce existing environmental protection measures which are able to support and promote pollution abatement until an acceptable level is attained, as defined by policy makers. Hence, within the context of high income and strong institutions, existing policies would prevent further increases in pollution levels. The relationship between environmental taxation and income would, therefore, result in an inverse U-shaped curve where emissions would actually increase with more intense environmental protection measures while decreasing emissions would correspond to less intensive measures.

Another theory that supports our interpretation of the environmental taxation-income trend is that of opportunity costs which argues that, in pollution abatement, wealthy countries have fewer opportunity costs with respect to less developed countries (Khanna and Plassmann 2004). Therefore, given that the demand for environmental quality is income-elastic (Bimonte 2002; Khanna and Plassmann, 2004; Magnani, 2000), higher income per capita would most likely be associated with lower exposure to pollution. This explanation thus links the degree of environmental protection, levels of income and the strengths of institutions. Under the strong rule of law the turning point of the ETKC would shift leftward, towards a point of lower income. This means that a strong institutional context facilitates environmental protection policies and makes it possible to achieve more effective environmental protection at lower levels of income. We argue that countries with different institutional environments would thus demonstrate different environmental taxation-income paths. While even countries with weak institutional contexts work towards pollution abatement (Galeotti, 2007; Magnani, 2000), in many cases such progress is undermined by unenforced regulations. Therefore, we hypothesize here that market-economy countries with strong rule of law have already reached an earlier turning point in the ETKC. Likewise, post-transition countries with lower levels of income and a weaker rule of law will either not have reached a turning point yet or have just started the declining trend.

[1] The positive links between economic growth and institutional development are found by numerous studies (Butkiewicz and Yanikkaya, 2006; Dollar and Kraay, 2000; Knack and Keefer, 1995; and others).

Model

To verify the existence of an inverse U-shaped curve of environmental taxation-income relationship and the influence of the rule of law on the behaviour of this curve, we start by considering direct and indirect effect the rule of law has on environmental taxation. The indirect effect is captured by evaluating the impact of the rule of law on per capita income levels, which in turn, is expected to influence environmental taxation. The direct effect is that of the influence of the rule of law on environmental taxation directly.

Our analysis is based on the alternative specification of the inverse U-shaped curve proposed by Bradford et al. (2005). In addition to the advantage of providing a more robust estimate with panel data by avoiding the use of nonlinear transformations of nonstationary regressors which occurs in quadratic and cubic regression functions[2], this specification makes it possible to capture direct and indirect effects of the rule of law on environmental taxation.

First, the indirect effect was evaluated with the following growth equation:

$$Y_{it} = \mu_i + \chi_t + \beta_1 R_{it} + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

where real GDP per capita (Y_{it}) is a function of the rule of law (R_{it}) and other regressors (X_{it}). The matrix (X_{it}) consists of classical variables of the growth model, such as capital stock per worker, level of education and share of trade in GDP, while μ_i and χ_t correspond respectively to unobserved specific effects of country and year.

The direct effect incorporates information on the indirect effect and considers the relationship between the rate of change in environmental taxation, the per capita income, and the growth rate per capita income at a given point in time:

$$\frac{\partial ET_t}{\partial t} = \gamma(y - y^*)g \quad (2)$$

We set the change of environmental taxation (ET) as a function of the growth rate of GDP (g) and of the distance of income (y) from the turning point (y^*). Therefore, ET increases until the turning point y^* is reached and decreases after this when the coefficient γ is negative, and g is positive. A negative sign of γ reflects the inverse U-shaped trend between environmental taxation and GDP per capita.

Following the approach proposed by Leitão (2010), we establish the turning point y^* as a function of the rule of law (RoL):

$$y^* = \varphi_1 + \varphi_2 RoL \quad (3)$$

We assume that $\varphi_2 < 0$ so that the stronger rule of law implies lower levels of GDP per capita at the turning point y^*.

Integrating with respect to time equations (2) and (3) while keeping income, average growth rate and average degree of rule of law constant, we obtain:

$$ET_t = \lambda + \gamma(y - (\varphi_1 + \varphi_2 RoL))gt \quad (4)$$

[2] The estimation of the pollution-income relationship based on these functions were found to suffer from severe econometric misspecifications (for a review see Stern 2004).

where λ is a constant of integration.

To estimate equation (4) we use the following reduced form, transforming environmental taxation into logarithms:

$$\ln ET_{it} = \lambda_i + \alpha_0(y_i g_i t) + \alpha_1(g_i t) + \alpha_2(RoL_i g_i t) + \alpha_3 Z_{it} + u_{it} \quad (5)$$

where the countries are indexed by i and time by t. ET is the environmental tax per capita, y_i is the average real per capita GDP, g_i is the average real per capita GDP growth and RoL_i is the average of the degree of the rule of law, all measured over the sampled period. Additional explicative variables are defined by matrix Z_{it}. These variables include the level of corruption, the quality of regulation, index of economic freedom, tax revenue in GDP and the share of exports and imports in GDP that are expected to influence the level of environmental taxation.

To obtain y_i and g_i we refer to the indirect effect of rule of law on environmental taxation and calculate the fitted values of Y_{it} by estimating equation (1). Average values of income per capita y_i and its growth rate g_i are calculated using interpolation techniques. We then compute the average value of per capita GDP of the first (Y_i^1) and the last (Y_i^2) four year period of the total of GDP series for each country. The average per capita GDP and its growth rate are given by:

$$Y_i^2 = Y_i^1 \exp(10 g_i) \quad (6)$$

$$y_i = Y_i^1 \exp(5 g_i) \quad (7)$$

where y_i and g_i are interpolated values at a sample mid–point.

To estimate equation (5) we use these interpolated values and a simple average of the degree of the rule of law (RoL_i) over the sample period.

Data, variables and descriptive statistics

Studies on environmental protection policies suffer from lack of available data (Magnani, 2000) and are proxied by indicators such as general taxation (Ekins, 1999), revenue from environmental taxation and environmental expenditure (Leiter et al., 2011), expenditure for environmental research and development (Magnani, 2000) and membership of environmental organisations (Damania et al., 2003). Here, to estimate environmental taxation-income relationship, we used the environmental taxation data provided by Eurostat Environmental Accounts (2011). Environmental taxation is measured in millions of euros divided by millions of ECU. Among the explicative variables we introduce the index of rule of law (Kaufmann et al., 2010). Other independent variables used are: the quality of regulation, index of economic freedom, level of corruption, tax revenue in GDP and shares of exports and imports in GDP. The first three variables reflect the quality of institutional environment which influences the process of tax withdrawal. Strong regulator quality, transparent economic systems and low corruption limit tax evasion, increasing taxation flow into the budget. The measures of the quality of regulation and level of corruption are also provided by Kaufmann et al. (2010). The index of economic freedom is taken from data provided by the Heritage Foundation and Wall Street Journal (2010). The variable on tax revenue in GDP reflects the volume of various taxes collected and is indicative of the volume of environmental taxation. Finally, economic

openness expressed in imports and exports reflects the level of economic activity, influencing the pollution level, and therefore, the amount of environmental taxes withdrawn. Data on both variables were taken from World Development Indicators (World Bank 2010). We expect that all explicative variables have a positive relationship with environmental taxation.

Data used in this analysis was obtained from a panel of 28 countries and spans the timeframe from 1996 to 2008 for a total of 392 observations. Table 1 reports the description of variables and source of data, while Table 2 presents a summary of the sample statistics. To estimate the indirect effect of rule of law on the environmental taxation–income relation and to obtain interpolated values of average income per capita (y_i) and its growth rate (g_i), we utilize classical variables found in models of economic growth (equation 1). These variables are real per capita GDP, capital per worker, education and share of export and import in GDP, all obtained from World Development Indicators (World Bank 2010).

For the purpose of better capturing the indirect effect, we divided countries according to their stage of economic development. This division was necessary in the light of criticisms put forth by Vincent (1997) and Galeotti (2007) on probable overlapping of country data series. This must be considered in our model since we have high-income observations from market-economy countries and low-income observations from post-transition countries. Moreover, this division is useful to capture how divers economic production and institutional conditions affect income and, therefore, environmental taxation. The first group (G1) includes European countries characterized by mature industrial and/or service sectors, such as Austria, Belgium, Denmark, Finland, France, Germany, Luxemburg, Netherlands, Norway, Sweden and United Kingdom. Countries that, according to the European Union regional policies, present delayed development in industrial and/or a growing service sectors at either the national or regional level constitute the second group (G2): Cyprus, Greece, Ireland, Italy, Malta, Portugal and Spain. Former transition countries with shrinking agricultural sector and developing industrial and service sectors were assigned to the third group (G3): Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

Estimations and discussion

One of the problems when estimating a growth model is the possible endogeneity between the rule of law and income since income is a function of the rule of law that, in turn, can be a function of income. In fact, countries tend to enter virtuous circles of institutional and economic development. To address the problem of endogeneity, the rule of law was instrumented by considering (i) the fraction of population that speaks English as a mother tongue; (ii) the fraction of population that speaks one of the five primary Western European languages, including English as a mother tongue and (iii) the index of economic freedom. First-stage regression indicates the validity of the instrumental variables used here. Moreover, the validity of the first two instruments has been confirmed by Cole (2007), Hall and Jones (1999) and Leitão (2010). Other variables were added as instruments in the regression but did not prove to be valid and did not alter the results (non reported). The endogeneity of the rule of law was also tested with the Durbin-Wu-Hausman test, the results of which (not shown in the table) led to rejection of the null hypothesis that the rule of law is exogenous.

Dealing with panel data, we considered the difference between fixed and random effect models (Cameron and Trivedi 2009). We preferred the random effects model since introducing time invariant instruments prevented the potential correlation between country–specific effects and the explanatory variables.

After obtaining the interpolated values of y_i and g_i from equation 1, it was possible to estimate the direct effect of the rule of law on environmental taxation (equation 5). In this case, it is very likely that a country's unobservable characteristics can be correlated with income, thus making it more appropriate to consider estimates derived from fixed effects rather than estimates from random effects. Moreover, given the significance of Hausman test statistics, the random effects model was rejected in favour of the fixed effects model.

Equation 1 is estimated (Table 3) for the three groups of countries: *G1, G2, G3*. Given the presence of fitted values of y_i and g_i we do not express variables in natural logarithms (Leitão, 2010), and instrument the rule of law by using 2SLS. As suspected, rule of law (R_{it}) does not have the same influence on income across the three groups of countries. In the *G1* group the rule of law has a positive and significant impact on income, while in the *G2* group the rule of law has a negative but also a significant impact on income. This unexpected sign can be due to the fact that institutional performance in these countries worsens in the presence of an increasing per capita income. It seems that the worsening effects of the rule of law on growth were strongly counterbalanced by other important economic factors. As expected, in former-transition countries (*G3*) which present the lower average value of the rule of law index, there is no statistically significant relationship between income and the rule of law. However, other variables such as capital stock, level of education and economic openness, expressed through exports and imports, all have a significant positive effect on income. This is so in all the three groups, with the exception of Edu in the second group.

Equation 5 (Table 4) was first estimated with no additional explanatory variables, involving only ygt, gt and $RoLgt$ which were obtained from interpolated values (specification 1). These variables were all significant with expected signs. As discussed in Section 2, the negative sign of the coefficient on ygt indicates the presence of the inverse U-shaped of environmental taxation - income relationship in European countries. At the same time, the positive coefficient on $RoLgt$ demonstrates the existence of the positive relationship between the strength of the rule of law and environmental taxation. Moreover, the estimated value of φ_2 is negative and statistically significant, indicating, in accordance to our theoretical model, that when rule of law is strong, the turning point of the curve occurs at a lower level of income per capita.

Successively, other explanatory variables were added (specification 2): control of corruption $(CCorr)$, regulation quality $(\mathrm{Re}gQual)$, index of economic freedom $(Ecfree)$, tax revenue in GDP $(Tax\,\mathrm{Re}v)$ and share of exports and imports in GDP $(XIM\,\mathrm{int})$. As expected, all the variables carry positive signs and are statistically significant. Control of corruption and regulation quality have a greater effect on environmental taxation with respect to index of economic freedom and economic openness, while the effect of taxation revenue is very small.

The above findings confirm our hypothesis on the improvements achieved by European countries in the environmental field and on the importance of rule of law enforcement for environmental policy application.

The last hypothesis we test is that of presence of heterogeneity in environmental taxation - income trend between countries with a long tradition of market economy (*mark*) and countries that have been involved in transition towards market economy i.e. post-transition economies (*ptrans*). Heterogeneity in the environmental taxation-income relationship is introduced by relaxing the assumption that these two groups of countries have the same turning point which is influenced by the state of the rule of law. Following Leitão (2010) we investigate this heterogeneity allowing for different income slopes across countries. As discussed in the first section, market-economy and post-transition countries have different position of the turning point due the degree by which rule of law is enforced.

The descriptive analysis of the data confirms this hypothesis. For the purpose of illustration, Figure 1 shows the environmental taxation-income path for three market-economies and three post-transition countries. As is evident, market-economy countries have already achieved their turning point and have reduced environmental taxation, while post-transition countries are still characterized by an upward slope which can be due to their weak rule of law enforcement. To test for heterogeneity, we add two additional variables, $y_i g_i t * ptrans$ and $RoL_i g_i t * ptrans$, which incorporate the effect of rule of law in post-transition economies into equation 5 and obtain the following equation:

$$\ln ET_{it} = \mu_i + \alpha_{01}(y_i g_i t) + \alpha_{02}(y_i g_i t * ptrans) + \alpha_1(g_i t) + \alpha_{21}(RoL_i g_i t) + \alpha_{22}(RoL_i g_i t * ptrans) + \alpha_3 Z_{it} + \mu_{it} \qquad (8)$$

Results obtained from equation 8 are presented in Table 4. Specification 1a contains basic variables, while specification 2a includes the control variables. Given that all the variables are statistically significant in all estimations, the heterogeneity assumption can be rejected.

To determine if the inverse U-shape curve characterizes the environmental taxation–income relation, we test the hypothesis of $\alpha_{01} < 0$ and $\alpha_{01} + \alpha_{02} < 0$ for, respectively, the market-economy and post-transition countries. By testing the hypothesis $\frac{\alpha_{21}}{\alpha_{01}} < 0$ and $\frac{\alpha_{21} + \alpha_{22}}{\alpha_{01} + \alpha_{02}} < 0$ for market-economy and post-transition countries, we evaluate if a relationship exists between rule of law and per capita income at the turning point. The results show that market-economy countries are characterized by the inverse U-shape environmental taxation-income path, where the enforced rule of law leads to a turning point which occurs at a lower level of per capita income (Table 5). As for post-transition economies, in the basic specification of the model (1a) there is no evidence for the inverse U-shape environmental taxation-income path and no impact from the rule of law. The evidence of the curve and the rule of law influence appears only when other control variables are considered (2a), meaning that post-transition economies have not yet achieved much progress in applying environmental policies.

Conclusions

In this paper we focus on the links between environmental protection policy and economic growth, assessing how this relationship is influenced by the quality of institutions in European Countries. In particular, we advance the hypothesis that the relationship between environmental taxation and per capita income is an inverse U-shaped curve, which is based on the presumable success achieved by European countries in pollution abatement, that we denominate Environmental Taxation Kuznets Curve. We argue that the rule of law plays a decisive role in the environmental taxation-income relationship by increasing the effectiveness of environmental policies. Our analysis also explains the differences in the progress achieved in the application of environmental policies in market-economy and post-transition countries.

The analysis covered 28 European countries and utilized data between 1996 and 2008. To check for the existence of the inverse U-shaped relationship between environmental taxation and per capita income, we apply an innovative Bradford et al. (2005) approach that avoids estimation of nonlinear regression and increases its robustness. While existing literature, such as Leitão 2010, extends Bradford et al. (2005) model to check for corruption effects for pollution–income relation, we take another direction and study how the

relationship between environmental protection and income is influenced by the rule of law. Nonetheless, our work can be also considered as a robustness test for the methodology presented by the above mentioned authors.

To investigate the role of the rule of law in the relationship between environmental taxation and per capita income we firstly address the indirect effect of the rule of law on environmental taxation through its impact on income per capita. Our results confirm the widely held opinion in economic literature opinion that the rule of law is positively related to per capita income in market-economy countries. At the same time, the direct effect of rule of law on environmental taxation demonstrates that enforcement of the rule of law has a positive impact on environmental policy application. In fact, we demonstrate the presence of an inverse U-shaped curve of environmental taxation–income relation for the entire panel where the rule of law has a negative impact on per capita income at the turning point of the curve. Therefore, countries with enforced rule of law achieve greater progress in environmental policies at a lower per capita income, thus reducing environmental taxation levels.

We also control for the heterogeneity in the environmental taxation–income path between market-economy and post-transition countries. The results show that post-transition economies have not yet reached the turning point of the environmental taxation-income curve and this probably reflects weaker enforcement of the rule of law which thus hinders the proper implementation of environmental policies.

As for policy implications, our analysis suggests that the effective implementation of environmental protection policies can be the result of the rule of law enforcement which deserves close attention in designing functional environmental policies to favor economic development.

References

Bhattarai, M., Hammig, M., 2001. Institutions and the Environmental Kuznets Curve for deforestation: a cross–country analysis for Latin America, Africa, and Asia. *World Development* 29, 6, 995–1010.

Bhattarai, M., Hammig, M., 2004. Governance, economics policy, and the environmental Kuznets curve for natural tropical forests. *Environmental and Development Economics* 9, 3, 367-382.

Bimonte, S., 2002. Information Access, Income Distribution, and the Environmental Kuznets Curve. *Ecological Economics* 41, 1, 145–156.

Bradford, D.F., Fender, R.A., Shore, S.H., Wagner, M., 2005. The Environmental Kuznets Curve: Exploring a Fresh Specification. *Contributions to Economic Analysis & Policy* 4, 1, 1–28.

Butkiewicz, J.L., Yanikkaya, H., 2006. Institutional quality and economic growth: Maintenance of the rule of law or democratic institutions, or both? *Economic Modelling* 23, 4, 648–661.

Cameron, A.C., Trivedi, P.K., 2009. *Microeconometrics Using Stata. College Station, Texas.*

Cole, M.A., 2007. Corruption, income and the environment: an empirical analysis. *Ecological Economics* 62, 4, 637–647.

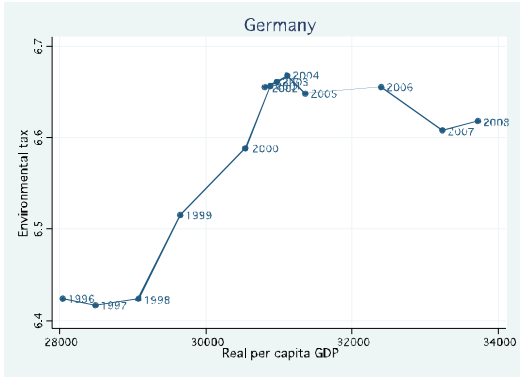
Culas, R.J., 2007. Deforestation and the environmental Kuznets curve: an institutional perspective. *Ecological Economics* 61, 2, 429–437.

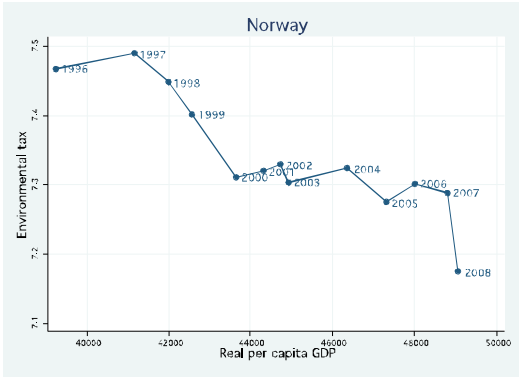
Damania, R., Fredriksson, P.G., List, J.A., 2003. Trade liberalization, corruption, and environmental policy formation: theory and evidence. *Journal of Environmental Economics and Management* 46, 3, 490–512.

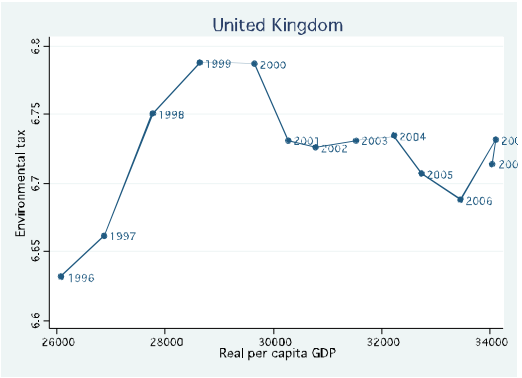
Dasgupta, S., Mody, A., Roy, S., Wheeler, D., 2001. Environmental regulation and 10 development: a cross-country empirical analysis. *Oxford Development Studies* 29, 2, 173–187.
Di Vita, G., 2009. Legal families and *environmental* protection: Is there a causal relationship? *Journal of Policy Modeling* 31, 5, 694–707.
Dinda, S., 2004. Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics* 49, 4, 431–455.
Dollar, D., Kraay, A., 2000. Property Rights, Political Rights, and the Development of Poor Countries in the Post–Colonial Period. *World Bank Working Papers*. Washington, DC. http://www.worldbank.org/research/growth.
European Environment Agency, 1995. Environment in the European Union. *Report for the Review of the Fifth Environmental Action Programme*.
Ekins, P., 1999. European environmental taxes and charges: recent experience, issues and trends. *Ecological Economics* 31, 1, 39–62.
Galeotti, M., 2007. Economics Growth and the Quality of the Environmental: Taking Stock. *Environment, Development and Sustainability* 9, 4, 427–454.
Galeotti, M., Lanza, A., Pauli, F., 2006. Reassessing the environmental Kuznets curve for CO2 emissions: A robustness exercise. *Ecological Economics* 57, 1, 152–163.
Frankel, J.A., Rose, A.K., 2002. Is Trade Good Or Bad For The Environment? Sorting Out The Causality. Working Paper 9201, *National Bureau Of Economic Research*.
Hall, R.E., Jones, C.I., 1999. Why do some countries produce so much more output per worker than others? *The Quarterly Journal of Economics* 114, 1, 83–116.
Kaufmann, D., Kraay, A., Mastruzzi, M., 2010. The Worldwide Governance Indicators: A Summary of Methodology, Data and Analytical Issues. *World Bank Policy Research*.
Khanna, N., Plassmann, F., 2004. The demand for environmental quality and the environmental Kuznets Curve hypothesis. *Ecological Economics* 51, 3-4, 225–236.
Knack, S., Keefer, P. 1995. Institutions and economic performance: cross–country tests using alternative institutional measures. *Economics and Politics* 7, 3, 207–227.
Leitão, A., 2010. Corruption and the environmental Kuznets Curve: Empirical evidence for sulfur. *Ecological Economics* 69, 11, 2191–2201.
Leiter, A.M. Parolini, A., Winner, H., 2011. Environmental Regulation and Investment: Evidence from European Industries. *Ecological Economics* 70, 4, 759–770.
Magnani, E., 2000. The Environmental Kuznets Curve, environmental protection policy and income distribution. *Ecological Economics* 32, 3, 431–443
Panayotou, T., 1997. Demystifying the Environmental Kuznets Curve: turning a black box into a policy tool. *Environment and Development Economics* 2, 4, 465–484.
Stern, D. I., 2004. The Rise and Fall of the Environmental Kuznets Curve. *World Development* 32, 8, 1419–1439.
Torras, M., Boyce, J.K., 1998. Income, inequality and pollution: reassessment of the Environmental Kuznets Curve. *Ecological Economics* 25, 2, 147–160.
Vincent, J.R., 1997. Testing for *environmental* Kuznets curves within a developing country. *Environment* and *Development Economics* 2, 4, 417–431.
Weisbuch, G., 2000. Environment and institutions: a complex dynamical systems approach. *Ecological Economics* 35, 3, 381–391.
Wier, M., Birr-Pedersen, K., Jacobsen, H.K., Klok, J., 2005. Are CO2 taxes regressive? Evidence from the Danish experience. *Ecological Economics* 52, 2, 239-251.

Figure 1: Trends in per capita environmental tax revenue and per capita income

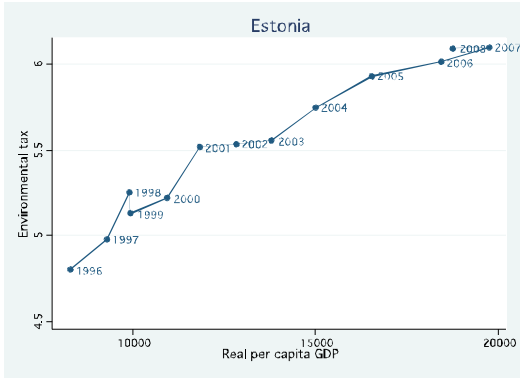
A) market-economy European countries

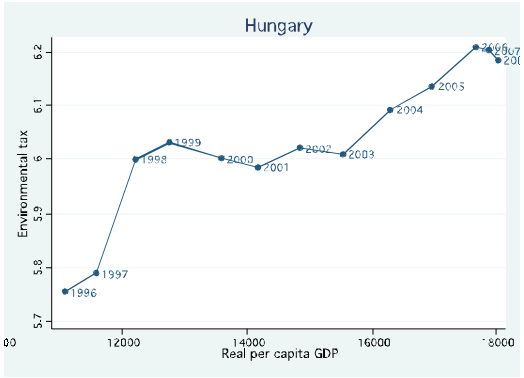






B) post-transition European countries





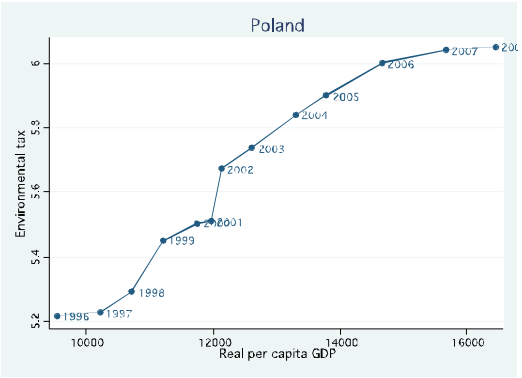


Table 1: Data information

Variable	Definition	Source
Y	Real per capita GDP	WDI (2010)
Kpw	Capital Stock per worker	WDI (2010)
R	Rule of Law	Kaufmann (2010)
CCorr	Control of Corruption	Kaufmann (2010)
EcFree	Index of Economic Freedom	Heritage Formation and Wall Street Journal (2010)
EDU	School enrolment, tertiary (% gross)	WDI (2010)
Engfrac	Fraction of a country's population that speaks English as a mother tongue	Hall and Jones (1999)
Envtax	Environmental tax	Eurostat (2010)
Eurfrac	Fraction of a country population that speaks one of the five primary Western European languages, including English as a mother tongue	Hall and Jones (1999)
RegQual	Regulation Quality	Kaufmann (2010)
TaxRevenueGDP	Tax Revenue (% of GDP)	WDI (2010)
XIMint	Share of exports + imports in GDP	WDI (2010)

Table 2: Sample summary statistics

	Mean	Std. Dev.	Min	Max	Obs
Y	24723.22	11987.3	5921.674	74421.63	363
Kpw	8459.583	5676.116	374.5925	32710.88	352
R	1.148901	0.580172	-0.193140	1.964045	364
CCorr	1.156859	0.794892	-1.021719	2.47	364
EcFree	66.15247	7.229807	45.7	82.6	364
EDU	53.12494	18.25695	9.626324	94.88895	321
Engfrac	0.061286	0.223440	0	0.974	364
Envtax	6.391923	0.637011	4.68375	7.654727	363
Eurfrac	0.244464	0.394537	0	1.004	364
RegQual	1.162789	0.423399	-0.234753	2.012003	364
TaxRevenueGDP	20816.41	4955.785	10700	32700	256
XIMint	105.6177	50.04793	44.15393	318.2252	362

Table 3: Estimation results for growth equation (1)

	G1	G2	G3
R	9,252.85	-6,659.37	993.273
	(4,661.173)*	(2,121.705)***	(1762.512)
Kpw	1.404	1.557	2.013
	(0.137)***	(0.167)***	(0.234)***
Edu	34.469	34.651	52.179
	(20.879)*	(25.81)	(8.016)***
XIMsh	52.481	43.318	36.532
	(11.664)***	(11.905)***	(7.301)***
Constant	-6,787.14	13,409.26	-106.849
	(7379.95)	(2,288.912)***	(1346.251)
Obs	119	70	122
N. of id	11	7	10
R–squared	0.776	0.828	0.844
Wald χ^2	577.25	222.7	2242.27
Prob.	(0.000)	(0.000)	(0.000)

Standard errors in parentheses

Statistically significant: * at 10%; ** at 5%; *** at 1%

Table 4: Estimation results based on interpolated values (Equation 4)

	1	2	1a	2a
ygt	-0.91	-1.298	-0.53	-1.072
	(0.201)***	(0.238)***	(0.246)**	(0.306)***
*ygt*ptrans*			0.218	0.15
			(0.053)***	(0.061)**
gt	9.118	12.021	3.912	8.978
	(1.744)***	(2.063)***	(2.332)*	(2.935)***
RoLgt	0.632	1.154	1.424	1.782
	(0.215)***	(0.255)***	(0.343)***	(0.352)***
*RoLgt*ptrans*			-1.185	-1.192
			(0.372)***	(0.449)***
CCorr		0.116		0.103
		(0.043)***		(0.042)**
RegQual		0.131		0.134
		(0.048)***		(0.048)***
EcFree		0.007		0.005
		(0.002)***		(0.002)**
TaxRevenueGDP		0.00003		0.00003
		(0.000)***		(0.000)**
XIMint		0.002		0.001
		(0.001)**		(0.001)*
Constant	-44.618	-25.587	-44.749	-31.438
	(3.256)***	(4.808)***	(3.240)***	(5.235)***
φ_2	-0.649	-0.889		
p-value	(0.000)	(0.000)		
Observations	338	241	338	241
Number of id	26	26	26	26
R-squared	0.59	0.72	0.61	0.73
F-test	145.99	66.94	95.49	55.58
p-value	(0.000)	(0.000)	(0.000)	(0.000)
Hausman	444.29	91.16	483.00	135.80
p-value	(0.000)	(0.000)	(0.000)	(0.000)

Standard errors in parentheses

Statistically significant: * at 10%; ** at 5%; *** at 1%

Table 5: Estimation results for heterogeneity model (equation 8)

	(Y1a)	(Y2a)
Market-economy European countries		
α_{01}	-0.91	-1.298
	(0.032)**	(0.000)***
$\frac{\alpha_{21}}{\alpha_{01}}$		
	-2.687	-1.662
	(0.015)**	(0.000)***
Post-transition European countries		
$\alpha_{01}+\alpha_{02}$	-0.312	-0.922
	0.107	(0.003)***
$\frac{\alpha_{21}+\alpha_{22}}{\alpha_{01}+\alpha_{02}}$		
	-0.766	-0.64
	0.1678	(0.007)***

p-value in parentheses
Statistically significant: * at 10%; ** at 5%; *** at 1%