JOURNAL OF ECONOMIC DEVELOPMENT 1
Volume 42, Number 1, March 2017

ECONOMIC LIBERALIZATION AND THE ENVIRONMENTAL KUZNETS CURVE: SOME EMPIRICAL EVIDENCE

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This paper applies the Environmental Kuznets Curve (EKC) model to examine the impact of trade openness, foreign direct investment liberalization, the decreasing role of the state, energy consumption and urbanization on per capita emission in countries at various stages of economic development and as a group. For this purpose, a dynamic panel estimation applying the Arellano-Bond's Generalized Method of Moments (GMM) was conducted using the average of five-year observations from 1980–2009. The findings suggest that while trade and Foreign Direct Investment (FDI) are not expected to affect environmental quality, increasing role of the state has a negative and significant impact only in developed countries. Further, the results suggest that energy consumption has a significant impact on all countries regardless of their stage of development, while urbanization affects environmental quality only in the least developed countries.

Keywords: Environmental Kuznets Curve, Economic Liberalization, Trade, Panel Analysis, Generalized Method of Moments
JEL Classification: F18, F64, Q56

1. INTRODUCTION

Economic liberalization and environment are two major issues defining today's political agenda (Baek *et al.*, 2009; Copeland, 2005; Copeland and Taylor, 2004). Although the theoretical backgrounds of economic liberalization on emission levels are not clear, studies in this area garner much interest (Jayanthakumaran and Liu, 2012) and much controversy exists on its impact on the environment.

While it is widely agreed that economic liberalization is a major stimulus to environmental effects (Baek *et al.*, 2009) its negative impacts have been highlighted by many studies (Cole, 2004; Daly, 1993; Greenpeace, 1997; Lang and Hines, 1993; Tisdell, 1999; World Wide Fund for Nature International, 1999).

Previous studies have much expanded understanding on the environmental consequences of economic liberalization. However, earlier investigations mostly used the much-criticized Environmental Kuznets Curve (EKC) in its simplest form (Arrow *et al*., 1995; Ekins, 1997; Stern *et al*., 1996; Stern and Common, 2001). A specific criticism leveled at the EKC is that it does not account for the patterns of the different dimensions of economic liberalization simultaneously and in a coherent framework. Such dimensions that include trade, foreign direct investment liberalization, and the decreasing role of the state could potentially have significant impacts on the environment. Further, the earlier studies paid little attention to the issue of endogeneity in evaluating the relationship among trade liberalization, FDI, income growth, and environment quality (Chintrakarn and Millimet, 2006; Coondoo and Dinda, 2002).

Although a number of papers have examined the separate impact of different dimensions of economic liberalization (Birdsall and Wheeler, 1993; Frankel and Rose, 2005; He, 2010; Jaffe *et al*., 1995; Jänicke *et al*., 1997; Mani and Wheeler, 1997; Tisdell, 2001), a clear simultaneous indication of the extent to which economic liberalization may be responsible for the emission level while controlling for other variables such as energy consumption and urbanization yet to be provided. That is the contribution of this paper which appraises the impact of different features of economic liberalization in a simultaneous and coherent framework, using the GMM to take into account issues of endogeneity.

This study uses different GMM estimators and detailed data on 166 countries comprising 36 developed economies, 83 developing economies and economies in transition, 47 least developed economies, and a combination of all the countries irrespective of their development stages. Apart from examining the validity of the EKC for each group of countries, this paper estimates the average turning point incomes for individual groups, and assesses the impact of trade liberalization, foreign direct investment liberalization, the decreasing role of the state on emissions. Further, the study ascertains whether patterns of urbanization and energy consumption could significantly impact pollution levels.

The remainder of the paper is structured in the following manner: Section 2 addresses the way that economic liberalization is measured and the linkages between different aspects of economic liberalization and the environment; Section 3 contains the econometric analysis, and finally, Section 4 concludes the paper.

2. ECONOMIC LIBERALIZATION AND THE ENVIRONMENT

2.1. Measuring Economic Liberalization

Although economic liberalization is a complex process encompassing many facets and effects (Frankel, 2009), this paper, like in Santareli and Figini (2002), characterizes it based on three different aspects: trade liberalization, FDI liberalization, and the decreasing role of the state. A commonly used measure of the structural dimension of economic liberalization is the degree of openness usually measured as the ratio of trade over GDP ($(Exports + Imports)/GDP$). Although economic liber- alization does not solely constitute openness to international trade, this is probably its most important feature (Santareli and Figini, 2002). Following Santareli and Figini (2002), another measure of economic liberalization used in this paper is the degree of openness to FDI that take into account net inflows of FDI over GDP ratios. Following the similar study, the third factor characterizing economic liberalization is the decreasing role of the state as measured by the change in public expenditure relative to GDP, over time.

2.2. The Impact of International Trade and Investment on the Environment

It is important to determine whether economic liberalization contributes to or detracts from achieving the optimal trade-off between environmental and economic goals. Economic liberalization is a complex trend encompassing many forces and many effects (Frankel, 2009) and can be characterised based on different aspects, including trade liberalization, foreign direct investment liberalization, and the decreasing role of the state (Santareli and Figini, 2002; Figini and Santarelli, 2006).

Trade and foreign investment can impact the environment mainly through two channels: some environmental effects of international trade come via economic growth, and others from a given level of income (Frankel, 2009), and the effects on the environment in both cases can be either beneficial or detrimental. According to Frankel (2009) probably the strongest effects of trade are via the economic growth channel.

With regard to the effects from the income aspect, a common finding is the so-called EKC, a loose U-shaped relationship between income and environmental quality. The EKC assumes that the relationship between one of the several indicators of environmental deterioration and per capita income or income level can be depicted by an inverted U-shaped curve. It shows that the level of environmental degradation increases with economic growth before it reaches a given critically high level (the so-called threshold or turning point), and then starts to decline. In this strand of research, a path-breaking study was that by Grossman and Krueger (1993) which concluded that the connection between some pollution indicators and income per capita could be described as an inverted-U curve. Some studies, including the original Grossman and Krueger (1993) paper, also used a cubic EKC in levels and found an N-shape EKC. The inclusion of cubic term indicates that emissions increase as a country develops decrease once the threshold GDP is reached, and then begin to rise again once a second income turning point is passed.

The origins of the EKC, which has attracted much attention since the early 1990s, can be traced to Kuznets (1955) who initially hypothesized that the relationship between inequality in income distribution and income growth follows an inverted U-shaped curve. Panayotou (1993) first named the inverted-U curve as the Environmental Kuznets Curve because of its similarity to the Kuznets Curve.

However, as Frankel (2009) points out, the system-wide effects of trade on the environment which do not operate via economic growth fall into three categories, namely those that are adverse, beneficial, and variable across countries depending on their comparative advantage. Adverse effects can be classified as the “race to the bottom”, the beneficial effects under the general title of “gains from trade”, and the third type as the “pollution haven” hypothesis. Such effects of trade that come from non-income channels can be negative or positive.

The *race to the bottom* hypothesis assumes that international trade and investment will create downward pressure on countries’ environmental standards and thus damage the environment across the global system. In this respect, the concern is that when countries are open to international trade and investment, environmental standards will be lower than they would otherwise be. The notion of gains from trade suggests that trade allows countries to attain more of what they want, which includes environmental goods in addition to market-measured outputs. The pollution haven hypothesis indicates that trade improves the environment in some open economies and worsens it in others. Based on the pollution haven hypothesis, to the extent that countries are open to international trade and investment, some will specialize in producing dirty products, and export them to other countries. Accordingly, the environment will be damaged in exporting countries, as compared to what would happen without trade. The environment will be cleaner in the second set of countries, those that specialize in clean production and instead import the dirty products from the other countries.

2.3. The Impact of the Decreasing Role of the State on Emissions

Despite the significant impact that reduction in the size of the government could have on the environment, the relationship between the two has not been adequately addressed in the literature and it has only recently started drawing stronger attention. As mentioned earlier, the size of government can be proxied by the change in public expenditure relative to GDP over time. The effects of government spending on the environment may be classified as direct and indirect. In particular, the indirect effect operates through the impact of government spending on economic growth and the subsequent relationship between income levels and pollution known as the EKC hypothesis. In other words, the indirect mechanism through which the share of government expenditure of GDP may influence pollution depends on both the income-pollution and government-growth relationships.

Empirical literature does not provide clear estimates of the direct effect of government size on pollution (Halkos, 2012). Barro (1991), Bajo-Rubio (2000), Bernauer and Koubi (2006), and Afonso and Furceri (2008) note that an increase in the government spending share of GDP is associated with worsening air pollution while more recent studies, such as by Bergh and Karlsson (2010), Lopez et al. (2011), Afonso and Jalles (2011), and Halkos (2012), find that it has the opposite effect. Lopez *et al.* (2011) stress that if governments reallocate their spending towards social and public goods, pollution would be reduced. Further, related papers by Bergh and Karlsson (2010) and Afonso and Jalles (2011) show that government expenditure may also boost economic performance due to positive externalities arising out of harmonizing conflicts between private and social interests, providing a socially optimal direction for growth as well as offsetting market failures. Other studies link the effect of public expenditure on the environment to the quality of the government (Frederik and Lundstrom, 2001).

3. METHODOLOGY AND DATA

3.1. Methodology

The empirical estimation in this study has two objectives. The first is to examine the validity of the EKC and its associated turning points in different groups of countries classified according to their levels of economic development. The second is to investigate the impact of different aspects of economic liberalization (trade openness, FDI liberalization and the decreasing role of government), energy consumption and urbanization patterns on the environment. For this purpose, the following dynamic panel data model is utilised:

$$lnCO2_{it} = \alpha_0 + \alpha_1 lnCO2_{it-1} + \alpha_2 lnGDP_{it} + \alpha_3 (lnGDP_{it})^2 + \alpha_4 (lnGDP_{it})^3 + \alpha_5 lnFDI_{it} + \alpha_6 lnOp_{it} + \alpha_7 lnPub_{it} + \alpha_8 lnEcp_{it} + \alpha_9 lnUp_{it} + \varepsilon_{it}, \quad (1)$$

where α_i's are the parameters to be estimated and $lnCO2$, $lnGDP$, $lnFDI$, $lnOp$, $lnPub$, $lnEcp$, $lnUp$ denote the per capita emission, per capita GDP, the share of inward FDI over GDP, share of trade over GDP, share of government expenditure over GDP, per capita energy consumption over GDP, and urban population, respectively. All the variables are in natural logarithm form. Subscripts i and t indicate countries in the sample and the time periods, respectively, while ε_{it} is a composite error term, consisting of μ_i the unobserved country-specific effect, and υ_{it} the idiosyncratic shocks $(\varepsilon_{it} = \mu_i + \upsilon_{it})$.

In the above equation, the fixed effects (μ_i's), which reflect the regional or demographic classification, are also called time-invariant country characteristics. If the time-invariant effects are correlated with the explanatory variables, it violates the assumptions underlying the classical linear regression model (Gujarati, 2003). Further, given the dynamic nature of the model, the presence of the lagged dependent variables $lnCO2_{it-1}$ will increase the autocorrelation. In other words, $lnCO2_{it-1}$are correlated with the fixed effect in the error term, which leads to a bias in results (Nickell, 1981). First-differencing the variables that are entered into the model can solve this problem by removing such fixed effects, as follows:

$$\Delta lnCO2_{it} = \alpha_1 \Delta lnCO2_{it-1} + \alpha_2 \Delta lnGDP_{it} + \alpha_3 \Delta (lnGDP_{it})^2$$

$$+\alpha_4\Delta(lnGDP_{it})^3 + \alpha_5\Delta lnFDI_{it} + \alpha_6\Delta lnOp_{it} + \alpha_7\Delta lnPub_{it}$$
$$+\alpha_8\Delta lnEcp_{it} + \alpha_9\Delta lnUp_{it} + \Delta v_{it}. \quad (2)$$

However, the following econometric problems might still be present in the estimation of Eq (2) and should be considered: (i) the correlation exists between the new error term (Δv_{it}) and the differenced lagged-dependent variable ($\Delta lnCO2_{it-1}$); (ii) since the data set is for several time observations (5-year averages from 1980-2009), the dynamic pattern of the data should not be ignored otherwise the stationarity assumption of all the variables included in the regression and homogeneity of cross-country coefficients will be violated; and (iii) this study encounters the endogeneity problem caused by the correlation between FDI, government expenditure, and energy consumption with GDP, which can produce biased estimated coefficients. In this case, the simple Ordinary Least Squares (OLS) approach can produce extremely misleading results (Im *et al*., 2002; Pesaran and Smith, 1995). Therefore, the empirical analysis for the estimation of Eq (2) should employ a methodology that accounts for heterogeneous dynamic panels (Pesaran *et al*., 1999). To overcome this, economists recommend the use of instrumental variables and, more recently, panel data techniques such as Pooled Mean Group (PMG) discussed in Pesaran *et al*., (1999) and the GMM procedure of Arellano and Bond (1991) to address the problems more efficiently. However, when the number of cross-section observations is quite large and the time-series dimension is relatively small, as is the case in this paper, the GMM estimator can produce more consistent estimates (Pesaran *et al*., 1999). The GMM estimator is useful for panel data with relatively small time dimensions, as compared to the number of cross sections (Roodman, 2009).

Considering the above discussion, the Arellano-Bond's (1991) GMM method that was first proposed by Holtz-Eakin *et al*. (1988) seems to be appropriate for the estimation of Eq (2). The estimation method addresses the problem of autocorrelation of the residuals and the endogeneity which may exist in the model. The Arellano-Bond GMM estimator employs lags of the dependent and independent variables as instruments. Since this method generates several instruments which may lead to the potentially poor performance of the results, an essential assumption for the validity of the GMM estimator is that the instruments are exogenous. In other words, the instrument set is assigned based on the orthogonality condition. For instance, if $E(CO2_{it-s}, \Delta v_{it}) = 0$ for all $s \geq 2$ in the level equation, then $CO2_{it-2}$, $CO2_{it-3}$, $CO2_{it-3}, CO2_{it-4}$ and so on are valid instruments for the first-differenced equation. To provide some evidence of the instruments' validity, over-identifying restriction tests can be performed. For this purpose, the so-called Sargan (1958) test of over identifying restrictions can be applied as well as the theoretically superior over-identification test based on the Hansen (1982) J statistic.

Finally, it should be noted that in GMM methodology, two transformations are commonly used to eliminate the dynamic panel bias caused by the correlation between the lagged dependent variable and the fixed effects in the error term. One is the first difference and the other is the forward orthogonal deviations (FOD) transformation. As widely discussed, the former has a weakness which magnifies gaps in unbalanced panels (Hayakawa, 2009; Roodman, 2009). In such situations, Arellano and Bover (1995) suggest the application of the FOD that preserves sample sizes in panels with gaps. In this method, the average of all future available observations of a variable subtracts from the current observation. Therefore, it is computable for all observations except the last for each individual no matter how many gaps, thereby minimizing data loss.

As this study depends on the panel of 166 countries over the fairly extensive period of 1980 to 2009, missing data is inevitable. Therefore, it adopts the FOD rather than the common first differencing to preserve the sample size. Consequently, Eq (1) appears as follows:

$$\begin{aligned}\widetilde{\Delta}lnCO2_{it} &= \alpha_1\widetilde{\Delta}lnCO2_{it-1} + \alpha_2\widetilde{\Delta}lnGDP_{it} + \alpha_3\widetilde{\Delta}(lnGDP_{it})^2 \\ &+\alpha_4\widetilde{\Delta}(lnGDP_{it})^3 + \alpha_5\widetilde{\Delta}lnFDI_{it} + \alpha_6\widetilde{\Delta}lnOp_{it} + \alpha_7\widetilde{\Delta}lnPub_{it} \\ &+\alpha_8\widetilde{\Delta}lnEcp_{it} + \alpha_9\widetilde{\Delta}lnUp_{it} + \widetilde{\Delta}v_{it},\end{aligned} \tag{3}$$

where $\widetilde{\Delta}$ indicates the FOD transformation according to the following formulation:

$$\widetilde{\Delta}X_{it} = x_{it}(X_{it} - \frac{1}{T_{it}}\sum_{s>t} X_{is}), \qquad X_{it} = \sqrt{\frac{T_{it}}{T_{it}+1}}, \tag{4}$$

where T_{it} is the number of observation for each country at the time t.

It should be noted that in utilizing the first difference transformation, the first and second order Arellano-Bond test for autocorrelation of residuals should be considered. But this is not the case while employing the orthogonal deviations because lagged observations of a variable do not enter the formula for transformation. As such, they remain orthogonal to the transformed errors and are valid as instruments (Roodman, 2009).

3.2. Data

In this study, data for the 166 countries were sourced from the World Bank World Development Indicators (2013) for the period over 1980-2009. Then values of individual variables within each five-year period were averaged to reduce the number of time observations to five leading to more reliable results when the GMM estimation method is used. Further, since the high level of heterogeneity among the countries studied would hamper the identification of stylized facts relative to the entire sample, some significant country aggregations were attempted based on their economic development stages to highlight different trends and behaviors. For analytical purposes, the World Economic Situation and Prospects (WESP) classifies all countries into three broad categories: developed economies, economies in transition and developing countries, and least developed economies. Thirty-six of the 166 countries in this study were classified as developed, 83 as developing economies and economies in transition and 47 as least developed (see. Appendix). As noted above, using the taxonomy of developed and developing countries, this study considers four different estimation scenarios, one for each of the countries' classification, and one for all the countries combined. For the purposes of the econometric analysis, the classification of countries based on their development stages singles out possible differences in the relevant coefficients determined by which category a country belongs to.

Figure 1 provides scatter plots of CO2 emissions (kt) against GDP (constant USD) for all countries and for each category of development stages. The variables are converted to the natural logarithm form for the period from 1980-2009.

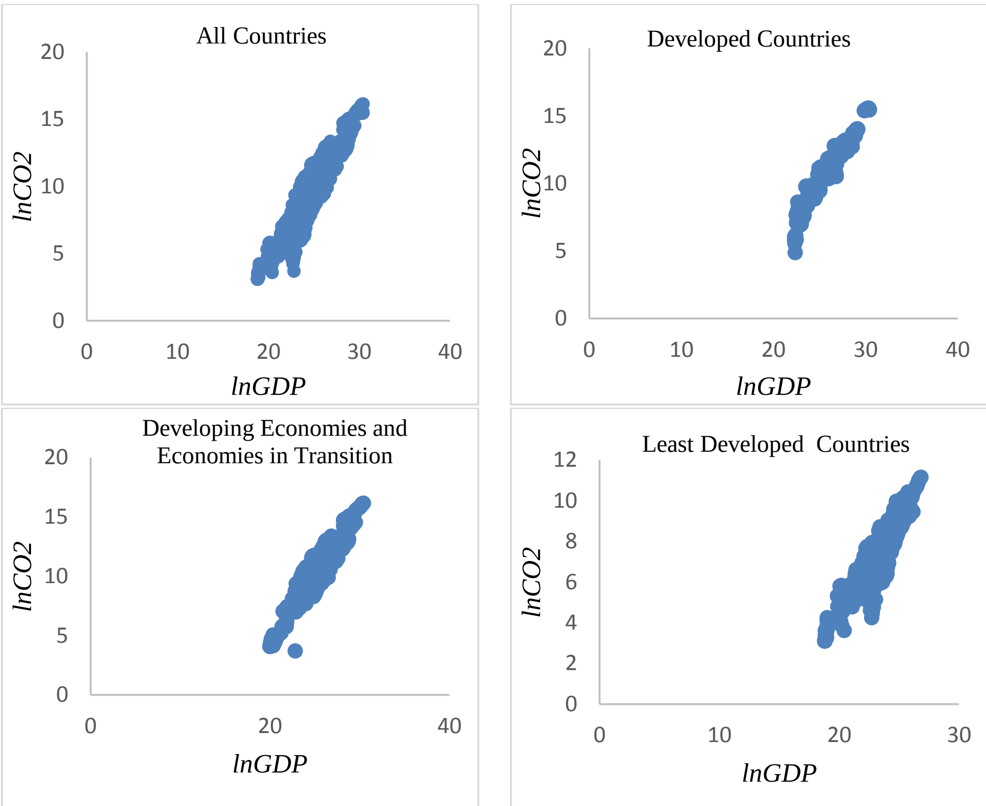

Figure 1. Scatter Plots of CO2 Emissions Against GDP

4. ESTIMATION RESULTS AND DISCUSSTIONS

For the purpose of empirical estimation, Eq (3) is used when the FOD transformation is employed. We estimated the coefficients for all groups in both cubic and square functional forms. However, our econometric estimation shows that the cubic term is significant only for the category developed countries. For this reason, the results presented in Table 1 show the estimated results for developed countries when the cubic term is included, while the cubic term for the other categories is omitted. Further, the literature which hardly supports the use of the cubic term for countries not classified as developed. Using a two-step difference GMM, the estimation results are shown in Table 1.

Table 1. Two Step Difference GMM

	Developed Economics' Coefficient		Developing Economics and Economics in Transition's Coefficient		Less developed Economics' Coefficient		All Economics' Coefficient	
$lnCO2$	0.505	(0.117)***	0.624	(0.139)***	0.692	(0.046)***	0.566	(0.156)***
$lnGDP$	67.566	(23.651)***	1.438	(0.658)**	4.565	(1.162)***	1.374	(0.535)**
$ln(GDP)^2$	-6.884	(2.401)***	-0.083	(0.039)**	-0.324	(0.085)***	-0.075	(0.032)**
$ln(GDP)^3$	0.233	(0.081)***	-	-	-	-	-	-
$lnFDI$	-0.012	(0.009)	0.002	(0.005)	0.0001	(0.009)	0.004	(0.004)
$lnOP$	-0.015	(0.077)	-0.07	(0.070)	0.002	(0.075)	0.021	(0.056)
$lnPub$	-0.134	(0.069)*	-0.063	(0.085)	-0.039	(0.101)	0.003	(0.072)
$lnEcp$	0.688	(0.085)***	0.453	(0.192)**	0.294	(0.158)*	0.394	(0.188)**
$lnUp$	-0.139	(0.146)	-0.005	(0.059)	0.114	(0.048)**	-0.008	(0.057)
Turning points	1st: 11,649 USD	2nd: 30,393 USD	5,783 USD		1,147 USD		9,509 USD	
No. Obs.	136		298		70		504	
No. Group	36		77		23		136	
No. Instrument	32		22		22		62	
	F(9,36) = 44.61***		F(8,77) = 54.07***		F(8,23) = 480.69***		F(8,136) = 99.61***	
Sargan J-Test	0.15		0.95		0.51		0.90	
Hansen J-Test	0.35		0.76		0.70		0.21	
Diff. in Hansen tests -p values	0.42		0.87		0.61		0.21	
	0.22		0.20		0.68		0.31	

Note: The dependent variable is natural logarithem of CO2 per capita. *, ** and *** indicate that coefficient is significantly different from zero at 10, 5 and 1 percent significance level respectively. Heteroskedasticity -consistence standard errors are in parentheses. The difference in Hansen IV test indicates the exogeneity of instrument variable (IV) subset which is not treated as endogenous.

All the cases indicate that the inclusion of the lagged dependent variable of the emissions per capita proved to be positively discernable, thus implying inertia in the level of the emissions and justify forming the dynamic panel model. The Sargan and

Hansen tests do not suggest rejection of the instrumental validity at conventional levels for any estimated cases. The Difference-Hansen test is also used to examine the validity of the Difference-GMM by testing whether the correlation between the error term (which includes the unobserved country specific term) and the instruments are statistically significant. The results suggest not rejecting the null hypothesis that the additional instruments are uncorrelated with the error term. This study opts for the Difference-Hansen test (rather than the Sargan and Difference-Sargan tests) because it is robust to heteroskedasticity. Furthermore, as noted in the methodology section, since this study applies the FOD transformation rather than the common first difference procedure, lagged observations of a variable remain orthogonal to the transformed errors and the Arellano-Bond test for the first and second order autocorrelations are not applicable (Roodman, 2009).

Following the diagnostic tests, it is possible to verify the shape of the EKC of each of the country classifications. The cubic estimation has the significant coefficients α_2, α_3, and α_4 with correct signs of the N shape which indicates that as income grows toward very high levels, the eventual turning point occurring at lower income levels is switched onto a new path of growing emissions in relation to income. The cube-shaped relationship which has two "turning-point" incomes where emissions are at a maximum and minimum, respectively, is given by: x_1^* and $x_2^* = exp(-\alpha_3 \pm \sqrt{\alpha_3{}^2 - 3\alpha_2\alpha_4}$ $/3\alpha_4)$. Table 1 shows the EKC turning point incomes for the corresponding emissions in developed countries. The first threshold is at the per capita income of USD11,649 while the second occurs at USD30,393.

Further, the quadratic estimations have the significant coefficients α2 and α3 with the correct signs of the inverted U shape, which are also statistically significant. For the inverted U-shape function, the "turning point" income, where emissions are at a maximum, is given by: $x^* = exp(-\alpha_2/2\alpha_3)$. As shown in Table 1, the turning point for the developing and in-transition economies is USD5,783 while that for the least developed economies is USD1,147. The estimate of an inverted U curve turning point of CO2 is within that determined by other researchers.

Comparisons show that less per capita income is required in least developed countries than developing countries to reach the turning point. Similarly, developing countries should bear lower costs than their developed counterparts to reach this threshold level.

The next issue is to determine if the pattern of various aspects of economic liberalization, including trade openness, foreign direct investment liberalization and decreasing role of the state show a downward or an upward shift in EKC. Put another way, it has to be established whether the beneficial or adverse effects of trade dominate the environment. Almost all the trajectories reveal that different features of economic liberalization have no significant impact on shifting the EKC. The only exception is the role of government in developed countries, where the coefficient of $lnPub$ is found to be negative and statistically significant at the 10% level, indicating that increasing the size of the government shifts the EKC downward. Such a result is expected as the quality of governments is higher in developed countries than elsewhere (Frederik and Lundstrom, 2001) and any expansion in government size could reduce pollution and have a positive effect on the environment owing to the positive externalities arising from harmonizing conflicts between private and social interests. Such a result is compatible with the findings of Bergh and Karlsson (2010), Lopez et al. (2011), Afonso and Jalles (2011), and Halkos, (2012).

The estimation result for all cases has shown a significantly positive α_8, the coefficient of energy consumption per capita, representing the upward shift of the EKC due to increasing energy consumption of countries. The findings also show that the coefficient of urbanisation is not significant except in the case of least developed economies where the negative and significant coefficient of urbanisation at 5% significance level indicates that urban expansion shifts the EKC upward. Again, the negative impact of urbanisation in these countries could be attributed to the low quality of governments and institutions where the urbanisation process has not matched environmental standards.

5. CONCLUSION

The validity or non-validity of the EKC and the environmental consequences of economic liberalization reveal both the challenges and opportunities faced by countries in their choice of the path to sustainable development. This paper sets out to examine through the EKC model, the impact of trade liberalization, foreign direct investment liberalization, decreasing role of the state, energy consumption and urbanization on emissions per capita for countries in various stages of development and a composite of all countries, for the period 1980–2009. To take into account the dynamic nature of the relationships examined, a dynamic panel estimation using the GMM estimator was carried out. The major contribution of this paper is that it combines economic -liberalization-related emissions hypotheses, urbanization, and energy consumption patterns in seeking empirical evidence for the EKC. Through this analysis, it was determined that an N-shaped relationship exists between CO2 equivalent emissions and GDP in developed economies, while an inverted U-shape relationship exists between these variables in developing countries and countries in transition, least developed countries, and for all countries when combined.

Our estimation results provide almost no support for the different aspects of economic liberalization to move the EKC upward or downward. The only support is provided for the impact of decreasing role of the state (size of government) in shifting the EKC up (or down) in developed economies. Energy consumption patterns, however, show the significant impact on shifting up the EKC for all countries regardless of their development stage. Lastly, the urbanization expansion seems to have no effect on the EKC except in least developed countries where it shifts the curve up.

The study is an attempt to estimate the impact of different features of economic liberalization on the EKC. Nevertheless, being aware of the use of narrow definition of economic liberalization the authors used rough proxies to capture various aspects of such liberalization in this paper. Future studies might be directed to the development of more insightful proxies for economic liberalization and then assessing their impacts on the environment.

APPENDIX

A1. Country Classifications

Developed Economics: Australia, Austria, Belgium, Bulgaria, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Swaziland, Sweden, Switzerland, United Kingdom, United States

Developing Economics and Economics in Transition: Algeria, Argentina, Bahrain, Barbados, Bolivia, Botswana, Brazil, Cape Verde, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Cuba, Dominica, Ecuador, Egypt, El Salvador, Gabon, Ghana, Guatemala, Guyana, Honduras, Hong Kong, India, Indonesia, Iran, Iraq, Israel, Jamaica, Jordan, Kenya, Korea Rep., Kuwait, Lebanon, Libya, Malaysia, Mauritius, Mexico, Morocco, Namibia, Nicaragua, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Qatar, Saudi Arabia, Singapore, South Africa, Sri Lanka, Sudan, Syrian Arab Republic, Thailand, Trinidad and Tobago, Tunisia, Turkey, United Arab Emirates, Uruguay, Venezuela, Vietnam, Zimbabwe, Albania, Armenia, Azerbaijan, Belarus ,Bosnia and Herzegovina ,Croatia, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Montenegro, Russian Federation, Serbia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.

Least Developed Economics: Afghanistan, Angola, Bangladesh , Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Congo Dem. Rep., Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, The Guinea, Guinea-Bissau, Haiti, Kiribati, Lao PDR, Lesotho, Liberia , Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, Tanzania, Timor-Leste, Togo, Tuvalu, Uganda, Vanuatu, Yemen Rep., Zambia.

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Received January 26, 2016, Revised January 24, 2017, Accepted February 13, 2017.