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Artur Tamazian and B. Bhaskara Rao

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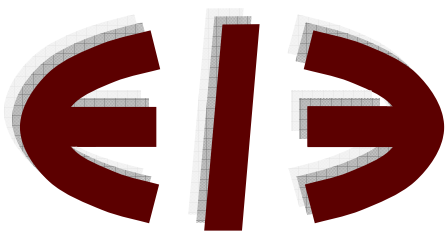

EERI
Economics and Econometrics Research Institute
Avenue de Beaulieu
1160 Brussels
Belgium

Tel: +322 299 3523
Fax: +322 299 3523
www.eeri.eu

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Artur Tamazian
artur.tamazian@usc.es

School of Economics and Business Administration
University of Santiago de Compostela

B. Bhaskara Rao

raob123@bigpond.com

School of Economics and Finance
University of Western Sydney, Sydney (Australia)

Abstract

Several studies have examined the relationship between environmental degradation and economic growth. However, most of them did not take into account financial developments and institutional quality. Moreover, Stern (2004) noted that there are important econometric weaknesses in the earlier studies, such as endogeneity, heteroscedasticity, omitted variables, etc. The purpose of this paper is to fill this gap in the literature by investigating the linkage between not only economic development and environmental quality but also financial development and institutional quality. We employ the standard reduced-form modelling approach to control for country-specific unobserved heterogeneity and GMM estimation to control for endogeneity. Our study considers 24 transition economies and panel data for 1993-2004. Our results support the EKC hypothesis while confirming the importance of both institutional quality and financial development for environmental performance. We also found that financial liberalization may be harmful for environmental quality if it is not accomplished in a strong institutional framework.

J.E.L. Codes: O13, P28, Q53, Q56
Keywords: Environmental Degradation, Economic Development, Financial Development, Institutional Quality, EKC.

1. Introduction

A key policy objective of international efforts to mitigate the adverse effects of global climate change is the reduction of global CO_2 emissions. The success of these efforts depends to a large degree on the commitment of the major CO_2 producing nations to meet global emissions targets. Since 1989, the transitional economies have experienced profound structural changes that continue to influence the evolution of regional CO_2 output, with potentially adverse consequences for global mitigation strategies. The rapid economic growth experienced by many transitional economies has been accompanied by a growing thirst for energy, much of which is generated by imported fossil fuels. According to the EBRD's (2007) report, transitional countries are much more energy intensive than their western European counterparts – all exceed the EU average per capita energy consumption and many consume around five times more per person.

The transitional economies are a heterogeneous group of countries in terms of income levels and relative development, but they share a common legacy of planned economies and energy-intensive production. They also share a common agenda of structural reforms that should ultimately lead to major shifts in economic structure and output. Recently while there is some evidence of declining energy consumption in these economies, for many it remains unclear what path CO_2 emissions follow over the longer term. Ideally the progress of the transition economies towards market-oriented systems should be accompanied by increasing efficiency in the use of resources including energy. This trend has already become apparent in countries where reforms are more advanced. Liberalization of prices has led to conservation and greater energy efficiency. In addition, shifts in the industrial composition of output may also have influenced energy saving for the economy as a whole.

A large literature investigates the relationship between environmental degradation and economic development. For some pollutants, a number of empirical papers find evidence of an inverted U-shape, i.e., the pollution levels rise and then fall as income increases (Copeland and Taylor, 2004; Dasgupta, Laplante, Wang and Wheeler, 2002; Dinda, 2004). However, these findings, also known as the Environmental Kuznets Curve (EKC), have been called into question by a number of authors. These authors show the EKC result is not robust to various changes in the specifications in the econometric models. Stern (2004) presents a critical history of the EKC. According to

him EKC is not based on strong econometric footing. He pointed out that, in addition to the specification problems, other major econometric weaknesses are heteroskedasticity, omitted variables bias, and critical issues relating to cointegration analysis. Consequently, policy makers have been watching the pros and cons of the EKC hypothesis since this debate on the existence of EKC is import for national and international policies (Tamazian, Pineiro and Vadlamannati, 2009). The crucial policy question, according to Barbier (1997), is "whether economic growth should continue to be the main priority, with protection of the environment a secondary consideration to be addressed mainly in the future, or whether explicit policies to control environmental degradation at the local, national and global level are urgently required today". This aspect is important for transitional economies since these countries are at an initial stage of development and the adoption of policy recommendation may help them to achieve sustainable growth in the future. In this context the World Bank has long maintained that economic growth is good for both people and the environment. This type of "win-win" situation is based on the view that an immediate benefit of economic growth is a rise in per capita income, which can contribute to the alleviate poverty and to clean up the environment. Others such as Beckerman (1992) advocated, without reservations, that economic growth is necessary first for curing environmental ills.

Nevertheless, why consider financial development when discussing the relationship between economic growth and environment? The most important reason is that financial development may attract FDI to the transitional countries, which in turn can speed up economic growth (Frankel and Romer, 1999) and the dynamics of the environmental performance. The second reason is that financial development provides with the motive and opportunity to use new technologies with clean and environment-friendly production processes. Consequently such technologies also improve the global environment (Birdsall and Wheeler, 1993; Frankel and Rose, 2002). A third reason for justifying examining the role of financial development, albeit somewhat negative, is that though financial development may enhance economic growth, it may also result in more industrial pollution and environmental degradation (Jensen, 1996; World Bank, 2000)[1].

Given the ambivalent nature of findings in the literature, our paper reexamines this issue and tries to answer whether economic growth, financial development and

[1] Moreover, since environmental control increases manufacturing cost, pollutant industries and enterprises may be transferred to underdeveloped areas where environmental standards are relatively low, and turn these areas into "pollution havens".

institutional quality in the transitional economies can be part of the solution rather than the cause of environmental problems. We use CO_2 emissions as the environmental pollution measure.[2] The salient features of this paper are as follows. Our regressions include a much larger set of relevant explanatory variables for cross country CO_2 variation than most other existing studies in the EKC literature. Furthermore, in addition to using the standard GLS and GMM methods of estimation of Arellano and Bond (1991), we shall also use a more efficient systems GMM estimator of Arellano and Bover (1995) and Blundell and Bond (1998) that exploits the stationarity restrictions, which give more robust results than the first-differenced GLS and GMM estimation methods. These first-differenced methods are known to have significant finite sample biases due to weak instruments (Bond, Hoeffler and Temple, 2001). To our knowledge, this paper is the first systematic quantitative study that attempts to relate the CO_2 emissions, economic, financial and institutional developments within selected FSU and CEE countries. Our policy recommendations are based on the fact that firms in the transitional countries do not have adequate incentives to invest in the pollution control mechanisms because of the weak institutional structures. Therefore, higher economic and financial reforms in future are necessary to strengthen institutional structure which, in turn, can provide adequate incentives for controlling pollution.

The rest of the paper is organized as follows. Section 2 discusses the importance of economic and financial development for environmental quality. Section 3 presents the empirical results. Section 4 concludes.

2. Economic Development and Environmental Degradation

There are a number of studies that examine the link between environmental degradation and economic growth. According to Meadows, Meadows, Randers, Behrens (1992), far from being a threat to the environment in the long-term, economic growth appears to be necessary to maintain and improve the environmental quality. However, there are growing concerns about the adverse environmental impacts of

[2] CO_2 emissions, once thought to be a harmless by-product of combustion, are now believed to be the primary greenhouse gas responsible for the problem of global warming (IPCC, 2007). Regulating and monitoring anthropogenic emissions of CO_2 from various economic activities has become a central issue in the ongoing negotiation for an international treaty on global warming (Cline, 1992; Revkin, 2000). Moreover, the scope of its spatial impact makes CO_2 pollution more suitable for country level aggregate study.

economic growth. For example Grove's (1992) concerns have led to a rich stream of research on the notion of environmentally sustainable economic development. This in turn made Anderson (1992) to explore the tradeoff between economic growth and environmental quality. Following this work the dominant view that has emerged is that this tradeoff between economic growth and environmental quality is not invariant to policies. It is possible to mitigate greatly this tradeoff through appropriate policies (Antle and Heidebrink, 1995; Grossman and Krueger, 1995; Selden and Song, 1994; Shafik, 1994). This issue is particularly significant for the transitional countries, which aim to achieve higher economic growth rates face the danger of adopting economic policies that run contrary to the objective of their long-term environmental sustainability. Kolstad and Krautkraemer (1993) point out the fact that there is a dynamic link between environment, resource use and economic activity. They argue that while resource use (especially energy sources) yields immediate economic benefits, this will have negative impact on the environment in the long run.

However, the net impact of economic development upon environmental quality seems to depend on the characteristics of different pollutants (Hettige, Lucas and Wheeler, 1992; Birdsall and Wheeler, 1992; Diwan and Shafik, 1992). For example, some air pollutants such as suspended particulate matter, sulfur dioxides, carbon monoxide and oxides of nitrogen, which have relatively significant health and environmental degradation effects, appear to take an inverted U-shaped relationship with economic development. Selden and Song (1994) have looked at various air pollutants like SO_2, NO_x and CO and find similar results related to EKC. Shafik and Bandyopadhyay (1992) show that the CO_2 emissions have been found to increase monotonically with per capita GDP. While in this article we strictly explore the existence of EKC, it is worth noting that Goldemberg (1998) argues that environment disasters may be prevented by following the past steps by the industrialized countries. The industrialized have incorporated modern and efficient technologies early in the development process. However, Panayotou (1997) found that the quality of both policies and institutions in a country can significantly reduce environmental degradation even if a country's income level is low. Higher future income levels are likely to speed up improvements to the environment. Policies such as more secure property rights under the rule of law and better enforcement of contracts and effective environmental regulations can help flatten the EKC and reduce the environmental cost of higher economic growth.

Financial development may also play a significant role in improving the environment. Greater financial sector development can facilitate financing at lower costs investment in environmental projects. Since much of environmental protection will be a public sector activity the ability to raise such financing is especially important for governments at the local, state, and national levels. This is also important for private sector's investment in the environment protecting equipment. For instance, the CIS energy sector has attracted substantial FDI inflows, being the primary target of foreign investors in many countries. In the first half of 2007, several large acquisitions in the Russian electricity and gas industries brought investments into energy sector to a level of over USD 28 billion, around 60% of the total FDI inflow during this period. In previous years, the share of the energy sector in total FDI inflows varied between 10% and 25% (European Commission, 2008).

FDI becomes relevant to the EKC debate to the extent that investment is expected to contribute to economic growth in the host country. However, the implication for the FDI-environment discussion is that it would be incorrect to assume that environmental effects of FDI-led growth will automatically be offset as income increases. An increased willingness to pay for higher environmental quality will not happen by compelling necessity (Nordström and Vaughan, 1999). It is worth noting that Jensen (1996) and World Bank (2000) find that FDI may stimulate economic growth but it may result in more industrial pollution and environmental degradation. Besides, since environmental controls increase manufacturing costs, pollutant industries and enterprises will be transferred to underdeveloped areas where environmental standards are relatively low, and turn these areas into pollution slums.

In this framework, Claessens and Feijen (2007) shown that through improved governance, financial sector development can spur greater environmental improvements. Recently, Kumbaroglu, Karali and Arikan (2008) argued that developed financial systems induce technological changes in the energy supply sector leading to emission reductions significantly. Dasgupta, Laplante and Mamingi (2001) argues that that environmental regulators in developing countries may explicitly harness financial market forces by introducing structured programs of information release on firms' environmental performance. Lanoie, Laplante and Roy (1998) argue that markets can create incentives for pollution control to the extent that they possess information regarding a polluter's environmental performance. At the same time, Dasgupta, Hong, Laplante and Mamingi (2004) examine the reaction of investors to the publication of the

lists of companies that fail to comply with national environmental laws and regulations in Korea. They find that enterprises appearing on these lists have experienced a significant decline in their market valuation. Thus, the overall results indicate that well developed financial system may provide enough incentive to firms to lower their CO_2 emission.

For the aforesaid reasons we believe that capital markets can and should play an important role in creating opportunities to address environmental challenges, especially in the transitional economies. Markets are particularly efficient at allocating capital and determining the appropriate prices for goods and services. The government can help the markets in this regard by establishing a strong policy framework that creates long-term value for greenhouse gas emissions reductions and consistently supports and provides incentives the development of new technologies that lead to a less carbon-intensive economy. Moreover, well developed capital markets are important because firms can reduce the liquidity risk and can mobilize funds required for developing energy-efficient technologies in the long run. However, for successful economic and financial development, strong institutional system is important (Cropper and Griffiths, 1994; Jones and Manuelli, 2001). Countries with strong institutional framework typically are wealthier and are better able to regulate emissions. Hence, a panel of countries with varying degrees of institutional strength could produce an inverted U-shape. They show that pollution increases with growth among poor countries with weak institutions and decreases with growth in wealthy countries with strong institutions. In this framework, Stokey (1998) and John and Pacchenino (1994) provide models with pollution-income curves that are inverted U-shaped, peaking when the optimum switches from a corner solution with zero abatement to an interior optimum with positive environmental investment. Low income countries use the dirtiest possible technologies so that pollution increases with income (Stokey, 1998) or consumption (John and Pecchenino, 1994). As income and consumption increase, the marginal utility of consumption declines, eventually to a point where cleaner technologies are optimal. Emissions then fall if preferences for environmental quality are strong enough.

Torras and Boyce (1998) added to the body of work by showing that the inclusion of institutional factors may be crucial for the EKC. They found in their analysis of seven indicators of air and water quality with samples of 19 to 42 countries (varying depending on the pollutant) that a more equitable distribution of power contributes positively to the EKC relation. As to the underlying reason, they argue that this effects

is due to enhanced influence of those who yield power and are likely to bear the costs of pollution relative to who benefits from pollution-generating activities. They find that literacy, political rights, and civil liberties are found to have particularly strong effects on environmental quality in low-income countries. Their analysis focused on the distinctions between high-income and low-income countries. In addition, Panayotou (1997) showed that the quality of policies and institutions can significantly reduce environmental degradation at low income levels and speed up improvements at higher income levels, i.e. better policies can help flatten the EKC. For another reason, a stronger institutional analysis seems necessary. Income often is not the causal factor, but rather income is correlated with causal factors such as the spatial intensity of economic activity and imports (Kaufmann et al. 1998).

3. Empirical Analysis

To test the objectives of this paper we use panel data methods and followe standard approaches in the existing EKC literature. Persson, Azar and Lindgren (2006) argued that the economic cost of stabilizing atmospheric concentration of CO_2 can be decreased if policies to reduce CO_2 emissions are implemented at an early stage of development of a country. Taking these findings, we focus on selected FSU and CEE countries since they are at their initial stage of development. Due to the limited availability of data we had to restrict our estimation period from 1993 to 2004. The sample includes 24 countries (see appendix 1). To our knowledge, the current analysis is the first of this nature with data from these countries. In this process we have also updated the adjusted operational indicator of institutional quality (IQ) index of Pineiro, Khan, Melikyan and Tamazian (2005).[3]

3.1. Estimation methodology

Our empirical model, as pointed out, has been estimated with panel data methodology. Unlike cross sectional analysis, panel data methods have an advantage since they allow to control for individual heterogeneity and thus eliminate the risk of biased results. Firstly, similar to Tamazian et al. (2009), we adopt the standard reduced form modeling approach. Following Hsiao (1986) and in order to address possible

[3] For a detailed explanation of the index construction see the original paper.

country specific unobserved heterogeneity, we use the random-effects specification as follows:

$$CO_{2it} = a + b_1 \ln(GDP_{it}) + b_2(INF_{it}) + b_3(FDI_{it}) + b_4(PRLIB_{it}) + b_5(FTRLIB_{it}) + \\ + b_6(TRADEOP_{it}) + b_8(FINL_{it}) + b_8(IQ_{it}) + b_9 \ln(ECONS_{it}) + b_{10}(EIM_{it}) + n_i + e_{it} \quad (1)$$

where:

CO_{2it} = CO_2 emission per capita in country i at time t

GDP_{it} = GDP per capita in country i at time t

INF_{it} = inflation in country i at time t

FDI_{it} = foreign direct investment in country i at time t

$PRLIB$ = a measure of price liberalization in country i at time t

$FTRLIB$ = a measure of forex and trade liberalization in country i at time t

$TRADEOP_{it}$ = trade openness in country i at time t

$FINL_{it}$ = a measure of financial liberalization in country i at time t

IQ_{it} = a measure of the institutional quality or efficiency in country i at time t

$ECONS_{it}$ = energy consumption levels in country i at time t

EIM_{it} = energy imports into country i at time t.

n_i and e_{it} indicate the country specific random effect and random error term, respectively. A detailed explanation of the variables and sources of data are in annex 1. The full list of countries is in annex 2.

Analogically, we test whether U-shaped effect may be confirmed or not. We simply add the quadratic term of the GDP into the main specification as follows:

$$CO_{2it} = a + b_1 \ln(GDP_{it}) + b_2 \ln(GDP_{it})^2 + b_3(INF_{it}) + b_4(FDI_{it}) + b_5(PRLIB_{it}) + \\ + b_6(FTRLIB_{it}) + b_7(TRADEOP_{it}) + b_8(FINL_{it}) + b_9(IQ_{it}) + b_{10} \ln(ECONS_{it}) + \\ + b_{11}(EIM_{it}) + n_i + e_{it} \quad (2)$$

Besides heterogeneity, endogeneity of explanatory variables may also affect the estimates and it is hard to assume strict exogeneity for all the explanatory variables. To control for the potential endogeneity of all the explanatory variables GMM estimation is applied. This strategy consists of obtaining additional instruments using the

orthogonality conditions that exist between lagged values of the right-hand side variables. Following Arellano and Bond (1991), the instrumental variables are all the right-hand side variables lagged twice or more. In this case, the system GMM estimator combines the standard set of equations in first-differences with suitable lagged levels as instruments, with an additional equation in levels with suitable lagged first-differences as instruments. The validity of instruments that give a set of over-identifying restrictions has been verified with the standard Hansen test, which confirms that in all cases our set of instruments is valid. Furthermore, the AR(1) and AR(2) tests, that check the hypothesis of absence of serial correlation, are also presented. The standard errors of coefficients are robust to heteroscedasticity. It is worth noting that GMM estimation related to environmental damage and economic development has been used so far only by Halkos (2003). He tested empirically the hypothesis of the inverted U-shaped relationship between environmental degradation from sulfur emissions and economic growth for 73 countries, but did not consider the effects of financial and institutional developments. We employ the following benchmark specification for *GMM* estimation to explain the environmental degradation:

$$y_{it} = \alpha y_{i,t-1} + X'_{i,t}\beta + v_i + \varepsilon_{it} \qquad (3)$$

where y_{it} is the dependent variable (CO_2 per capita emissions), X'_{it} is a vector of explanatory variables described above, β is a vector of parameters to be estimated, v_i is the individual effect, and ε_{it} is the error term.

3.2. Empirical Results

Our estimates with *GMM* for 24 transition economies are presented in Table-1 and Table-2. Table-1 presents estimates using the random effects model to address possible country specific unobserved heterogeneity. Table-2 results using GMM estimation are given. Each table consists of 8 different models. Our sample consists of 288 observations that correspond to the 24 transition economies over 1993-2004 period.

We observe in the random effect models that initially economic growth has significant negative impact on environmental disclosure. On the contrary, we find that both financial and institutional development have significant positive impact on environment. The institutional quality coefficients ranging from -0.40 to -0.47 reported in columns 1 to 6 suggest that an improvement in institutional quality leads to a decline

in CO_2 emissions. With respect to the financial development variables, we find that particularly a 1% increase in FDI inflows leads on average to 0.007% decline in CO_2 emissions. Our results confirm the findings of (Tamazian et al., 2009) that an increase in FDI inflows can help improve R&D expenditure and thereby higher energy efficiency leading to an improvement in the environmental quality in BRIC countries. Similarly, we find that every 1% increase in trade openness is associated with an average increase in emissions by 0.004%. In addition, our results indicate that, jointly considered, trade and forex liberalization have a positive effect, but an insignificant effect in reducing the environmental degradation. Only in columns 1 and 3 (see Table 1) this joint effect is significant at 10%. Yet, importantly financial liberalization contributes to the reduction of CO_2 emissions in the countries under consideration and the coefficient values are marginally higher than that of FDI inflows. This indicates that financial liberalization seems to have encouraged policies in these transition countries to improve their environmental disclosure.

In column 2 we introduce the squared value of per capita GDP to test for the presence of curvilinear effect. The results confirm the existence of an inverted U-shaped relationship between acceleration of economic growth and CO_2 emissions. Therefore our results support the EKC hypothesis in transition economies. The inverted U-shaped relationship remains robust and unaltered when the interaction effect variables (see columns 4, 6 and 8 in Table 1) are introduced.

The inclusion of the interactive effect variables tests the joint importance of the institutional quality and financial liberalization and institutional quality and trade openness. These factors are important in transition economies since they are at their initial development stage (Pineiro et al., 2005). The result in column 5 shows a 'complementary effect' of both on per capita CO_2 emissions. This means that the positive impact of financial liberalization on environmental degradation should be complemented by proper institutional quality. It is worth noting that in columns 3 to 4 and 7 to 8 the financial liberalization variable was found to be statistically insignificant, though being positive for environmental disclosure. However, when introduced as an interactive term with institutional quality (see column 5 and 6, Table 1), its effect become significant at 5% and 10% confidence levels, respectively. The complementary effect remains similar in column 6 despite introduction of squared value of per capita GDP. The interaction between institutional quality and financial liberalization suggests a complimentary effect which means that both are interdependent on each other. On the

contrary, when the interaction effect between institutional quality and trade openness on per capita CO_2 emissions is considered, we find a significant 'substitution effect' (see column 7, Table 1). The coefficients of both variables show interesting trends. While the coefficient of institutional quality is 0.76%, the same for trade openness is 0.01%. Therefore, in the long run as institutional quality improves, the negative impact of trade openness on per capita CO_2 emissions seems to have decreased. In particular, our results related to the importance of institutional quality are in line with the findings of Zugravu, Millock and Duchene (2009) that show a significant impact of institutional quality on the environmental policy, and thus on pollution.

Amongst control variables, we find that inflation, used as a proxy for macroeconomic stability, contributes to a reduction in environmental degradation. While this result is surprising, the coefficients are asymptotically equal to 0 which practically eliminates its effect on CO_2 emissions. Yet, according to our results price liberalization helps to reduce emissions suggesting that as the economic structure in these transition countries moves towards free markets (from centrally planned ones) the effect of price liberalization on per capita CO_2 emissions is reduced. The coefficients of the estimates in the columns 1 to 8 are stable and statistically significant at 1% confidence level for all models. Furthermore, regarding the energy consumption control variables, we find that higher levels of energy consumption increase per capita CO_2 emissions. Net energy imports exert positive impact on per capita CO_2 emissions which may be due to higher energy-intensive imports. However, it should be noted that the impact of energy imports on emissions is somewhat ambiguous. Increase in energy imports lead to a decline in energy consumption if the imported industrial goods are used to replace the domestic manufactured goods which consume high energy. Thus, imports of manufacturing goods, by replacing domestic production, would have reduced the energy requirements in transition economies.

However, if energy imports are utilized in capital intensive goods production, this can lead to an increase in energy consumption levels adding to the existing production in the country. Thus, the net effect of increase in energy imports can be either positive or negative specially in the case of developing economies (Tamazian et al., 2009).

TABLE 1: Random effect Results of Environmental Pollution

Dependent Variable: Log (Per capita CO_2 Emissions)

	I	II	III	IV	V	VI	VII	VIII
Constant	-5.3717*** (.9900)	-7.9726*** (3.1846)	-5.3319*** (.9919)	-8.0414** (3.2000)	-5.3481*** (.9886)	-8.4116*** (3.1882)	-6.8054*** (1.0344)	-8.0332** (3.1866)
GDP per capita	.3940 (.0584)	1.2414* (.6233)	.4005*** (.0616)	1.2501* (.6261)	.4048*** (.0615)	1.3498* (.6225)	.45314*** (.0574)	.9708 (.6302)
GDP per capita squared	—	-.0562 (.0427)	—	-.0569 (.043)	—	-.0628 (.0427)	—	-.0371 (.0433)
Inflation	-.00003** .00001	-.00002* .00001	-.00003** .00001	-.00002* .00001	-.00003** .00001	-.00002* .00001	-.00003* .00001	-.00002* .00001
FDI	-.0075*** (.0029)	-.0068** (.0029)	-.0074** (.0029)	-.0068** (.0029)	-.00725** (.0029)	-.00666** (.0029)	-.00780*** (.003)	-.00722** (.0029)
Price Liberalization	-.159*** (.0383)	-.1564*** (.0383)	-.1569*** (.0386)	-.1572*** (.0386)	-.1566*** (.0383)	-.1563*** (.0383)	-.1579*** (.0421)	-.1605*** (.0386)
Forex and Trade Liberalization	-.0459* (.0281)	-.0375 (.0276)	-.0452* (.0281)	-.0379 (.0278)	-.0445 (.0279)	-.0373 (.0275)	-.0358 (.0327)	-.0273 (.028)
Trade Openness	.0016*** (.0006)	.0018*** (.0006)	.0016*** (.0006)	.0018*** (.0006)	.0016*** (.0006)	.00180*** (.0006)	.0120*** (.0047)	.0116*** (.0033)
Financial Liberalization	—	—	-.0084 .019	-.0037 .0188	-.1263** .0643	-.1038* .0636	-.0104 .0158	-.0007 .0188
IQ	-.4016*** (.1412)	-.3862*** (.1421)	-.4143*** (.1439)	-.3802*** (.1455)	-.4759*** (.1464)	-.4347*** (.1474)	.7588* (.4604)	.7119* (.387)
Energy Consumption	1.0405*** (.1885)	.9105*** (.1911)	1.0175*** (.1928)	.9207*** (.1949)	1.0263*** (.1919)	.9223*** (.1941)	1.0277*** (.1934)	.9247*** (.1934)
Energy Imports	-.0025*** (.0009)	-.0021** (.0009)	-.0024*** (.0009)	-.0021** (.0009)	-.00274*** (.0009)	-.0024*** (.0009)	-.0025* (.0015)	-.0021** (.0009)
IQ*Financial Liberalization	—	—	—	—	.1469* (.0764)	.1344* (.0758)	—	—
IQ*Trade Openness	—	—	—	—	—	—	-.0127** (.0053)	-.0120*** (.004)
Adjust. R2	0.7288	0.6652	0.7225	0.6677	0.7278	0.6698	0.7059	0.6624
F-stat.	159.47	131.34	158.38	131.18	162.39	133.87	184.10	148.44
Prob(F-stat.)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Countries	24	24	24	24	24	24	24	24
Total no. observations	288	288	288	288	288	288	288	288

Note: Given the potential for autocorrelation in our pooled cross-sectional dataset, we used generalized least squares estimation for all models.

*** Significant at 1% confidence level; ** Significant at 5% confidence level *Significant at 10% confidence level. Heteroscedasticity-Consistent Standard Errors are reported in parenthesis.

One of our contributions in this study is the use of GMM estimation not only for testing the existence of an EKC hypothesis but also to study the nexus between economic, financial and institutional deepening and environmental degradation. In Table 2 we report GMM estimates of the dynamic equation. The validity of instruments that give a set of over-identifying restrictions has been verified with the standard Hansen test, which confirms that in all cases our set of instruments is valid. The standard errors of coefficients are robust to heteroscedasticity. Correct statistical specification of the models has been additionally checked with tests for the presence of first and second order residual autocorrelation.

In models with endogenous regressors, using too many instruments could result in biased estimates. Hence, we only use a subsample of the whole history of the series as instruments in the later cross-section. To determine the optimal lag length of the instruments, we use the procedure suggested by Andrews and Lu (2001). We start by using the full set of moment conditions and reduce them step by step. For each set of moment conditions, we compare the Hansen test to the Hansen test of the last regression. Once the Hansen test starts to increase in significance, we stopped the procedure and the last specification is taken, which has the highest p-value. To further reduce the problem of biased estimates, we combine the columns of the optimal instrument matrix by addition and, hence, use only one instrument for each variable and lag distance, rather than one for each time period, variable, and lag distance. As already pointed out AR(1) and AR(2) terms are the application of the autocorrelation tests developed in Arellano and Bond (1991) to check for first and second order autocorrelation in the residuals of the differenced equations. The fact that there is evidence of first order but not second order autocorrelation implies that the models are correctly specified in levels, as expected. At the same time Hansen's test confirms the appropriate instrumental selection.

The results are almost identical with those obtained in Table 1. We find that per capita income has a strong and positive impact on environmental degradation. This result confirms the findings of Dasgupta et al. (1995) and Eliste and Fredriksson (1998). The hypothesis of an inverted U-shaped curve for the relationship between CO_2 emissions and income per capita is not rejected and the existence of EKC hypothesis in countries under consideration still holds. Regarding financial deepening the results suggest that higher degree of overall financial development contributes to the reduction of environmental degradation. The same holds for institutional quality.

However, there are studies that show that FDI inflows lead to increased environmental degradation (Cole and Elliot, 2005; Feridun, 2006). In contrast our GMM results show that higher FDI inflows are associated with lower levels of per capita CO_2 emissions. These findings are similar to those obtained by List and Co (2000), He (2002), de Soysa and Neumayer (2005) and Liang (2006), who found that increased FDI leads to a decline in CO_2 emissions. Same is the case with financial liberalization. While its effect is not statistically significant in all the equations, it is significant at 1% in equations (IV) and (VIII). Regarding trade openness its impact on environmental disclosure is negative. This might be explained by the course of specific development of the economies in transition. They were strongly and irrationally industrialized during the Communist period. While the direct effect of trade openness has been to increase environmental degradation, its interaction with the institutional quality variable reduces this effect, which highlights the importance of institutional quality in the transition economies. In addition, our results show that while higher levels of energy consumption increase per capita CO2 emissions, net energy imports reduce the CO_2 emissions. Both effects are statistically significant at 1%.

Interpretation of the interactive variables is as follows. We first analyze the quantitative importance of institutional quality on financial liberalization and trade openness. With interaction terms included, one cannot interpret the coefficients on the individual components in the conventional way. Instead, the coefficient on IQ in a model with a significant interaction terms viz., FINL*IQ and TRADEOP*IQ is the effect of IQ on CO_2 when the FINL and TRADEOP variables are held constant. We calculate the marginal effects of both interactive variables for full model specification, i.e., with squared GDP term and GMM estimation. Marginal effects are calculated at the sample means of IQ for the models. Following Baltagi, Demitriades and Law (2007) we computed first order partial derivatives of per capita CO_2 emissions with respect to each of the interactive variables to assess the short-run effects.

TABLE 2: GMM Estimates of Environmental Degradation

Dependent Variable: Log (Per capita CO_2 Emissions)

	I	II	III	IV	V	VI	VII	VIII
Constant	-1.4751*** (.3199)	-5.7955** (.3110)	-1.4540*** (.3301)	-8.6716*** (.6556)	-1.6338*** (.3766)	-8.3687*** (.6849)	-1.2980*** (.4926)	-8.8277 (0.6884)
CO_2 per capita$_{t-1}$	.7410*** (.0328)	.7328*** (.0299)	.7413*** (.0337)	.7285*** (.0272)	.7274*** (.0361)	.7220*** (.0295)	.7442*** (.0345)	.7314*** (.0279)
GDP per capita	.1428*** (.0408)	.1036*** (.0327)	.1520*** (.0442)	.1454*** (.0380)	.1697*** (.0471)	.1423*** (.0380)	.1529*** (.0450)	.1454*** (.0382)
GDP per capita squared	—	-1.6457*** (.5652)	—	-2.3931*** (.6651)	—	-2.3304*** (.6678)	—	-2.3922*** (.6694)
Inflation	-.0002*** .0000483	-.0001*** .0000448	-.0002*** .0000506	-.0001*** .0000442	-.0002*** .0000502	-.0001** .0000441	-.0002*** .0000509	-.0001*** .0000445
FDI	-.0072** (.0035)	-.0070** (.0032)	-.0072** (.0036)	-.0069** (.0029)	-.0071** (.0035)	-.0069** (.0029)	-.0071* .0037)	-.0069** (.0029)
Price Liberalization	-.2334*** (.0778)	-.2475*** (.0708)	-.2459*** (.0822)	-.2184*** (.0662)	-.2234*** (.0836)	-.2080*** (.0683)	-.2468*** (.0827)	-.2193*** (.0667)
Forex and Trade Liberalization	-.0610 (.0460)	- .1151** (.0451)	-.0538 (.0486)	-.1570*** (.0473)	-.0467 (.0478)	-.1513*** (.0479)	-.0536 (.0488)	-.1568*** (.0476)
Trade Openness	.0042*** (.0009)	.0035*** (.0009)	.0040*** (.001)	.0039*** (.0008)	.0039*** (.001)	.0039*** (.0008)	.0021693*** .0042977	.0020874*** .0034451
Financial Liberalization	—	—	-.0088 (.0135)	-.0245* (.0139)	-.0893 (.1085)	-.0718 (.0886)	-.0086 (.0136)	-.0247* (.014)
IQ	-.1343 (.0927)	-.1678** (.0848)	-.1384 (.0954)	-.1698*** (.0768)	-.1386 (.0927)	-.1693** (.076)	-.3189 (.4316)	-.3503** (.0346)
Energy Consumption	.01451*** (.0029)	.0187*** (.0029)	.0145*** (.003)	.0204*** (.0028)	.0145*** (.0029)	.0203*** (.0028)	.0144*** (.003)	.0203*** (.0029)
Energy Imports	-.0022*** (.0006)	-.0024*** (.0005)	-.0022*** (.0006)	-.0026*** (.0005)	-.0024*** (.0006)	-.0027*** (.0005)	-.0022*** (.0006)	-.0026*** (.0005)
IQ*Financial Liberalization	—	—	—	—	.1124*** (.0123)	.055*** (.1017)	—	—
IQ*Trade Openness	—	—	—	—	—	—	-.021* (.011)	-.021* (.012)
J-stat	0.956	0.742	0.970	0.345	0.935	0.278	0.988	0.505
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.550	0.540	0.580	0.519	0.590	0.520	0.577	0.525
Countries	24	24	24	24	24	24	24	24
Total no. observations	264	264	264	264	264	264	264	264

Note:

J-stat is Hansen's test for overidentifying restrictions. AR(1) and AR(2) test refer to the test for the null of no first-order and second-order autocorrelation in the first-differenced residuals.. p-values are reported for the Hansen, AR(1) and AR(2) tests.

******* Significant at 1% confidence level; ****** Significant at 5% confidence level ***** Significant at 10% confidence level. Heteroscedasticity-Consistent Standard Errors are reported in parenthesis

In cases, where the estimated parameters are not significant either at 1%, 5% or 10% levels, zero value is assigned to the correspondent parameter. Results of this exercise are presented in Table 3. Complementary to the short run effects, we also calculate the long run effects by dividing the short run values by one minus the estimated coefficient of the lagged dependent variable.[4]

TABLE 3: Marginal effects of Institutional Quality on CO_2 Emissions

Interactive Terms	CO2 per capita emissions	
	Short run Effects	Long Run Effects
Institutional Quality * Financial Liberalization	-0.1606%	-0.6785%
Institutional Quality * Trade Openness	-0.3981%	-1.9103%

It follows from our estimations that there is a significant positive effect of financial liberalization and trade openness conditioned by institutional quality in both short and long runs on per capita CO_2 emissions. The financial liberalization conditioned by institutional quality has a positive contribution related to environmental pollution of -0.1606% and -0.6785% in the short and long terms, respectively. In the interactive framework, trade openness has positive contribution of about -0.3981% in the short run and -1.9103% in the long run. A different conclusion emerges when examining the overall short run versus long run effects. In the case of financial liberalization and trade openness, conditioned by institutional quality, the impact is marginally higher in the short run. One plausible explanation for this could be the current weak state of institutional quality in transition economies where even a marginal improvement would have a higher impact in the short term. Once the institutional quality improves significantly in the long term, its impact on trade and financial deepening becomes weaker.

[4] For a detailed exposition about the interpretation and importance of the marginal effects in an interaction model framework see Brambor et al. (2006).

4. Conclusions

The main objective of this paper is to test the role of economic, financial and institutional developments on environmental degradation. In this process we also investigated the validity of EKC hypothesis with a sample of 24 transition countries for the period from 1993 to 2004. We have used different econometric panel data techniques to shed lights on these hypotheses and these are the random-effects specification to address possible country specific unobserved heterogeneity and GMM estimation to deal with potential endogeneity of the explanatory variables. The use of these techniques partially fulfills the econometric criticism of the EKC of Stern (2004). Here, it is worth noting that we find only one article developed by Halkos (2003) that uses the GMM approach to study the nexus between economic growth and environmental pollution. While Halkos concentrates only on sulfur emissions and economic growth relationship we extend the idea to financial and institutional developments and considered CO2 emissions as measure of environmental degradation.

Firstly, our empirical results showed that economic development decreases environmental degradation when controlled for endogeneity of the explanatory variables and the effects of institutional quality are taken into account. Our findings thus confirm empirically the EKC hypothesis. In some respects our work also fulfills one of the main shortcomings in a vast number of studies that have ignored variables like institutional quality and its interactive effects with other variables viz., trade openness and financial developments.

Secondly, while the majority of the existing research is focused on the consequences of economic growth on environmental degradation, we show that financial developments do play a positive role in environmental disclosure of the transitional economies. Particularly, we find that higher levels of FDI help to achieve lower CO_2 per capita emissions while financial liberalization may be harmful if not accomplished by strong institutional framework. In this sense, it is noteworthy that governments can help to improve environmental disclosure by establishing strong policy and institutional structures that have long-term benefits for reductions in greenhouse gas emission. Furthermore,

governments should also support the development of new technologies that lead to a less carbon-intensive economy.

Thirdly, our results showed that the effect of trade openness is to increase environmental degradation, but this result is attenuated when interacted with institutional quality. The very industrialized economic structure and the comparative advantage in the strongly polluting production of capital intensive goods, at the beginning of the transition, could explain this result. Moreover, we updated the institutional quality index proposed by Pineiro et al. (2005) which resulted in an important variable for the reduction of environmental degradation in countries under consideration.

Finally, the message to the policy makers of the transitional countries is that enhancing the institutional infrastructure in the short term will probably permit to achieve a green growth in the future.

However, as argued by Ang and Liu (2006), the need for further empirical analysis remains pertinent and hopefully our paper will facilitate improved further investigations.

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Annex 1: Data Description

Variable	Source
CO_2 metric tons per capita	WDI
GDP per capita (1995 US$), growth rates (%)	WDI
FDI, net inflows (% GDP)	WDI
Inflation, average consumer prices (Index, 2000=100)	IMF, World Economic Outlook (WEO) and EBRD
Price Liberalization	EBRD
Forex and Trade Liberalization	EBRD
Trade Openness, (%GDP)	WEO
Financial Liberalization*	Chinn and Ito (2008)
IQ	Own calculations
Fossil fuel energy consumption (% of total)	WDI
Energy imports, net (% of energy use)	WDI

Note: * For some countries where the data were not available we used linear interpolation and extrapolation to fill the missing values.

Annex 2: Country List

Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia FYR, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Tajikistan, Ukraine, Uzbekistan.