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Sustainable Pathways: CO_2 Emissions, FDI, Trade, and Energy in Post-Communist Economies

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ABSTRACT

This study explores the intricate interplay among CO_2 emissions, economic development, foreign direct investment (FDI) inflows, trade, and energy consumption in post-communist republics spanning from 1995 to 2017. Utilizing a panel cointegration test, we unveil a profound and enduring relationship among these variables. Long-term elasticities are meticulously examined through Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) regressions, both of which consistently reveal a positive association between GDP per capita, FDI inflows, trade, energy consumption, and CO_2 emissions per capita over the long term. Moreover, employing a panel causality test, our analysis identifies a robust unidirectional causality, specifically from CO_2 emissions to energy consumption, signifying a pivotal link in the chain of influence ($P < 0.01$). These findings shed light on the nuanced dynamics of CO_2 emissions and their intricate connections with economic growth, foreign investments, trade, and energy usage in the post-communist context.

Keywords: Economic Growth, Energy, CO_2, FDI, Trade
JEL Classifications: F18, O13

1. INTRODUCTION

Ambient air pollution is responsible for nearly 4.2 million lives lost every year. Moreover, at least 90% of global population inhale polluted air (WHO, 2016). Therefore, the causes and correlates of CO_2 emissions across developing and developed countries have been intensively investigated in the empirical literature (Udara Willhelm Abeydeera et al., 2019). Ample cross-national studies show that energy consumption and economic growth are among drivers of carbon emission across countries (Chen et al., 2012; Menegaki, 2014). On the other hand, a separate strand of empirical literature shows that drivers of air pollution and energy use such as FDI, tourism, trade, financial development, among others, may also have both direct and indirect effect on carbon emissions (Gökmenoğlu and Taspinar, 2016; Jebli et al., 2019; Mirziyoyeva and Salahodjaev, 2023).

In this vein, FDI is a crucial ingredient of economic growth in transition countries as they undergo reforms which require influx of substantial capital to generate employment and promote structural transformation. For example, Popescu (2014 p. 8153) argues "transition countries … are well positioned to gain from the technology and knowledge shift related to FDI. Attracting FDI is an important matter in the policy program in transition countries". Apart from that FDI increase entrepreneurship rates, promote exports and improve human capital which in turn enhances economic growth (Zhang, 2001).

On the other hand, FDI may also influence environmental degradation through two conflicting channels: the pollution haven hypothesis and the halo effect hypothesis. The pollution haven hypothesis suggests that relocation of "dirty" industries from high income countries to less economically developed countries leads to the rise in CO_2 emissions in host countries. FDI increases energy consumption and financial development which as suggested above are among drivers of air pollution. In addition, less stringent environmental standards in developing countries attracts foreign companies driven by the goal of production cost minimization, again, increasing carbon emissions.

In contrast, the pollution halo hypothesis implies that there is negative link between FDI and environmental degradation (Balsalobre-Lorente et al., 2019). These studies suggest that FDI bring innovations, energy efficient and environmentally friendly technologies that permit nations to decrease carbon emissions. Similar arguments are put forward by research investigating the role that trade expansion and policies play in explaining carbon emissions. For example, trade openness may reduce market failures, improve the strategy of resource distribution by the economic system and speed up the adoption of international environmental standards (Shahbaz et al., 2017). In contrast, opponents of trade openness refer to neoclassical model which postulates that international economic division would result to increase in air pollution with the expansion of trade in less developed nations (Copeland and Tylor, 1995).

In light of significance of the relationship between economic growth, energy consumption, FDI and carbon emissions, the aim of this research is to explore the long-run relationship between these two variables in a sample of Post-Communist countries which report per capita energy use and carbon emissions well above global averages. For example, climate change performance index for 2021 ranks Russia 52nd of 61 nations. These features of Post-Communist states make them interesting object of research to explore the interrelationship between economic growth, energy consumption, FDI and carbon emissions. The rest of the study is developed as follows. Section 2 provides a brief overview of related literature. Section 3 presents data and empirical methodology, while Section 4 offers main results. Finally, Section 5 concludes the study.

2. LITERATURE REVIEW

2.1. Economic Growth, Energy and CO_2 Emissions

Ang (2007) uses French data between 1960 and 2000 to explore dynamic causal relationship between carbon dioxide emissions, energy consumption and economic development applying cointegration approach and vector error-correction model. Their findings suggest that economic development enhances both energy consumption and pollution in the long-term. Similar results are obtained by Zhang and Cheng (2009), who find unidirectional causality running from economic development to energy consumption and from energy consumption to CO_2 emissions in China between 1960 and 2007. Acaravci and Ozturk (2010) employ autoregressive distributed lag (ARDL) bounds testing approach to study the relationship in 19 European countries. Their findings suggest long-term cointegrating relationship between CO_2 emissions, energy consumption and GDP per capita seven economies in their sample. Positive long-term elasticities observed between emissions and energy consumption and GDP per capita. Granger causality models reveal short-term bidirectional causality running from GDP per capita to energy consumption for some countries. For Denmark and Italy causal relationship between GDP per capita and carbon emissions is observed.

Using data on Russia during 1990-2007, Pao et al. (2011) conclude that emissions are elastic with respect to energy use and inelastic with respect to economic development. Causality analysis indicate significant bidirectional causal relationship between the variables. Variable readjust to the long-term equilibrium in the case of external shocks. Al-Mulali and Normee Che Sab (2013) explore the link between the variables in 16 emerging countries including Brazil, Chile, China, Egypt, India, Indonesia, Jordan, Malaysia, Mauritius, Mexico, Morocco, Pakistan, Peru, Philippines, South Africa, and Thailand during 1980-2008. Pedroni panel cointegration reveal long-term relationship between energy consumption, carbon emissions and economic development. Based on Granger-causality test results, energy consumption enhances both economic development and carbon emissions. Bastola and Sapkota (2015) investigate relationship between economic growth, energy and CO_2 emissions in Nepal. Johansen cointegration and ARDL bounds testing reveal two cointegrating vectors in models where energy consumption and carbon emissions are dependent variables. Granger causality test reveal causal bidirectional relationship between energy and carbon emissions and unidirectional causality running from economic growth to carbon emissions and energy consumption. Sadikov et al. (2020) employ data on post-communist states between 1990-2018 to study the long-term relationship between the variables. Empirical estimates are based on Pedroni's panel cointegration technique and Peseran's Pooled Mean Group estimator (PMG), which confirm cointegrating short- and long-term relationship between CO_2 emissions, economic growth and use of energy.

2.2. FDI, Trade and CO_2 Emissions

Recent years there is a growing interest towards contribution of FDI and international trade to environmental pollution. Blanco et al. (2013) employs data on 18 Latin American countries between 1980 and 2007 to explore the relationship between sector-specific FDI and carbon emissions. Foreign capital inflows in pollution-intensive sector cause CO_2 emissions. Hao and Liu (2015) investigate the relationship in China-the biggest CO_2 emitter. In general, FDI negatively impacts carbon emissions through GDP per capita. Trade, however, has no effect on carbon emissions. Haug and Ucal (2019) apply nonlinear asymmetric ARDL model to explore the effect of FDI and trade on carbon emissions in Turkey. Authors employ three different measures of CO_2 emissions which are CO_2 emissions per capita, CO_2 intensity and $CO_{2\ sec}$toral emissions. They derive several interesting conclusions regarding FDI, exports and imports. When using emissions per capita as dependent variable, FDI is insignificant. In the long run, in the short-term exports reduces CO_2 emissions, yet in the long term its impact is insignificant. Similarly, imports are insignificant in the long-term, while in the short-term it enhances CO_2 emissions. In contrast, when modelling CO_2 intensity neither FDI nor imports and exports. Furthermore, relationship between CO_2 emissions and international trade is asymmetric for two sectors. Hakimi and Hamdi (2016) study the effects of trade liberalization and FDI inflows on environmental degradation in Marocco and Tunisia using various econometric approaches. Their findings suggest that FDI inflows are usually invested in pollution-intensive sectors, thereby degrading environments. As of trade liberalization, it increases CO_2 emissions as well.

Essandoh et al. (2020) investigate the relationship using a sample of 52 developed and developing economies between 1991 and 2014. Pooled mean group autoregressive distributive lag (PMG-ARDL) regression identify negative long-term relationship between trade and CO_2 emissions in developed economies, yet the opposite is true for developing countries. Developed economies takes the advantage of developing by transferring "dirty" manufacturing industries in developing countries which will lead to environmental improvement in the former and degradation in the latter. He et al. (2020) examine emissions-trade-FDI relationship in BRICS countries employing Bootstrap Autoregressive Distributed Lagged Model (ARDL) method. Their findings reveal cointegrating relationship between the variables in some countries. There is no causal relationship between FDI and CO_2, yet there is causal relationship between CO_2 and trade. Moreover, trade and FDI also exhibit positive causal relationship. Among recent studies, Saqib et al. (2023) explore the relationship between FDI, trade, economic growth and CO_2 emissions on a sample of 16 EU member states over the period 1990-2020. The authors aim to test the existence of pollution haven or pollution halo hypothesis with the aid of Dimitescu and Hurlin causality test. The results suggest that pollution halo hypothesis is valid and FDI has inverse link with ecological footprint. Moreover, the authors show that there is inverted U-shaped relationship between GDP and environmental degradation, confirming the EKC hypothesis. Ali et al. (2023) examine the relationship between agriculture, economic growth and CO_2 emissions on a panel of African countries, using generalized method of moments for the years 1997-2020. The results suggest that economic growth leads to an increase in CO_2 emissions, while agriculture value added and labor productivity tend to mitigate air pollution. Moreover, capital and FDI are also positively related to CO_2 emissions. The authors suggest a number of policy implications based on the findings. Salahodjaev et al. (2023) examine the role that industrialization plays in CO_2 emissions among OIC member states. Using two-step system GMM estimator for the years 1995-2020, the results suggest industrialization increases CO_2 emissions, while renewable energy consumption and financial development reduces environmental degradation. Moreover, ICT and economic growth lead to an increase in CO_2 emissions. Mentel et al. (2022) explore the relationship between industrialization and CO_2 emissions in Europe and Central Asia over the period 2000-2018. The study attempts to test the role that renewable energy consumption may play in industrialization-emissions nexus. Using two-step system GMM estimator, the study reports that industrialization increases CO_2 emissions, while renewable energy offsets the negative impact of industry value added on air pollution. The results are robust to a series of tests.

3. DATA AND METHODS

3.1. Data and Sample

Current study explores long-term determinants of carbon dioxide emissions as well as their causal interlinkages, employing a sample of secondary data on 24 post-communist economies between 1995 and 2017. To satisfy the criteria of some empirical tests, we work with strongly balanced panel sample including Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Turkmenistan and Ukraine. Total number of observations is 480. Table 1 provides summary statistics.

3.1.1. CO_2 emissions

Average CO_2 emissions in our sample is 6.6 metric tons per capita. Between 1995 and 2017 average CO_2 emissions demonstrate increasing trend, yet fluctuating significantly (Figure 1). A dramatic decline in emissions between 1995 and 1999 is due to significant economic slowdown and economic restructuring as a result of dissolution of Soviet Union. That period is followed by the up rise in carbon emissions, accompanied by gradual economic recovery. Second most dramatic decline is observed in 2008-2009 during the Global financial crisis and oil price fall. Thereafter, carbon dioxide emissions are never higher than its past peak in 2007, which is 7.1 metric tons per capita. In 2018 largest CO_2 emissions observed in Kazakhstan, Estonia and Turkmenistan (Figure 2). Relatively high pollution levels in Kazakhstan, Turkmenistan and Russian Federation is due to significant dependence on fossil fuels and comparatively low environmental concern. On the other hand, Estonia also demonstrate relatively large amounts of carbon dioxide emissions comparing to the rest EU-members. Countries with lowest emissions shares in our sample are pre-industrialized economies-Armenia, Kyrgyz Republic and Moldova.

3.1.2. Independent variables

Following previous studies (Karakaya and Özçağ, 2005; Li et al., 2020), we describe CO_2 emissions by GDP per capita, foreign direct investment, trade and energy use. Average GDP per capita is about 9 thousand USD per person. Mean foreign capital inflows is 5% of GDP, which is greater than global average. Post-communist states are quite opened in terms of trade: average GDP share of exports and imports of goods and services is 102%. Average energy use is 184 kg of oil equivalent per $1000 GDP.

3.2. Methodology

3.2.1. Model

Following Li et al. (2020) and Sadikov et al. (2020), CO_2 emissions can be described as follows:

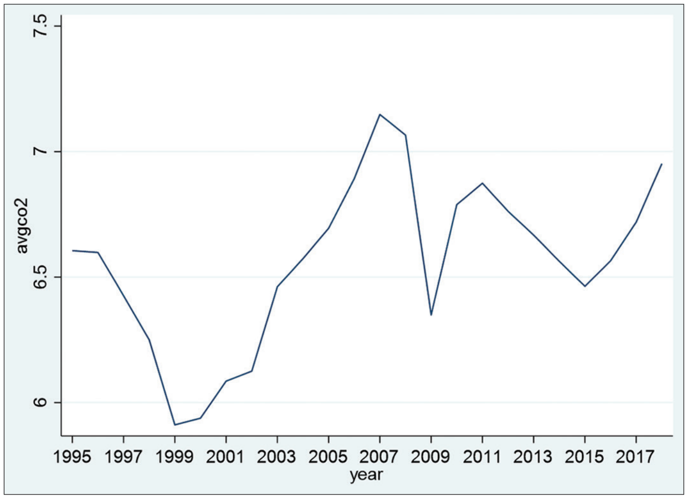
$$CO_{2i,t} = f(Y_{i,t}, FDI_{i,t}, T_{i,t}, EN_{i,t}) \quad (1)$$

where CO_2 is carbon dioxide emissions per capita, Y is GDP per capita, *FDI* - foreign direct investment as a share of GDP, *T*-trade as a share of GDP, *EN*-energy use. *i* and *t* represent individual and temporal dimensions.

Table 1: Summary statistics

Variable	Indicator	Source	Mean	SD	Min	Max
CO_2	CO_2 emissions per capita (metric tons)	Global carbon atlas	6.6	3.7	0.8	17.6
Y	GDP per capita (constant 2010 US$)	WDI	8870.5	6071.5	521.7	26190.5
FDI	Foreign direct investment, net inflows (% of GDP)	WDI	5.3	7.1	-41.5	55.1
T	Trade (% of GDP)	WDI	102.0	32.6	35.2	190.4
EN	Energy use (kg of oil equivalent) per $1,000 GDP (constant 2017 PPP)	WDI	184.4	126.2	69.4	816.0

Figure 1: Trend in CO_2 emissions between 1995 and 2017



All variables are expressed in different measurement units. It is therefore suggested to transform Eq.1 into logarithmic form as it decreases data sharpness and improves distributional properties of the data (Paramati et al., 2017; Zafar et al., 2020). Thus, we transform Eq.1 as follows:

$$\ln CO_{2i,t} = \beta_0 + \beta_1 \ln Y_{i,t} + \beta_2 \ln FDI_{i,t} + \beta_3 \ln T_{i,t} + \beta_4 \ln EN_{i,t} \quad (2)$$

where all abovementioned variables expressed in natural logarithms; *i* and *t* represent individual and temporal dimensions.

3.2.2. Panel unit-root test

We first investigate the order of integration employing five panel unit root tests - LLC test by (Levin et al., 2002), Breitung's test by (Breitung, 2002), IPS test by (Im et al., 2003) and two Fisher-type tests by Maddala and Wu (1999). If all variables are stationary at level form, we proceed our analyses with Ordinary Least Squares (OLS) otherwise we adopt cointegration approach. As Pedroni (1999) states, stationarity testing is imperative for cointegration approach since cointegrating relationship arises is a set of variables, individually integrated of order one and stationary.

3.2.3. Pedroni's cointegration

Once stationarity is approved, we employ Pedroni's (Pedroni, 1999) panel cointegration test. Using seven parametric and non-parametric test statistics, Pedroni's approach tests the null hypothesis of no cointegration, in a one-tailed test and follows normal distribution. Test statistics represent either group-mean average or panel estimates (Neal, 2014). Cointegrating relationship is confirmed if majority of test statistics reject the null. Long-term elasticities are reported using time series cointegrated regression estimators (DOLS and FMOLS).

3.2.4. Dumitrescu and hurlin's causality test

To investigate causal relationship, we employ panel non-causality test for heterogeneous panels developed by Dumitrescu and Hurlin, (2012), which is modeled as follows:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_{ik} y_{i,t-k} + \sum_{k=1}^{K} \beta_{ik} x_{i,t-k} + \varepsilon_{i,t} \quad (3)$$

where $x_{i,t}$ and $y_{i,t}$ are observations of two stationary variables in a strongly balanced panel dataset for individual i in period.

By running individual regressions, DH test obtains individual Wald statistics, which is averaged across panels. The test reports underlying z-bar and z-tilde statistics to reject or accept the null hypothesis of non-causal relationship. As Lopez and Weber (2017) suggest, z-bar tilde is preferable for samples with relatively small number of observations (N) and time periods (T).

4. RESULTS

The following section provide results of empirical testing and results discussion. We first report results of panel unit root tests in Table 2. Most of the variables included in our model are non-stationary at the level form. We therefore take first differences of the variables. At 1% significance level our variables are stationary at I (1). These results indicate that OLS results will be biased and the use of more sophisticated techniques is required.

Once we confirmed integration order, we obtain Pedroni's cointegration test results (Table 3). Six out of seven test statistics support the alternative hypothesis at $P < 0.01$, thereby confirming cointegrating relationship between the variables. Additionally, Kao (Kao, 1999) panel cointegration test is performed to verify results and it also supports cointegration between variables.

Since cointegrating relationship is confirmed, we re-estimate Eq. 2 to obtain coefficients of regression. All variables are represented in natural logs, so the coefficients are long-term elasticities.

Previous research provides plenty of econometric techniques to obtain long-term coefficients of cointegrating variables in time-series and panel data. Fully Modified Ordinary Least Squares (FMOLS) is typically applied when all variables exhibit cointegrating relationship (Pedroni, 2001). It provides more robust estimates compared to DOLS (Gozgor et al., 2020) and avoids the lose of degrees of freedoms, which is common when applying the latter.

Figure 2: CO_2 emissions in 2018

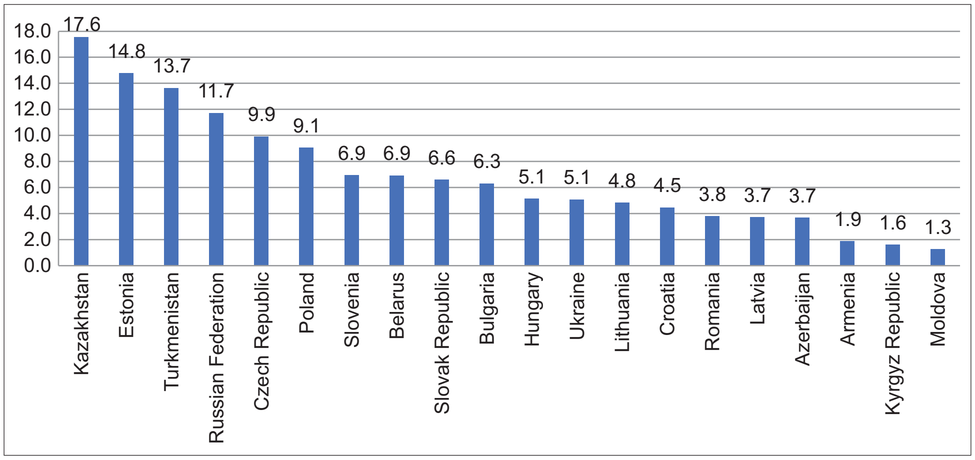


Table 2: Panel unit-root test results

Form	Variable	LLC	Test			
			Breitung	IPS	ADF Fisher	PP Fisher
Level	ln CO_2	−3.2710***	−0.4744	−0.3052	74.7495***	53.3027*
		(0.0005)	(0.3176)	(0.3801)	(0.0000)	(0.0776)
First-difference	Δ ln CO_2	−9.5920***	−9.4082***	−10.8193***	240.4670***	418.3082***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Level	ln Y	−3.7591***	9.3206	2.2484	24.9976	21.8357
		(0.0001)	(1.0000)	(0.9877)	(0.9694)	(0.9914)
First-difference	Δ ln Y	−7.3121***	−9.0457***	−8.8130***	158.4345***	266.3468***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Level	ln Tr	−3.0666***	1.7457	−0.1807	60.1867**	42.8248
		(0.0011)	(0.9596)	(0.4283)	(0.0211)	(0.3509)
First-difference	Δ ln Tr	−10.7482***	−8.2531***	−10.1005***	250.9916***	346.0489***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Level	ln FDI	−3.8447***	−6.6865***	−4.5754***	82.7063***	122.9000***
		(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
First-difference	Δ ln FDI	−10.3885***	−12.2824***	−10.7696***	282.3448***	624.4000***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Level	ln EN	−6.5048***	8.0202	−0.0346	64.0637***	43.7908
		(0.0000)	(1.0000)	(0.4862)	(0.0092)	(0.3138)
First-difference	Δ ln EN	−6.7307***	−8.9911***	−10.2674***	150.7069***	346.1068***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. Figures in parentheses are P values

Table 3: Pedroni's panel cointegration

Test statistic	Score
V-stat	−1.22
Panel rho-stat	−3.93***
Panel PP-stat	−15.57***
Panel ADF-stat	−8.83***
Group rho stat	−2.712***
Group PP stat	−19.74***
Group ADF stat	−9.13***
Kao's ADF	−11.91***

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively

Table 4: Long-term elasticities

	DOLS	FMOLS
Δ ln Y	0.89***	0.83***
	(11.95)	(44.98)
Δ ln Tr	0.00	0.09***
	(0.91)	(7.89)
Δ ln FDI	0.01***	0.05***
	(4.67)	(5.13)
Δ ln EN	0.12***	0.80***
	(6.49)	(54.17)

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. While figures in parentheses are t-statistic

Table 4 provides long-term elasticities by estimating Equation 2 with both FMOLS and DOLS. Both estimators provide similar results. GDP per capital positively related to CO_2 emissions in the long term. According to FMOLS estimator, 1% increase in GDP per capita is associated with 0.83% increase in CO_2 emissions ($P < 0.01$). Growth-pollution nexus is widely studied and the results from post-communist research confirms positive relationship (Sadikov et al., 2020). Economic development is related to growing industry, production, trade and tourism, which in turn leads to higher pollution levels. In case of post-communist economies, environmental concern is of lower importance, compared to growth. Moreover, some post-communist economies abundant with conventional natural resources such as oil and gas their use is quite extensive.

Table 5: Dumitrescu and Hurlin's non-causality test

Hypothesis	Test statistic (z-bar tilde)	Optimal number of lags (AIC)
CO2 does not cause Y	0.8386 (0.4017)	1
Y does not cause CO_2	1.0637 (0.2875)	1
CO2 does not cause Tr	0.2141 (0.8305)	5
Tr does not cause CO_2	−0.6718 (0.5017)	1
CO2 does not cause FDI	0.1048 (0.9166))	5
FDI does not cause CO_2	−1.2476 (0.2122)	1
CO2 does not cause EN	8.2532*** (0.0000)	1
EN does not cause CO_2	−0.4779 (0.6327)	1

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. While figures in parentheses are P-values

Higher trade shares increase CO_2 emissions as FMOLS suggest: 1% increase in trade share related to 0.09% increase in CO_2 emissions and significant at $P < 0.01$. The coefficient of trade is insignificant in DOLS estimator. Most of post-Soviet countries are developing economies, where environmental policies are less stringent to achieve the comparative advantages in their production (Yasmeen et al., 2019). International trade based on traditional production methods and low environmental concern is therefore deteriorates environment.

Foreign direct inflows are positively associated with CO_2 emissions in the long term and the result is significant in both DOLS and FMOLS regressions. Indeed, some studies state that FDI inflows may attract investment into the most polluting industries (Lee, 2009), especially when economic growth is prioritized over environment protection, FDI is likely to be attracted to the most profitable industries. As it was expected, energy enhances CO_2 emissions in the long term, which is in line with Sadikov et al. (2020). On average, one per cent increase in energy use is associated with 0.1% increase in CO_2 emissions, ceteris paribus.

Finally, we report causality tests results in Table 5. We test eight non-causality hypotheses to reveal causal interlinkages among emissions, GDP per capita, trade, FDI and energy use. Our analyses reveal unidirectional causality running from CO_2 emissions to energy use to at $P < 0.01$. Unfortunately, we fail to reveal causal relationship among other variables, yet we still able to derive some policy implications. First, CO_2 emissions additionally pressuring energy use and therefore demand for energy. Policy makers may target energy demand by introducing environmental policies. On the other hand, environmental policies aimed at CO_2 reduction, will have no impact neither on economic growth, trade, nor foreign capital inflows.

Several possible channels, through which CO_2 causes energy use is manufacturing sector and energy-intensive industries development, which require ever-increasing amounts of energy as expanding. Such factors are recommended to be considered by future studies. Moreover, different measures of carbon emissions may be applied such as CO_2 emissions per capita, CO_2 intensity, and CO_2 sectoral emissions.

5. CONCLUSION

This study explores and tests the links between economic growth, energy consumption, trade openness, FDI and carbon emissions, by using a sample of 24 Post-Communist countries. This paper covers the period 1995-2017. For the econometric analysis we have relied on Pedroni's cointegration test, panel FMOLS and DOLS regression and Dumirescu and Hurlin's panel Granger non-causality test.

The findings from panel cointegration test reveals long-term cointegrating relationship between the variables. Long-term elasticities are reported with DOLS and FMOLS regressions, which yields quite similar results: GDP per capita, FDI inflows, trade and energy use positively related to CO2 emissions per capita in the long term. Panel causality test, however, identify unidirectional causality running from CO_2 emissions to energy use.

There are several principal points of interest in this research. First, we find that, 1% increase in GDP per capita is associated with 0.83% increase in CO_2 emissions. This implies that economic growth in transition countries leads to greater carbon emissions. Therefore, policymakers should foster rapid adoption of innovative efficient technologies that would promote economic growth with lower pressure on carbon footprint. In addition, these countries should actualize novel environmental policies to decrease carbon emissions. At this stage economic growth leads to environmental worsening, however, these policies should not hamper GDP growth rates as it would lead to poverty and unemployment.

Second, we document that both FDI and trade openness have positive impact on CO_2 emissions in our sample. Thus, our study confirms 'pollution haven' hypothesis for Post-Communist countries. One potential solution to this dilemma is to create tax and other incentives for foreign companies to channel their FDI in low-carbon economic sectors such as high-tech, for example. Apart from that carbon emissions may be reduced if polluting industries undergo technological upgrading and adopt energy efficient technologies (Zhang and Zhang, 2018; Liu et al., 2023). Finally, the findings of this research highlight that transition countries need to integrate climate change considerations in the long-term development strategies more profoundly to decrease carbon emissions and maintain sustainable economic development.

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