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**On Environmental Impacts of Market-Based Reforms:
Evidence from the European and Central Asian Transition Economies**

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Global warming and other adverse climate change impacts induced by anthropogenic carbon dioxide emissions are a major public policy concern around the world including transitional economies. This paper, therefore, examines the impacts of market-based economic reforms on per capita CO₂ emissions in the European and Central Asian transition economies where environmental degradation was pervasive prior to these reforms. A dynamic panel data model is employed for this purpose for 28 countries covering 22 years from 1990-2012. Our overall results suggest that economic openness may not necessarily result in sustainable development although reforms in competition policy and corporate governance were the significant drivers of emissions reductions in the region. Hence, advances in competition policy and governance reforms are desirable given the available scope to extend these reforms. The structural shift to and emergence of light industries also contributed to declining CO₂ emissions in the transition process. The *direct* impact of the Kyoto Protocol in reducing emissions is debatable which also raises doubts on the effectiveness of the Paris agreements.

Keywords: CO₂ emissions, economic reforms, environmental policy, climate change

JEL Classification: Q57, Q54, Q56, P28

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1. Introduction

The early 1990s marked the end of command-based policies in former member nations of the Soviet Union. They become transitional economies (TECs) and embarked an era of market-based economic reforms (both Type I and Type II) consisting of pervasive political, social and economic changes¹. Type I reforms included economic liberalization, macroeconomic stabilization, restructuring and privatisation and institutional reforms (Williamson, 1993). Type II reforms included the design and enforcement of laws, regulation and supportive institutions to buttress and facilitate the functioning of the market-based reforms in this transformation process (Svejnar, 2002).

The transitional process exposed the broad-scale environmental degradation that took place during the command-based regime in these countries (Soderholm, 2001). High levels of airborne particulates from industrial and household sources; widespread contamination of soil and water from toxic chemicals and nitrates; and a persistent negligence of nuclear safety and waste management issues were some of the common and urgent environmental problems identified in the fifth European Community Environmental Action Programme (EAP) for Central and Eastern Europe in 1993. The legacy of industrial inefficiency, obsolete and polluting technologies coupled with weak environmental management and regulation had exacerbated the ecological woes in the region.

The fifth EAP was a powerful forum because the meeting identified the long-term European environmental agenda for the decades to follow. A central principle of the EAP was that the process of economic reforms and restructuring associated with the transition were expected to eliminate the perverse incentives that underlay many of the ecological problems of the centrally planned economies (Hughes and Lovei, 1999). The importance of effective environmental policies; institutions and investments in supporting the market-based reforms improving the environmental performance of developed economies was also recognised. Now, more than 20 years after the commencement of economic reforms by European and Central Asian TECs, it is possible to use available data to examine the effect of market-based reforms on environmental quality such as air pollution. Has the prediction of the fifth EAP been vindicated? This paper investigates empirically the extent to which this is the case for reductions in carbon dioxide (CO₂) emissions in this group of countries. We focus on CO₂ because these emissions are viewed as the primary greenhouse gasses responsible for climate change and regulating and monitoring CO₂ remains a central issue in the ongoing international negotiations on

¹ The transitional economies, in this study, comprise the countries of Central Europe and Baltic States (CEB), South East Europe (SEE) and Eastern Europe and the Commonwealth of Independent States (CIS) belonging to the former Soviet Union (FSU).

climate change (IPCC, 2007; 2014). The scope of its spatial impact also makes CO₂ pollution appropriate for a country-level aggregate study in the light of data unavailability for other sources of pollutants even though climate change agreements have extended beyond limiting CO₂ emissions since the Vienna Conference in 1985.

Improving air quality by reducing the amount of air pollutants such as carbon dioxide (CO₂) in the atmosphere has also been an actively pursued global agenda since the 1992 United Nations Framework Convention on Climate Change (UNFCCC) came into force. The Kyoto Protocol, which extended the UNFCCC, was adopted in Kyoto on 11 December 1997 and entered into force on 16 February 2005 while the first commitment period expired in 2012. All the TECs in the group considered here had agreed to cap and eventually reduce their emissions of CO₂ considering the international importance of combating global warming. However, the extent to which international climate change agreements like Kyoto Protocol (a post Kyoto analysis) reduced the CO₂ emissions of these countries remains an important empirical question especially in the aftermath of the 2015 United Nations Climate Change Conference (COP 21). This is because COP 21 signalled a global agreement on the reduction of climate change impacts but with no detailed timetable or country-specific goals for emissions reductions incorporated into the agreement as opposed to the Kyoto Protocol.

The European and Central Asian (ECA) TECs still contribute about 15 percent of the global greenhouse gas emissions (GHGs) even though their carbon emissions have fallen substantially since 1990. Furthermore, this is the only major region in the world where per capita carbon emissions fell substantially by about 28 per cent between 1990 and 2008 despite an average increase in real GDP in this region by about 22 per cent over the same period (EBRD, 2011). This fall in CO₂ emissions can be attributed to the combined effects of economic reform and other underlying factors such as economic growth, investments in clean energy, changed composition of energy use, environmental policies and compliance with the EU directives that could potentially affect the trends in total emissions and environmental quality. However, the extent of impacts of economic reforms and other underlying factors on the falling levels of CO₂ emissions in the TECs is unknown in the existing literature.

The purpose of this study is to evaluate the impacts of the transitional process on environmental quality concentrating on comparisons of changes in CO₂ emissions among fast and slow reformers in the ECA TECs by capturing the combined effects of their economic reforms, growth, environmental interventions and studying trends. This study aims to achieve two main objectives. First, there is a paucity of published econometric studies gauging the impacts of market-oriented economic reforms on

environmental quality in TECs. This is particularly the case for ECA TECs. This study helps to fill this gap and identifies the main drivers of CO₂ reductions in ECA TECs. Secondly, identifying the drivers of CO₂ emissions reductions will guide policymaking on combating climate change in the TECs, as the TECs will have to further reduce emissions over the coming decades to achieve the required scale of global emissions reductions. For example, the region still includes some of the most carbon-intensive countries in the world such as Russia, Turkmenistan, Uzbekistan, Kazakhstan and Ukraine implying that there is much scope for improvement in environmental quality.

The remainder of the study is organized as follows. Section 2 reviews the relevant literature on the relationship between economic reforms, environmental regulations and environmental quality. Section 3 describes the econometric methodology and data used. The results are presented and discussed in section 4 along with relevant policy implications. Section 5 concludes the paper.

2. Review of Relevant Literature

The empirical literature on the relationship between CO₂ emissions and economic growth is large and is beyond the scope of this paper to review extensively. In general, the relationship between several indicators of environmental degradation and income can be typified by an inverted U-shaped relationship. This relationship is referred as the Environmental Kuznets Curve (EKC) and was originally proposed by Seldon and Song (1994) implying that pollution is a diminishing problem as per capita income rises. In 1995, Grossman and Krueger (1995) studied the EKC following cross-country studies on urban air pollution (sulphur dioxide emissions and smoke) and several indicators of water pollution as measures of environmental degradation. The EKC, hence, is a hypothesized relationship between indicators of environmental degradation and economic development which shows that the intensity of environmental degradation tend to increase as economic growth occurs until average income reaches a certain point. Several empirical studies such as Shafik (1994), Hilton and Levinson (1998), Harbaugh, Levinson and Wilson (2002), Dinda (2004) have confirmed this relationship although the functional form and data properties can influence findings on the existence of an EKC curve. Other studies such as Tisdell (2001), Stern (2004, 2014), Perman and Stern (2003) underscore the limitations of EKC and outline the conditions under which the EKC relationship may not exist such as heterogeneity, spurious regressions, endogeneity, heteroscedasticity, omitted variables and spatial dependence.

Another strand of literature focusses on the relationship between economic openness and environmental quality. Economic globalisation and trade openness is viewed as a possible positive

force for environmental improvement and as a major factor increasing the likelihood of sustainable development through its likely boost to global investment (Tisdell, 2001). Earlier empirical studies such as Dean (2002); Copeland and Taylor (2004) and Frankel and Rose (2005) have confirmed a positive relation between trade openness and environmental quality. Tamazian et al. (2009) show that higher degree of economic and financial openness led to CO₂ reduction among the BRIC (Brazil, Russia, India and China). The impact of environmental regulation and policy such as the ratification of the Kyoto Protocol on environmental degradation has also been captured by several studies. Grunewald and Martinez-Zarzoso (2009) found in testing the theory of the EKC while taking account of environmental regulations that Kyoto obligations had a reducing effect on CO₂ emissions in both developed and developing countries. Iwata and Okada (2014) found that the effects of commitment to the Kyoto Protocol significantly reduced the CO₂ emissions among 119 countries from 1990 to 2005. Similarly, Jalil and Habibullah (2013) estimated that Kyoto commitment and Kyoto Clean Development Mechanism produced a statistically significant effect in reducing CO₂ emissions in Asia and the Pacific region for the period 1971-2009. Aichele and Felbermayr (2011) conducted the first ex-post empirical evaluation of Kyoto Protocol to analyse the carbon content of bilateral trade. The results showed that Kyoto has led to carbon leakage among countries. Carbon leakage implies that environmental regulation and restrictions in some countries could change relative goods prices and hence shift production of CO₂ intensive goods to countries that are exempt from such restrictions (Copeland and Taylor, 2005). For example, it is possible for higher income countries to reduce their pollution intensities by shipping polluting industries offshore (e.g. in China and India) as environmental restrictions add to the private costs of locating eco-unfriendly businesses in higher income countries.

Aspects of governance such as corruption and absence of democracy can also result in socially sub-optimal environmental policy and regulation. Lopez and Mitra (2000), Damania et al. (2005) and Pelligrini and Gerlagh (2005) show that corruption has a negative effect on reducing environmental degradation. Moreover, Cole et al. (2006) found that foreign direct investments (FDI) were associated with less stringent environmental policy when corruption level is very high. Damania, Fredriksson and List (2003) analysed the joint effect of trade openness and corruption on the stringency of environmental policy. Their results showed that trade openness increased the stringency of environmental policy in countries with more corruption (low governance). Halkos and Tzeremes (2013) found a nonlinear relationship between countries' CO₂ emissions and governance measures such as voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law and control of corruption. Their findings showed that increasing the quality of governance factors does not always result in lower carbon dioxide emission levels.

In the context of transitional economies, an earlier study by Soderholm (2001) argued that environmental problems can also be due to institutional inertia in the economic and political system and are not necessarily only a result of market imperfections. For example, the stringency of environmental policies set under decentralised regimes also depends on political centralization, measured by the strength of national level political parties (Fredriksson and Wollscheid, 2014). Zugravu et al. (2008) demonstrated that increases in stringency of environmental policy led to a significant net reduction in CO₂ emissions among the Central and Eastern European countries between 1995 and 2003 even though their output growth increased industrial CO₂ emissions. The results confirmed the importance of institutional factors in reducing pollution in transition countries.

Another study by Tamazian and Rao (2010) investigated the linkage between economic development, financial development and institutional quality on environmental degradation in transition countries using GMM (Generalised Method of Moments) for 24 transition countries from 1993-2004. The results lend support to the EKC hypothesis while also confirming the importance of both institutional quality and financial development for reducing CO₂ emissions in the region. Financial liberalization may be harmful to the environment of transitional countries if a strong institutional framework does not accompany it. However, the existing studies do not study the effect of overall market-based economic reforms accounting the reform progress across all economic dimensions on environmental degradation. The use of GMM estimations for small sample size (in particular for unbalanced panels) is also contentious when alternative estimation techniques have proven to be superior in terms of reducing bias and root mean square errors (RMSE) in the econometrics literature (Bruno, 2005). The impacts on CO₂ emissions resulting from specific environmental policies, structural change in the economy and any autonomous technological progress still remains unknown. This presents a major gap in the literature, which this study aims to fill.

3. Methodology and Data

The relationship between market-oriented economic reforms and their environmental implications is complex, as the implementation of economic reforms cannot instantaneously lead to reductions in per capita CO₂ emissions. The estimates of the dependent variable can depend upon the past values of itself along with a set of independent and control variables (Bruno, 2005). This necessitates specifying a dynamic panel data model and this can be expressed as:

$$y_{it} = \rho y_{i,t-1} + x'_{it}\beta + \alpha_i + \epsilon_{it}; \quad |\rho| < 1; \quad i = 1, \dots, N \text{ and } t = 1, \dots, T \quad (1)$$

where y_{it} is the dependent variable, x_{it} is the $\{ (k - 1) * 1 \}$ vector of strictly exogenous explanatory variables, ρ is the coefficient of the lagged value of the dependent variable, α_i is an unobserved individual effect, $x'_{it}\beta$ represents the matrix of explanatory variables and coefficients and ϵ_{it} is an unobserved white-noise disturbance with constant variance. However, econometric literature establishes that a dynamic panel data model based on fixed-effects or the Least Squares Dummy Variables (LSDV) analysis with a lagged dependent variable generates biased estimates when 'T' is small as is the case here (Roodman, 2006). Kiviet (1995) that produced the lowest Root Mean Square Error (RMSE) for panels of all sizes (Bun and Kiviet, 2003) devised a bias-corrected LSDV estimator applicable only for a balanced panel.

These earlier works led to the development of a bias-corrected LSDV estimate (LSDVC) by Bruno (2005) for unbalanced panels as in our case. The approximation terms are all evaluated at the unobserved true parameter values implying no direct use for estimation. Hence, the true parameter values are replaced by estimates from some consistent estimator to make them work (Bruno, 2005). The estimates obtained from a dynamic LSDV are also not meaningful unless they are corrected for bias in small samples. The preferred estimator is then plugged into the bias approximations formulae while the resulting bias approximation estimates β_{i_hat} are deducted to derive the corrected LSDV estimator as in (2).

$$LSDVC_i = LSDV_i - \beta_{i_hat} \quad (2)$$

where $i=1$ in STATA by default indicates the accuracy of the bias approximation². In order to initialize the bias corrections, a consistent estimator needs to be chosen and could vary, for example, between the Arellano-Bond (AB) and the Blundell-Bond (BB) estimators (Bruno, 2005). The AB estimator is a GMM estimator for the first differenced model relying on a greater number of internal instruments (Arellano and Bond, 1991). The BB estimator assumes that the first differences of the instrumental variables are uncorrelated with fixed effects and augments the AB estimator by allowing for introducing more instruments and improve efficiency of the estimates (Blundell and Bond, 1998).

² The estimation includes one lag by default.

An alternative to LSDVC estimates would be to use other consistent Instrumental Variable (IV) and Generalized Methods of Moments (GMM) estimators (Roodman, 2006). However, the relative performance evaluation of LSDVC in comparison to LSDV, AB and BB estimators by Bruno (2005) for unbalanced panels with small 'N' concludes that LSDVC is superior to all other estimators in terms of root mean square errors (RMSE) and bias.

We thus use the LSDVC model to examine the impact of several market based economic reforms on per capita CO₂ emissions in transition countries unlike earlier studies such as Tamazian and Rao (2010) that uses GMM estimations. Earlier studies using the LSDVC technique include Nepal and Jamasb (2011), Nepal (2011) and Nepal and Jamasb (2013). We report the results for the estimators used to initialize the bias corrections (AB and BB). Equation 3 examines the reform impacts on emissions across the whole sample while equation 4 models the reforms impacts on missions across the specific country groups (SEE, CEB and CIS) of TECs.

$$LPCEMS_{it} = \rho LPCEMS_{it-1} + \beta_1 PVTI_{it} + \beta_2 OMLRI_{it} + \beta_3 GRI_{it} + \beta_4 CMPI_{it} + \beta_5 EUM + \beta_6 LSREN_{it} + \beta_7 ENVMP + \beta_8 LPGDP_{it} + \beta_9 LPECS_{it} + \beta_{10} LSMFT_{it} + \beta_{11} t + \text{year specific time dummies} + \epsilon_{it} \quad (3)$$

$$LPCEMS_{it} = \rho LPCEMS_{it-1} + \beta_1 PVTI_{it} + \beta_2 OMLRI_{it} + \beta_3 GRI_{it} + \beta_4 CMPI_{it} + \beta_5 LSREN_{it} + \beta_6 LPGDP_{it} + \beta_7 ENVMP + \beta_8 LPECS_{it} + \beta_9 LSMFT_{it} + \beta_{10} t + \epsilon_{it} \quad (4)$$

We use the revised and updated (in 2012) version of the 'Transition Indicators' developed by the European Bank for Reconstruction and Development (EBRD) as a measure of progress of market-based economic reforms across the TECs. The transition indicators remain the best publicly available measures for assessing the market-based reform progress in the transition countries among scholars and policymakers. The reform assessments are made in six areas which includes 1) large scale privatization, 2) small scale privatization, 3) governance and enterprise restructuring, 4) price liberalisation, 5) trade and foreign exchange system and 6) competition policy. The measurement scale for these indicators ranges from 1 to 4+, where 1 represents little or no change from a rigid centrally planned economy while 4+ represents the standards of an industrialized market economy. Progress is measured against the standards of industrialized market economies, while recognizing that there is neither a "pure" market economy nor a unique end-point for economic transition (EBRD, 2014). For example, a score of 4+ in competition policy reforms imply that there is unrestricted entry to most market and competition policy is effectively enforced representing the standards and performance typical of advanced industrial economies. Likewise, a score of 1 indicates no competition legislation and

institutions in place (see EBRD, 2014). Earlier studies by Nepal and Jamasb (2011); Nepal and Jamasb (2013), Nepal (2011) have also extensively used the 'Transition Indicators' in their analysis.

We construct the following economic reform indicators from the set of six indicators to summarize and reflect the different types of market driven economic reforms in the transition countries:

- *Privatisation Reform Index (PRI)*: composite index based on un-weighted average of small-scale privatisation and large scale privatisation reforms.
- *Governance Reform Index (GRI)*: comprising corporate governance and enterprise restructuring reforms.
- *Overall Market Liberalization Reform Index (OMLRI)*: composite index based on un-weighted average of reforms in price liberalization and trade and foreign exchange reforms.
- *Competition Policy Reform Index (CMPI)*: comprising competition policy reforms.

Per capita CO₂ emissions are used a measure of environmental degradation in this study³. We focus on CO₂ because CO₂ emissions (from fossil fuel use, deforestation, biomass decay, manufacturing and others) are the largest source of GHGs accounting for around 75 percent of the total emissions globally in 2010 (IPCC, 2014). Hence, the contribution of CO₂ emissions to global warming and inducing adverse climate change impacts is internationally recognised implying that reducing CO₂ emissions is an issue of global importance. The data on CO₂ emissions is also rich, consistent and publicly available as compared to other pollutants. We control for the effect of economic growth on carbon emissions by including per capita Gross Domestic Product (GDP) as an indicator of economic growth in the econometric model. The literature studying the relationships between emissions and growth supports this inclusion (Grossman and Krueger, 1991).

We also account for the effect of energy use by using per capita energy consumption as a control variable. This is important as energy use contributed around 35 percent of CO₂ emissions in 2010 (IPCC, 2014). The share of carbon-neutral generation technologies in the generation mix such as renewable energy (SREN) is important in reducing the reliance on emissions intensive generation technologies in the TECs. Furthermore, countries joining the European Union (EUM) have established a common framework for the use of energy from renewable sources aiming to obtain 20 percent of their energy from renewable sources by 2020. SREN is treated exogenously in our model since the choice of

³ Carbon dioxide emissions are the economy wide emissions levels as reported in the WDI.

technology is largely driven by the availability of resources (such as hydro) in this region. We explicitly control for the existence of an environmental policy (ENVMP) by considering the ratification/acceptance of the Kyoto Protocol by the TECs. This is binary variable and captures the different timings of acceptance/and ratification of the Kyoto Protocol by the ECA TECs. We account for the share of the manufacturing sector to the GDP (SMFT) since the manufacturing sector is the largest energy user in the region. A time trend is also included in the model to capture the effects of autonomous technical change, if any.

All comparisons are on per-capita basis as population growth is an important factor and the data are expressed in levels. Further, the per capita GDP is adjusted for purchasing power parities (PPP) to remove the price level differences levels across countries for comparison. Table 1 reports the list of variables used in this study.

Table 1: List and description of variables

Type	Variables	Description	Units	Source
Dependent Variables	PCEMS	Per Capita CO ₂ Emissions	Metric tons per capita	World Development Indicators (WDI)
Independent Variables	PVTI	Privatisation Reform Index	Scaled from 1 to 4+	EBRD
	GRI	Governance Reform Index	Scaled from 1 to 4+	EBRD
	OMLRI	Overall Market Liberalization Reform Index	Scaled from 1 to 4+	EBRD
	CMPI	Competition Policy Reform Index	Scaled from 1 to 4+	EBRD
	PGDP	Per Capita GDP	Constant 2011 international US dollars	WDI
	PECS	Per Capita Energy Consumption	Million Btu per capita	Energy Information Administration (EIA)
	SREN	Share of Renewable Energy Generation	Ratio	EIA
	ENVMP	Environmental Policy	Binary variable	UNFCC
	SMFT	Share of Manufacturing	Ratio	WDI

The period of analysis ranges from 1990-2012 (22 years) covering 28 countries (out of 34) in the EBRD areas of operation unlike previous study by Tamazian and Rao (2010), which covered only 11 years (1993-2004) and 24 economies. The year '1990' marks the dawn of economic transformation in most of the ECA transition countries. Some of the transition countries have already obtained a membership at the EU while some are in the process of being a EU member and have the potential for joining EU. Out of the included 28 countries in our sample, 15 are associated with the EU while 7 out of 9 EU members in the sample belong to the CEB region. Table A1 in Appendix lists the countries included in our analysis⁴. Thus, the data comprises an unbalanced panel including 28 cross-sections with short time series of 22 years that captures the key reform period from 1990-2012.

Table 2 shows the descriptive statistics for the dependent and independent variables. In general, the results indicate that many transition countries have not fully reached the economic reform standards of industrialised economies in all sectors. Thus, market-based economic transformation is an on-going and even stalled process in many transitional countries (Nepal, Jamasb and Tisdell, 2014). We can infer that liberalizing the economy as a whole (involving opening up trade, liberalising foreign exchange and price liberalization) has been on high agenda of reforms across the transitional countries though the extent of progress varies considerably across them. There is significant scope for advancing competition policy and governance reforms in these countries as the average reform scores are far below the 4+ levels observed in industrialized market economies. The average share of renewable energy installed capacity in the total energy mix is only around 30 percent across the TECs.

Table 2: Descriptive statistics

Variable	Mean	Standard Deviation	Minimum	Maximum	No. of Observations
PCEMS	5.46	3.37	0.293	15.895	573
PGDP	10294.5	6647.5	1040.23	31057.57	610
SREN	0.294	0.284	0	0.913	590
SMFT	19.51	8.632	4.2	73.7	642
PECS	3089.017	1456.7	398.25	7137.83	629
PVTI	2.96	0.96	1	4.17	644
GRI	2.05	0.77	1	3.7	644
OMLRI	3.49	0.994	1	4.33	644
CMPI	1.99	0.74	1	3.7	644

⁴ We exclude Turkey, Egypt, Kosovo, Jordan, Tunisia and Morocco from our analysis due to lack of the data although they fall within EBRD areas of operation.

The average annual amount of economy-wide CO₂ emissions per capita is around five and half tonnes. There are also large disparities both in changes in emissions between 1990 and 2008 such as a reduction of 56 percent in Eastern Europe and the Caucasus to an increase in emissions by 108 percent in Turkmenistan (EBRD, 2011). The region still includes some of the weakest performers in the world in terms of carbon intensity (e.g. Uzbekistan, Kazakhstan and Russia), along with countries such as Latvia and Hungary, which are close to the global leaders in carbon performance. Figure 1 shows the evolution of per capita CO₂ emissions across specific groups of TECs. All these groups experienced a significant decline in emissions during the early phase of economic transition. The early phase of economic transition was marked by a decline in real GDP and economic activities in the region. The per capita emissions experienced a decade of decline (especially among the SEE countries) but began to gradually rise after 2000 and continued to do so until the global economic recession triggered by the global financial crisis during 2008-2009, though needs to be econometrically tested. While the level of regional greenhouse gas emissions began rising again after 2000, the rate of its increase has been much lower than economic growth (EBRD, 2011). Since 2010, per capita emissions have been rising across the CEB and CIS countries. However, the average per capita emissions have fallen in the SEE region as a result of the impact of Eurozone crisis of 2011-2013 on these economies.

Fig 1: Per capita CO₂ Emissions in the ECA TECs

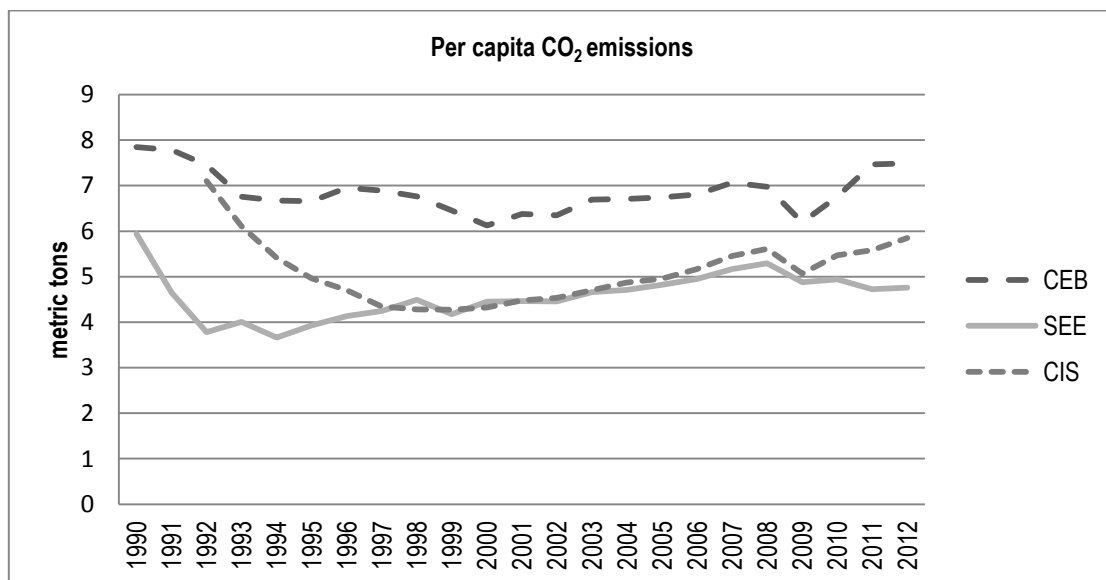
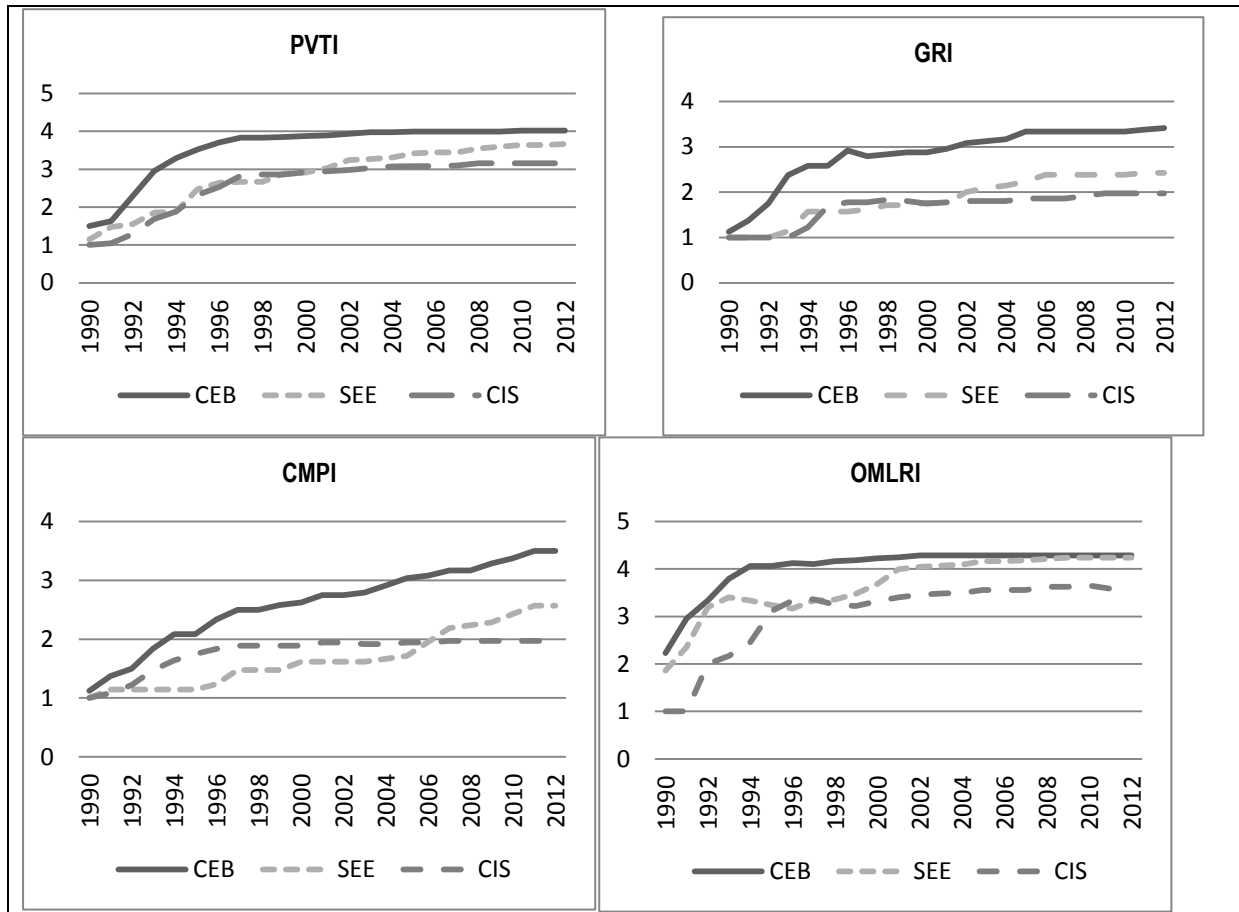


Figure 2 shows the evolution of different market-based economic reforms in the region. Privatization and overall market liberalization reforms seem to have stagnated and stalled in all country groups. Countries belonging to the CIS region have not achieved the reform levels experienced by the CEB and SEE countries. Thus, there is a significant scope for advancing reforms in order to reach the standards

of the industrialized market economies across all economic reform measures for the CIS countries. Governance and competition policy reforms indicate an upward trend among the TECs as these reforms have advanced slowly historically in the region. In all cases, the scope for additional market reform has tapered off, even though further scope remains

Fig 2: Progress of economic reforms across different country groups of TECs



4. Results and Discussions

This section reports the results obtained using the LSDVC methodology in examining the impacts of several market-oriented economic reforms on environmental degradation where we consider per capita CO₂ emissions as its measure. The regression analysis is based on the new LSDVC technique involving a third order bias corrections and is initialised by the AB and BB estimators. The standard

errors are bootstrapped and obtained from 1000 iterations⁵ as in earlier studies such as Nepal and Jamasb (2013). The AB tests of autocorrelation and BB test of over identifying restrictions was also performed for the econometric estimations as test diagnostics ⁶.

Table 3 shows the results of the regression analysis based on Equation 3 for the whole sample. The carbon emissions, being a cumulative air pollutant, imply that previous level of per capita emissions significantly affect the current per capita emissions. Reforms in governance and enterprise restructuring contributed to a decline in the emissions levels. However, we find that overall market liberalisation in the form of (price liberalisation, trade openness and foreign exchange liberalisation) had the opposite effect in reducing per capita emissions levels in these countries. This is possible since trade openness induces specialization on more energy intensive industries (Zhang, 2013). Reforms in competition policy, on the other hand, significantly reduced the per capita emissions levels. EU members have a common framework for the use of energy from renewable sources and have operationalised market based arrangements such as emissions trading scheme and tradable green certificates. There is a significant difference in the per capita carbon emissions levels among the EU and the non-EU members. However, the share of the existing renewable energy capacity in the generation mix is insignificant in driving the per capita emissions in the whole sample which suggests greater needs to invest more in renewable energy by the non-EU members.

The Kyoto Protocol had also no effect on reducing the per capita CO₂ emissions of non-EU member countries since their accepting and ratifying the Protocol. The impact of energy consumption on per capita emissions is also significant. Structural change involving an expanding manufacturing sector decreased per capita emissions. This is expected since there was a significant shift from 'heavy' (highly capital and energy intensive) to 'light' (low capital and energy intensive) manufacturing industries in the transition economies (Hare and Turley, 2013). Likewise, the global financial recession of 2008-2009 also led to declining per capita emissions⁷.

⁵Bootstrap is an established method for measuring the accuracy of the sample estimates and generates an estimate of the sampling distribution of almost any statistic using simple methods.

⁶The results can be provided upon request as we do not report them in the paper. We also performed an OLS and FE (i.e. LSDV) estimations and compared the results to determine the nature of bias of the estimates. In all cases, we observed bias as OLS and FE does not take endogeneity into account.

⁷ We also tested for the long run impacts of increasing per capita GDP (PGDP squared) considering that the literature has often identified a non-linear approach between carbon emissions and economic growth (i.e. the Kuznets curve). Our results showed a significant positive relationship though the results are not reported but can be provided if requested.

Table 3: LSDVC regressions results for the whole sample

LSDVC Dynamic Regression (Bootstrapped SE)	Arellano-Bond (AB)	Blundell-Bond (BB)
LPCEMS. L1	0.754*** (0.028)	0.643*** (0.028)
GRI	-0.140* (0.012)	-0.121* (0.10)
OMLRI	0.011* (0.008)	0.153* (0.084)
CMPI	-0.236*** (0.009)	-0.197*** (0.011)
PVTI	0.089 (0.084)	0.115 (0.096)
LPGDP	0.159*** (0.042)	0.147*** (0.053)
LPECS	0.007*** (0.037)	0.004*** (0.049)
EUM	-0.403*** (0.113)	-0.439*** (0.115)
LSREN	0.602 (0.010)	0.732 (0.014)
ENVMP	-0.080 (0.066)	-0.126 (0.074)
LSMFT	-0.051* (0.026)	-0.102** (0.032)
t	-0.005 (0.001)	-0.006 (0.002)
year 2009	-0.064*** (0.014)	-0.062*** (0.017)

*, **, *** denote significance at 10, 5 and 1% respectively. Numbers in () reports the bootstrapped SE

However, any generalisations of the above results need to be with caution due to the variability in country-specific characteristics. The impact of market-based reforms on environmental quality is likely to depend on the initial conditions while cross-country results are likely to hide significant heterogeneity which may lead to the wrong policy discussions and conclusions. Hence, table 4 shows the impacts of market-based reforms and other underlying factors on the per capita CO₂ emissions for specific groups of the TECs estimated using equation 4. No significant link is observed between economic growth and environmental degradation among the SEE and CEB countries apart from the positive link in the CIS countries. Per capita energy consumption is also driving the emissions level in the CIS and CEB countries. Advances in competition policy reforms significantly reduced per capita emissions among the CEB and SEE countries while economic openness through overall market liberalisation increased per capita emissions in the SEE countries. Governance reforms also reduced emissions levels in the CEB and SEE countries. The share of installed renewable energy capacity in the generation mix only

reduced per capita emissions in the CEB countries. Countries belonging to the CEB responded (it seems) to the Kyoto Protocol because their per capita CO₂ emissions fell after they ratified it.

Table 4: LSDVC regressions results for the specific groups

Country Groups	CIS		CEB		SEE	
	Arellano-Bond (AB)	Blundell-Bond (BB)	Arellano-Bond (AB)	Blundell-Bond (BB)	Arellano-Bond (AB)	Blundell-Bond (BB)
LPCEMS. L1	0.658*** (0.038)	0.690*** (0.038)	0.357*** (0.073)	0.454*** (0.075)	0.669*** (0.062)	0.688*** (0.064)
GRI	-0.016 (0.169)	-0.007 (0.196)	-0.019* (0.181)	-0.211 (0.239)	-0.277 (0.254)	-0.271* (0.283)
OMLRI	-0.008 (0.110)	-0.004 (0.127)	-0.397 (0.341)	-0.358 (0.442)	0.317** (0.133)	0.292** (0.151)
CMPI	-0.034 (0.140)	-0.034 (0.164)	-0.050** (0.021)	0.001 (0.199)	-0.43** (0.174)	-0.43** (0.201)
PVTI	0.169 (0.143)	0.197 (0.167)	-0.077 (0.131)	-0.007 (0.176)	0.145 (0.169)	0.153 (0.193)
LPGDP	0.079*** (0.016)	0.074*** (0.015)	-0.043 (0.021)	-0.052 (0.022)	0.057 (0.026)	0.068 (0.031)
LPECS	0.043*** (0.013)	0.045*** (0.015)	0.098*** (0.018)	0.086*** (0.023)	0.035 (0.002)	0.042 (0.002)
LSREN	-0.588 (2.413)	0.783 (2.893)	-2.16* (0.036)	-1.41 (0.035)	-0.712 (0.091)	-0.365 (0.061)
ENVMP	-0.0495 (0.0922)	-0.641 (0.109)	-2.566* (0.133)	-0.273 (0.181)	-0.042 (0.197)	-0.0627 (0.225)
LSMFT	-0.041* (0.003)	-0.082** (0.023)	-0.423*** (0.121)	-0.507** (0.205)	-0.095** (0.089)	-0.055** (0.128)
t	0.001 (0.368)	0.002 (0.001)	-0.002 (0.002)	-0.271 (0.024)	-0.017 (0.008)	-0.165 (0.012)

*, **, *** denote significance at 10, 5 and 1% respectively. Numbers in () reports the bootstrapped SE

Overall, the above results suggest a weak positive relationship between economic growth and per capita CO₂ emissions (environment-growth nexus) in the TECs beyond basic industrialisation as suggested in earlier findings by Tisdell (2001)⁸ and Grubb, Muller and Butler (2011). Majority of the TECs that implemented reforms experienced resurgent economic growth without growth in per capita emissions levels. The decline in per capita emissions associated with the initial transition process has not symmetrically reversed over-time. The energy-environment nexus seems to be valid only for the CIS and CEB countries. Most of the countries in the CEB region are also governed by the European Directive (2009/28/EC) of the European Commission that established a common framework for the promotion and production of energy from renewable sources. Adhering to the Kyoto Protocol has not

⁸ The EKC may also have shifted to the left so it reaches a maximum at a lower level of GDP per capita.

delivered the anticipated benefits given its insignificant impact in reducing per capita emissions in the TECs. Elsewhere, pollution intensive countries like the US also did not ratify the Protocol stating that the Protocol did not include the “meaningful” participation of all developing as well as industrialized countries. Canada also dropped out of the Protocol in 2011. While the Kyoto Protocol is now expired, the need for stronger international climate change agreements involving the ECA TECs is desirable in the future in mitigating the adverse impacts of global climate change.

Our results indicate the advances in competition policy reforms seem to be the biggest driver of per capita emissions reductions in the ECA TECs⁹. Creating robust competition legislation and institutions can drive the future reductions in per capita emissions while these is also a significant scope for advancing competition on policy reforms across all country groups in the TECs. Advancing competition policy reforms are also important as some market-based policy measures require substantial institutional capacity for effective implementation (EBRD, 2008). For example, tradable green certificates are an attractive market-friendly instrument, but they also require substantial institutional capacity and long development periods to deliver the anticipated environmental benefits. Good governance is an element of institutional capacity required to sustain the market-based reforms. Strengthening reforms in corporate governance and enterprise restructuring in the economy through sound accounting principles, corruption control and enterprise level transparency will also help achieve reductions in per capita emission in the TECs.

Our findings demonstrate that trade openness (coupled with price and foreign exchange liberalisation) increased per capita emissions levels. In this case, this is at odds with the view that trade contributes to sustainable development significantly as it facilitates better transfer of clean technology and knowledge skills that are required to improve the industrialisation process (Hansen, 1990). However, economic openness may not necessarily result in sustainable development if only the 'weak conditions' are satisfied which entails accumulating man-made capital so as to substitute natural capital without adversely affecting economic production. 'Strong conditions' probably need to be satisfied to achieve significant sustainable development from economic openness as environmental stocks have an essential and irreplaceable economic role to play (Tisdell, 2001).

In many transitional economies, completed market reforms were sufficient to reduce CO₂ emissions per capita but as these reforms became more pronounced, their marginal impact declined. Therefore, with the passage of time, further reductions in CO₂ per capital have become more dependent on policies

⁹ It probably did not happen in China's case but that has yet to be fully explored. In China's case, the reforms might have had a positive effect but economic growth and other factors might have had a negative effect on CO₂ emissions outweighing the pollution-reducing effects of the market reforms.

specifically targeted at reducing CO₂ emissions, such as the use of tradable permits, taxes on emissions, subsidies for abatement technologies. In short, the marginal effect of pure market reforms on CO₂ emissions is probably declining and further significant reductions may require increased targeting.

While some reduction in CO₂ emissions per capita in European and Central Asian Transitional Economies may have been associated with the assent of these countries to the Kyoto Protocol, we suggest that this was not the main reason for this trend. Market reforms, which resulted in prices being more, aligned than previously with marginal costs (inclusive of energy costs). The switch from heavier to lighter industry and to tertiary industry, occurring independently of Kyoto also decreased the emissions level. A change in the energy mix, particularly greater use of natural gas due to its greater availability and reduced cost relative to coal also explains a decline in the emissions level. All of these factors combined contributed a reduction in per capita CO₂ emissions it seems to greater extent than policies associated with the Kyoto Protocol.

The insignificance of economic reforms on per capita emissions also portray that reform implementation may not always be translated into reform performance or outcome unless implemented properly. This implies that the effect of economic reforms on environmental performance is non-linear and complex. In many transitional countries, reforms may have only advanced in paper but not in practice. Hence, only effective implementation of reform measures can achieve the desired outcomes of reforms. Nonetheless, our model may not capture all the qualitative dimensions and steps involved in the reform process considering that not all aspects of reform outcomes are readily quantifiable in physical and monetary units. The model also does not capture the effect of the lagged reform variables on environmental degradation, as their effects can be distributed over-time. The relevant distributed lag can be different for different economic reform variables.

5. Conclusions

This paper examined the impacts of market-based economic reforms on environmental performance in the TECs since the inception of the fifth EAP in 1993. One of the core beliefs of the EAP that economic reforms and restructuring would eliminate the perverse incentives which contributed to vast environmental degradation in these command-based economies. We used a dynamic panel data model based on the LSDVC technique to gauge the impacts of the reforms on per capita CO₂ emissions, as a

measure of environmental performance, across the TECs. We also consider other underlying factors such as energy consumption, economic growth, environmental policy and the scale of renewable energy in the generation mix that can potentially explain the per capita CO₂ emissions patterns in the transition region.

The results from the LSDVC analysis suggest that the objectives of the fifth EAP have been partially met after more than two decades of market-based economic reforms in the transitional countries. Reforms in competition policy (which at a minimum included setting up of competition policy legislation and institutions and some reduction of entry restrictions or enforcement action on dominant firms) and improved governance seem to have contributed to significant decline in per capita emissions levels in these countries. Hence, there exists scope to advance these reforms and achieve further reductions in per capita CO₂ emissions levels. This is because the transitional countries remain considerably more carbon intensive on average than either advanced economies or emerging market economies, like China. Moreover, the carbon performance of the leading countries in the region (e.g. Hungary, Latvia and Lithuania) demonstrates that a strong carbon reduction performance is possible with adequate reforms and policies.

The Kyoto Protocol produced no direct effect in reducing emissions levels in the TECs although other market-based arrangements such as emissions trading schemes and tradable green certificates seem to have reduced CO₂ emissions. This result implies that the intended effect of the recent COP 21 further remains doubtful in the absence of country-specific emissions reduction targets and goals although it's too early to reach a conclusion. The increasing amount of steaming coal use and other carbon-based fuels is also a concern. As such, further investments in renewable generation capacities especially among the non-EU members may be an option to produce any significant carbon reduction impacts. Likewise, reducing energy consumption by promoting energy efficiency is desirable to curb energy consumption and the related per capita emissions arising from energy usage. These measures are necessary as the carbon performance of the EBRD region as a whole remains mixed indicating that the polluting legacy of central planning is still pervasive.

Hence, the main conclusions of this study is that at least for several years after the start of economic reforms, the reforms were the main contributors to reduction in CO₂ emissions per capita in the ECA TECs. The Kyoto Protocol did not come into effect until 2005. For most of the period considered, Kyoto Protocol was not a factor influencing the CO₂ emissions. It seems likely that it was not specific policies to reduce CO₂ emissions but rather increased economic efficiencies resulting from the reforms that were the main factor in reducing CO₂ emissions per capita in ECA TECs. In fact, after Kyoto came into

operation we observe no major decline in CO₂ emissions per head. There was, however, a slight decline in the emissions by SEE probably due to the European recession.

Future research may focus on the interaction of the market-based reforms and their effect on per capita CO₂ emissions. Adequate attention also needs to be paid to the importance of time lags in the adjustment of economic systems to various market-based reforms. Alternative measures of environmental degradation also needs be considered in the future analysis depending on the availability of data. Also, the direct econometric impact of COP21 on per capita emissions levels can be examined with the passage of time.

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Appendix

Central Eastern Europe and Baltic States (CEB)	South Eastern Europe (SEE)	Commonwealth of Independent States (CIS)	Others
Croatia**, Estonia*, Hungary*, Latvia*, Lithuania, Poland*, Slovak Republic* and Slovenia*	Albania***, Bosnia and Herzegovina***, Bulgaria*, FYR Macedonia**, Serbia, Romania* and Montenegro***	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan	Mongolia
*EU member countries, ** EU candidates and *** Potential EU candidates			

Table A1: Countries included in the study