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Asymmetricity in the Effect of Economic and Environmental Factors on Social Sustainability: Empirical Evidence from Eastern European Economies using Dynamic Analysis with CCEMG & D-H Causality Approaches

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Abstract:

Purpose: *This study explores asymmetricity in the effect of economic and environmental factors on social sustainability with empirical evidence from Eastern European economies using a dynamic analysis with CCEMG & D-H causality approaches.*
Design/Methodology/Approach: *Data for this study was purposefully sampled from nine (9) Eastern European economies between 1998Q4 and 2017Q4. Empirical weakness of nascent studies on carbon dioxide emissions, economic growth and increasing poverty call for the need for a dynamic analysis.*
Findings: *Outcomes affirm, (ii) Economic sustainability, regulatory quality as well as R&D exert positive impact on social capital. (ii) CO2 emissions has significant negative effects on social sustainability.*
Practical implications: *These outcomes provide significant insights for global rethinking on social sustainability, especially on its relationship with environmental sustainability.*

Keywords: *Social, environmental, economic, sustainability, development, CCEMG, FGLS.*

JEL codes: *Q61, O2, F18, O40, O44, 052.*

Paper type: *Research article.*

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1. Introduction

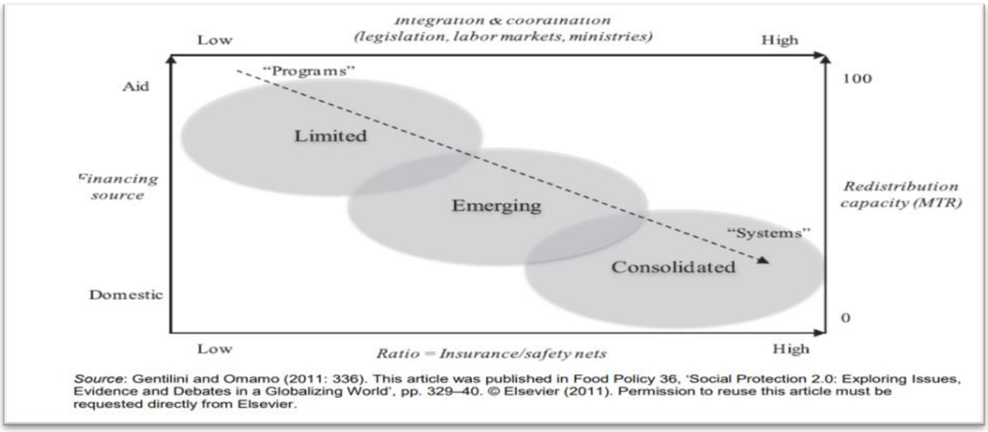
For several decades, increasing social problems have been observed to be interconnected with other traditional determinants of sustainability, i.e., environment and economic factors. Diminishing resources, reality of population growth, and limited planetary boundaries have culminated in this global awakening, and for rethinking development and well-being. This is because, by crossing planetary boundaries, the world is reaching a social development tipping point. Population growth and rapidly increasing urbanization have over stretched urban infrastructure and its ecological systems. In 2005, the World Bank estimated that over three billion people lived on less than $2.50 per day (UN World Social Situation, 2005; World Bank, 2008).

For many parts of the world, extreme poverty rates have worsened, with some 1.6 billion people living without electricity; 1.1 billion do not have drinking water access; and basic sanitation is lacked by 2.6 billion people (UN World Social Situation, 2005). In many of the poor economies, rising population growth continue to divert household resources away from savings to consumption; and government expenditure in education has reduced. Given the aging populations and rising dependency ratios, pressure on earnings of the few workforces usually leads to forced migration.

To deal with this problem, governments across the world have committed to dealing with worsening social capital. Social capital according to (McEloy *et al.,* 2006), refers to shared knowledge, networks, and values (e.g., governments, healthcare systems, courts, financial and educational systems, etc.) enhancing effective individual and collective action in human social systems. Shared values also include transparency, fairness, balance, equality, well -being, health and safety within human systems which promote the realization of human dignity. Towards realizing these objectives attempts to accurately measure social capital have culminated in many social policy typologies (Figure 1) and initiatives such as the *Sustainable Australia Communities* which places emphasis of social policy on meeting human capital deficits for economic growth, which target both poverty reduction and inequality prevention goal (Australian Government, 2011).

Social sustainability is been recognized as an emerging concept which is least studied, and has been described as the most conceptually elusive term in sustainability discussions (Vavik and Keitsch, 2010). It has been observed that scholars have for decades overlooked its dimension and role within global journey toward sustainable development. Over the years, there has been vague delimitation of sustainable development and social sustainability, including accurate definition of the objectives of the social pillar of sustainability delivery (Soneryd *et al.,* 2012). Brundtland-report on the definition of sustainable development, recognizes that economical, ecological, and social aspects of sustainability should be given equal weight. It is only in recent years that efforts have been made to bring the other two aspects of sustainable development back into balance; but these efforts have not yet succeeded.

Figure 1. *Social protection typologies across the world*

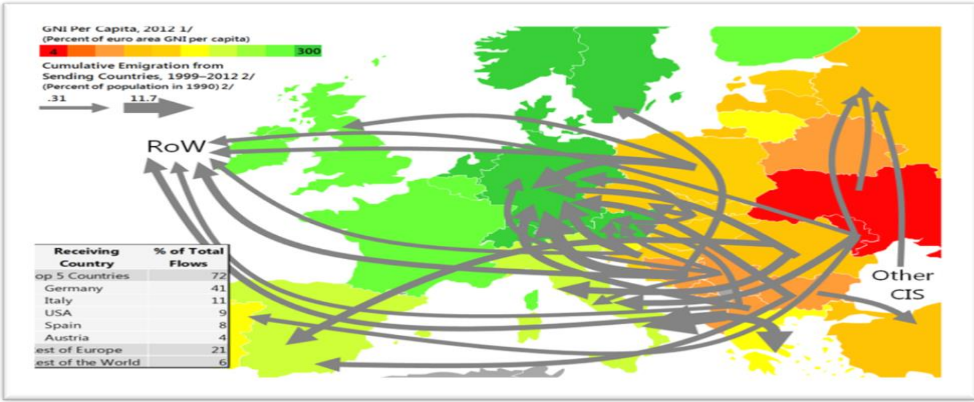


The historical one-pillar model of sustainable development generally considers only the ecological dimension, although this has lately been considered a myth, since both social and economic components are equally noted for causing environmental sustainability problems. In fact, over the years, economic and social variables have been recognized as prerequisite for environmental protection in developing countries, provided regulatory and institutional bodies effectively function (WCED 1987). It is only in the three-pillar model of sustainable development that the social dimension is recognized. Several experts have claimed, there is no clarity to definitions of "social matters", its dynamics and breaks (Littig and Grießler, 2004).

Eastern European economies present an interesting case for studying the effects of economic and environmental factors on social sustainability. Available literature indicates that virtually no such studies have been occasioned in Eastern European region. Historical records show that after receiving political independence in1990s, these economies initiated economic reforms towards meeting the requirements for EU membership (Schwan, 2020). Regrettably, the reforms resulted in high economic growth rates across the region; but this generated severe social and environmental negative impacts across the region (Steenge, 1991). It is instructive to note, despite huge regional diversity, their health systems share common features and challenges, and it is historically funded by the state, anchored on Semashko's social capital theory.

Further, this region for many years has been a source of migration to Western European economies perceived to have better social protection policies (Jakovljevic, *et al.*, 2021). Available studies indicate the gradual rise in migration to the UK for better social systems which has generated controversy at policy circles concerns migrants from eight EU Accession countries such as Czech Republic; Estonia; Hungary; Latvia; Lithuania; Poland; Slovakia; and Slovenia (Blanchflower *et al.*, 2007). Figure 2 explains this in graphical terms.

Figure 2. *Geography of emigration from Eastern Europe countries*



To validate and bring clarity to this debate, this study investigates the effects of economic and environmental sustainability on social sustainability; while controlling regulatory quality and research and development factors. Empirical investigations on regulatory quality and research and development indicate they affect social sustainability in much the same way as the economy and environment do. This study aims at giving credence to these assertions and contributes to existing literature on sustainability knowledge stock. Data for this study is purposefully sourced from nine (9) Eastern European economies between 2000Q1 and 2016Q4.

The weakness of nascent empirical studies of carbon dioxide emissions and economic growth on social capital informs the necessity for adopting modern and advanced dynamic econometric assessment methods, including cross-sectionally augmented Dickey Fuller (CADF), Common correlated effects mean group (CCEMG), and Dumitrescu Hurlin panel causality methods. Findings could inform Eastern European regional and local policy on social capital development, including addressing regulatory gaps and failures that hinder green economic development. Authors are motivated by social contract theory (Coase, 1937). This theory offers significant contributions on how modeling could be employed by policy makers in dealing with complexities in social sustainability thinking. The remainder of the work is: next section is literature review; that will be followed by research methodology and the findings sub-sections. The last section will be conclusions and suggestions for academic and policy action.

2. Literature Review

For decades, even though sustainable development concept included social dimension, it has regrettably been neglected, and only mentioned at policy levels when characterizing sustainability, which has largely focused on bio-physical environmental issues**.** This neglect of its recognition for policy action has culminated in widening global inequality and poverty. Global interest in social sustainability concept has gathered momentum in only recent years, and our considered literature review suggests, there is a conceptual and theoretical chaos. The gap created for decades by scholarly interest and policy considerations on social sustainability has contributed immensely to compromising its academic and policy utility (2015).

According to Nakanishi and Black (2015) social sustainability can be defined as "the degree by which social values, social identities, social relationships and social institutions can continue into the future". But Torjman (2000) in his characterization, defines social sustainability to mean that from social perspectives, the wellbeing of man cannot be sustained without a healthy environment and a vibrant national economy. Other experts such as Gilbert *et al.,* (1996) defines social sustainability to require that cohesion of society with its ability to realize common goals be maintained, while ensuring the realization of individual needs, which includes: health and well-being, nutrition, shelter, education, and cultural expression.

Approaches to the delivery of social dimensions of sustainable development are so diverse like those of the economic and environmental pillars. Martin (2002), finds in his studies that assessing social dimension of sustainable development is less clear-cut in both definition and delivery. Several sustainability scholars have claimed over the years that the social dimension of sustainable development discussions reflects diverse aspects, such as social policy, urban development, organization performance, products design, and lifecycle (e.g., Weingaertner, and Moberg, 2014).

The relevance of the concept of social sustainability is normally witnessed in both social policy and public discourse. The multidimensional nature of the concept has resulted in varied conceptual definitions (Littig, 2005). For instance, there is the one-pillar conceptual framework in the literature of social sustainability which focuses on ecological sustainability, and considers social matters are relevant only when they cause ecological problems that needs conscious and deliberate mitigation (i.e., it seeks to preserve ecological systems for future social life, such that social institutions are only needed for responsible governance).

The concept of social sustainability encompasses a continuous better change in society, focuses on issues including poor health and income gaps, according to Brundtland's report (Axelsson *et al.,* 2013). In 1992 conference, the right to have a decent life was added to the description of the concept including, intergenerational and intragenerational social justice and local participation in the delivery of sustainability outcomes (Foladori, 2005). By tracking the change of interest and scope of sustainable development, Lee and Jung (2019) observe two periods in the delivery of the social dimension: First, the social sustainability concept has changed from 1988 to 2000 been related to sustainable development and anchored on economic growth and other social factors besides environmental or ecological factors; and secondary, between 2001 and 2018, the social development concept became most preferred subject and viewed as standalone sustainability factor and not made part of sustainable development determining variables. Examples of such factors include: unemployment, education, waste collection and sustainable retrofit.

Academic attempts to develop theoretical framework for social sustainability concept have its strength from the Brundtland report of 1987, which proposed profound changes towards connecting global bio-physical environmental, social and economic policy objectives. Many proposed theories to social sustainability claims that poverty alleviation is necessary but should not entail environmental degradation or economic consequences to society. Under the theory of social sustainability, poverty alleviation should be achieved within existing environmental and economic resource base of the economy (Kumar, Raizada, and Biswas, 2014; Scopelliti *et al.*, 2018).

However, critics argue that determining social measures of sustainable development has always been a function of power instead of policy coherence (Littig and Griessler, 2005). In their essay about "Sustainability Quotients and the Social Footprint" McElroy *et al.* (2008) introduced an approach to measuring social sustainability, dubbed, "binary theory" which uses quotients to create a social footprint of ac action. This theory is a variant of "absolute goal orientation theory" because it is anti-relativistic, and claims for example, "artefact is either wholly sustainable or not", and differs only in terms of performance scores (quotients) and are used to create social footprints.

For corporations, Coase (1937) in his seminal article, propounded the "social contract theory". The theory claims that corporations reduce transaction costs, which normally take place by contracting with other stakeholders to realize its objective. This theory gained its root from aggregate entity theory (Phillips, 1996). Critics of the social contract theory argue that some social contracts are incompletely specified or have vague risks (Boatright, 1996). Other also argue markets and governments treat such contractual transactions differently.

Empirical literature on the social pillar of social sustainability has lately gained prominence. Investigating social component of sustainable development concept, Boyer *et al.* (2016) suggest five kinds of conceptual applications in literature and practical implementation. First, they observe the concept as standalone and not related both environmental and economic sustainability issues. Second, the concept is immensely tied to economic and environmental pillars; and that sustainable development is recognized as reconciling contending factors such as social equity, economic development, and priorities of ecological safety. Third, social sustainability concept is viewed as a foundation for all other sustainability pillars.

By this Boyer *et al.* (2016) explained the concept to mean the stock of social capital requirements for societal economic and environmental progress. It is also a concept which can compensate for relevant shortcomings of both economic and ecological capital, such that any investments in the social development have the potential to improve the economy and the environment; Forth, social sustainability concept or pillar is viewed as a causal mechanism for environmental and economic change.

This means, that the concept is not a precondition, but stimulates economic and environmental progress. By this viewpoint, social changes stimulate environmental progress; and five, social sustainability could be place-based, process-oriented and integrated concept. Here, entities and special values which have been historically separated into different disciplines are now seen to be integrated.

Notwithstanding these defined frameworks, critics argue those are expressions for achieving general objectives of the social policy, which are contrary to the clear definition of Colantoni, (2008). This is perhaps the reasons social sustainability aspect of sustainable development is the most significant determinant for sustainability of human civilizations. Many sustainability scholars have over the years not yet settled on the distinctive roles of social sustainability.

The major questions lingering on social sustainability aspect concern determination of scope (i.e., whether it is growth, global inequality, good healthcare system, or some other factors). Any societal must be benchmarked, and made contingent on true conceptualization of social sustainability. But there has not been aby consensus as critics claims selecting right indicators remain contentious (Hicks *et al.*, 2016; Griessler and Littig, 2005). Other critics also argue selection of indicators is often grounded on political motives and not theory-based. Hale *et al.* (2019) argues that notwithstanding debates on indicator selection, no one has claimed the selected indicators lack value. Regardless of the criticisms of indicator selection, Partridge (2014) touts their usefulness ensuring issues of social justice.

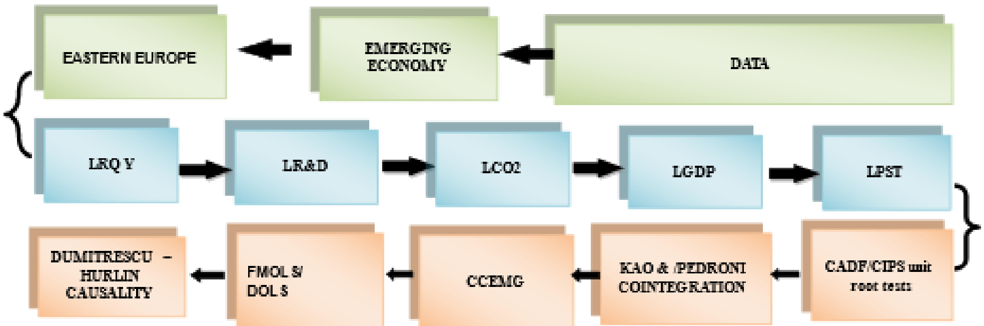
Based on this review, the fundamental interconnectedness of the concept to other sustainability variables seems understudied, notwithstanding the initial and growing debates. To close this gap, this study aims at empirically modelling social sustainability through the impact of economic and environmental sustainability for emerging economies. To achieve our objectives, the study controls regulatory quality (Gambetta *et al.*, 2019), as well as research and development (Silvestre, & Ţîrcă, 2019). which many researchers believe contribute to accurate estimation of social component of sustainable development. Data for this study is sourced from nine Eastern European economies ranging from 1998Q4 and 2017Q4. To ensure accurate and consistent outcomes, the study employs dynamic econometric approaches.

3. Research Methodology

We obtained quarterly time-serries panel data of sampled nine countries (Azerbaijan, Czech Republic, Hungary, Moldova, Poland, Romania, Russian

Federation, Slovakia, Ukraine) from 1998Q4 to 2017Q4. Data was collected on (i) Social Sustainability (Scopelliti *et al.*, 2018), involving a proxy from political stability from worldwide governance indicators of the World Bank. (ii) Environment sustainability data involved a proxy data from carbon dioxide emission calculated in metric tons. Authors sourced data from United Nations Framework Convention on Climate Change database. (iii) economic sustainability data comprises a proxy from LGDP growth with data from World Bank database (iv) Research & Development, determined by expenditure on LR&D, expressed as a percent of LGDP. Data was collected from World Bank database. (v) Regulatory quality data was collected from Worldwide Governance Indicators.

Figure 3. *Methodological flowchart*



3.1 Data Source, Type and Span

Model, specification and definition of variables: To investigate social sustainability in Eastern Europe, the study follows the SOLA model (Pieper *et al.*, 2019). Which is grounded in general systems and action theory and can equally factor inclusive growth espoused by (Deeming and Smyth 2018). Further, it can recognize social sustainability as a construct of interrelated oriental practices intended to address major social issues. Authors write the empirical equation as

$$PST = f(GDP, CO2, Rgy, R\&D) \quad (1)$$

Where, PST is proxy for Social Sustainability, CO_2 is proxy for Environmental Sustainability; GDP is proxy for Economic Sustainability; Rgy is Regulatory quality; R&D is Research and Development .

Specification of the Model: First, series data were transformed into logarithms. This is done to ensure actual elasticities between selected variables. Authors now write the empirical equation as:

$$\ln PST_{0it} = \beta_0 + \beta_1 \ln GDP_{1it} + \beta_2 \ln CO2_{2it} + \beta_3 \ln RQY_{3it} + \beta_4 \ln R\&D_{4it} + \varepsilon_{it} \quad (2)$$

where β_0 is constant; the slope of coefficients is represented by β, economies are represented by i; t; is time (1998Q4–2017Q4), LPST is proxy for Social Sustainability, CO_2 is proxy for Environmental Sustainability; GDP (growth) is proxy for Economic Sustainability; RQY is Regulatory quality; R&D is Research and Development and ε is the error term.

Econometric methodology: The objective of the study is to model social sustainability in emerging economies using data from 9 Eastern European economies. To achieve our objectives, we first undertake data description to determine the basic features of the variables (Table 1).

Cross-Section Dependence test: Recent interest in cross-sectional dependence in panel data estimations has increased mainly because errors arising out of them have serious consequences on outcomes (Chudik and Pesaran, 2013). The assumption of Cross-sectional dependence is due to the evidence obtained on the strong co-movements among the economic variables, and the assumption that the individual time series in the panel are cross sectional independent is not practical in cross-country regressions (Barbieri, 2009). To achieve the stated objectives, we check if cross-sectional units are affected equally by unobserved factors in the panel data using De Hayos (2006). The outcomes of these two tests are illustrated in Table 2.

Slope heterogeneity test: In the next step, the study checks the model specification and covariance using the approach proposed by Hsiao (1960) or (Hausman 1978) by conducting slope heterogeneity test to see if all parameters of the model (constant and slope coefficients) vary across individuals (Table 3). We prove this by the normality of the residuals and economic reasoning behind them (Hurlin, 2018).

CIPS-Unit root test: Many studies have shown that panel data suffer have limitations of cross-sectional dependence arising out of unobserved factors and shocks in different periods from cross border financial or economic integration, off-shoring practices, and common shocks like oil price hikes (De Hoyos and Sarafidis 2006; Latif *et al.*, 2018; Dogan *et al.*, 2017). To check cross sectional dependencies, we first examine the unit root properties of the data using second-generation panel unit root test in heterogeneous panels developed by Pesaran (2007) also called in many studies as CIPS-Unit root Test which allows for individual dynamics specifications (Table 4).

Panel cointegration test: Nonstationary time series have a mean or variance that varies over time. When you first difference nonstationary time series, they become stationary. Time series that are not stationary tend to wander. Cointegration indicates that the series wander together over time, indicating an equilibrium relationship between them. Despite the differences between these related tests of cointegration, the results are the same: the panels are cointegrated. In this study, Kao and Pedroni cointegration estimators are employed for the cointegration analysis. In the case of Kao (1999), the cointegrating vector is assumed to be the same across all panels;

which restricts $\beta i = \beta$ in (1). In this approach, panel-specific means are estimated, and time trends are not taken into account. The null hypothesis is there is no cointegration among series. The alternative hypothesis is that series are cointegrated with the same cointegrating vector. Cointegration test of Pedroni (2004) allows panel-specific cointegrating vectors and AR coefficients (*i) to be compared across panels. Both tests allow unbalanced panels; and require that N is large such that the average sample distribution of panel-level statistics converges to its population distribution. We show results in Table 5.

Common Correlated Effects (CCEMG): From the literature, panel data estimations with heterogeneous coefficients that contain large dimensions of observations over cross-sectional units (N) and periods (T) have allowed researchers to identify and threat errors on cross-sections separately. The works of Pesaran, (2006) and Chudik and Pesaran, (2015) have tremendously helped in accounting for unobserved dependencies between cross-sectional units, since not accounting for them causes the error term to be autocorrelated, leading to biased OLS regression results (Ditzen 2018). For this purpose, the most recent theoretical and empirical work on CCE estimation approach by Chudik and Pesaran (2015) is employed for my model.

The importance of this method is that it allows the use of statistical package CCE to combine two strands of the literature by accounting for Mean Group (MG) estimations in a dynamic panel with dependence between cross-section units. MG estimates are obtained by two steps. First, the coefficients of interest are estimated for each cross-sectional unit separately, and various unit-specific estimates are averaged across all groups. Second, the method approximates for cross-sectional dependence by adding cross-section averages and lags (Pesaran, 2006; Chudik and Pesaran, 2015). It tests for weak cross-sectional dependence in the error terms and enables instrumental variable estimation. Last, the approach supports unbalanced panels (Table 6).

Robustness test: Estimation robustness check historically dates back as far as 1931 (Agostino and Marcato, 2001). It is intended to (a) check the null hypothesis (robustness of validity) and (b) ensure the power of the test remains great and does not depart from the alternative hypothesis (robustness of efficiency) as claimed by Agostino and Marcato (2001). To ensure robustness, the work employs advanced panel dynamic least squares approached (DOLS) and Full Modifier Leased Squares (FMOLS) recently used by Erdogan *et al.* (2020) (Table 7).

Causality test: Finally, many scholars employ short run panel data causality test which allows slope heterogeneity, but does not unfortunately consider cross-sectional dependence issues which creates biases and size distortions if found to be present. To deal with this, we employ very simple recent approach developed by Dumitrescu and Hurlin (2012) for the panel. This method is principally based on specific Wald statistics of Granger non-causality test, which takes cross-section averages and heterogeneous units. The test assumes a causal linkage of the variables, from x to y for sub-units, and adopts bootstrapped values for cross-section dependent units instead of asymptotic critical values. We have illustrated the outcomes at Table 8.

4. Empirical Outcomes

With the insignificance of the p-values, the null hypothesis of abnormal distribution is rejected for all the variables at 1% level of significance (Table 1). Out checks show no existence of outliers.

Table 1. *Descriptive statistics*

Description/variables	LPST	LCO2	LGDP	LRQY	LR&D
Mean	-0.664	19951903.000	1.474	-0.464	0.277
Median	-0.734	19479931.000	1.523	-0.447	0.218
Std. Dev.	0.428	7882772.000	0.556	0.371	0.167
Skewness	1.998	4.238	-0.789	1.872	3.709
Kurtosis	8.739	20.979	5.223	9.464	17.475
Jarque-Bera	162.987	1316.944	24.778	185.980	881.832
Probability	0.000*	0.000*	0.000*	0.000*	0.000*
Observations	80	80	80	80	80

Note: *LGDP is LGDP Growth, LPST is Political stability, LR&D is Research and Development, LRQY is Regulatory quality, LCO2 is Carbon dioxide emissions. The stars * denote statistical level of significance respectively*.

The results of the LM-based CD Tests are denoted in Table 2. The outcome of the test indicates a rejection of no cross-section independence assumption at 1% significance level; and infering possible long run relationship within the panel. This could be explained, according to recent survey by World Bank (2008), that price shockwaves on commodities across the region worsened in 2008, and created headline inflation, which reduced disposable incomes.

Table 2. *Baltagi et al., (2012) LM based tests for Cross-Section Dependence*

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	729.0873	36	0.000*
Pesaran scaled LM	81.68112		0.000*
Pesaran CD	-2.83185		0.004*

Note: *The star * denotes level of statistical significance.*

The increasing economic and financial integration across Europe are blamed. According to OECD report, this explains why individual economy's ability to respond to common "shocks" and unobserved factors were affected (OECD 2018). These findings support findings Grossman and Helpman (2015) and Jones *et al.* (2016) which claims existence of spillovers of economic factors. Thus, to avoid inconsistency in estimation outcomes, approaches robust to cross-section dependence will henceforth, be used in the estimation process.

Table 3. *Slope heterogeneity test*

Variable	Pettitt	SNHT test	Buishand	von Neumann
LPST	<0.0001*	<0.0001*	<0.0001*	<0.0001*
LRQY	<0.0001*	<0.0001*	<0.0001*	<0.0001*
LR&D	<0.0004*	<0.0001*	<0.0002*	<0.0001*
LGDP	<0.0001*	<0.0001*	<0.0001*	<0.0001*

Note: *The stars *, ** and *** denote statistical level of significance at 1%, 5% and 10% respectively.*

The results indicate that the null hypothesis is rejected at 1% significant level, indicating the panel is heterogenous. We find (Table 4) that variables possess same integration order, indicating panel has unit root is rejected at 10% significance level, help us to assume the presence of a long-run relationship, signifying the adoption of second generation-based v cointegration test (Table 5).

Table 4. *Unit root/CIPS test*

Variable	Level Constant	1st Difference Constant and Trend	Order of Integration
LRQY	2.54	3.04***	I(1)
LR&D	2.54	3.04***	I(1)
LCO2	2.54	3.04***	I(1)
LGDP	2.54	3.04***	I(1)
LPST	2.54	3.04***	I(1)

Note: *The stars *, ** and *** denote statistical level of significance at 1%, 5% and 10% respectively.*

This test applies despite integration order and can handle heterogeneous panels corrects errors associated. This outcome supports empirical findings of Bai and Ng (2004) and (Damette and Marques 2018). The outcomes are similar to those of Banerjee, Marcellino, and Osbat (2005) who argue that because of cross-unit co-integration and long-run linkages among countries, panel unit-root tests normally reject the null hypothesis.

Table 5. *Kao (2004) & Pedroni (2004) cointegration test*

	Pedroni's cointegration test				Kao's panel cointegration test		
	Within dimension		Between - dimension				
Account	Stats	prob	Stats	Prob.	Desc.	t-Stats	Prob.
Panel v-Statistic	3.94518	0.000*			ADF	-3.61589	0.001*
Panel rho-Statistic	-2.0354	0.020**	-2.8492	0.106	Residual variance	33.1631	
Panel PP-Statistic	-1.7135	0.043**	-3.5817	0.040*	HAC variance	72.2799	

Panel ADF-Statistic	-4.4156	0.000*	-0.5126	0.000*	RESID (-)	-6.4822	0.000*

Note: *The stars *, ** and *** denote statistical level of significance at 1%, 5% and 10% respectively.*

The results indicate that null hypothesis of no cointegration is rejected at 1% level of significance (Table 5). This means, we accept the alternative hypothesis, hinting a long-run relationships among the variables. This indicates that it is best to adopt a CCEMG Test of Pesaran, (2006) as the most appropriate estimation tool (Table 6). The result also aligns with the study by Banerjee, Marcellino, and Osbat (2005).

Table 6. *Pesaran (2006) Common Correlated Effects Mean Group estimator*

LPST	Coef.	Std. err.	z	P>|z|
LGDP	.1442138	.0974824	1.48	0.139
LCO2	-.0422771	.0447601	-0.94	0.345
L R&D	.8240678	.2876352	2.86	0.004
LRQY	.1065627	.1487329	0.72	0.474
LPST avg	.9241338	.1315576	7.02	0.000
LGDP avg	.0053431	.0809212	0.07	0.947
LCO2 avg	-.0012271	.0044112	-0.28	0.781
LR&D avg	.0738446	.581208	0.13	0.899
LRQYavg	.2604442	.3971404	0.66	0.512

Note: *Root Mean Squared Error (sigma): 0.1383; Cross-section averaged regressors are marked by the suffix avg. Figures in *, ** and *** denote p-values statistically significant for rejecting the null hypothesis at 1%, 5% and 10% respectively.*

The CCE estimates (Table 6**),** in the short run, a unit change in LGDP, LR&D and LRQY has positive effect on LPST by 0.14%, 0.824% and 0.106% respectively. In the same period, a similar unit change in C02 negatively imposes 0.042% effects on LPST. The long-run CCEMG estimates suggests, a unit change in LGDP, LR&D, and LRQY induce a positive impact on LPST by 0.005% and 0.260% respectively, a similar unit change in LCO2 had a negative effect on LPST by 0.001%. These outcomes reflect similar results by Gholipour, (2019) and Hwang *et al.* (2021).

Table 7. *Model Robustness test*

Dependent Variable: LPST	Method: FMOLS & DOLS			
REGRESSER	FMOLS	DOLS	FMOLS	DOLS
Variable	Coefficient	Coefficient	Prob.	Prob.
LGDP	0.0059	-0.0005	0.861***	0.988***
LCO2	0.0002	0.00051	0.821***	0.610***
LR&D	0.5252	0.50166	0*	0.0001*
LRQY	0.4225	0.41559	0.0016*	0.0048*
R-squared	0.8539	0.90599		
Adjusted R-squared	0.8513	0.88529		

S.E. of regression	0.303	0.26519		
Long-run variance	0.3063	0.183		

The results suggest (Table 7) indicates that the R-squared has a coefficient of 0.853 regressed under FMOLS, and 0.905 under DOLS regression. This means the independent variables can explain 85% or 90% respectively of the dependent variables, so the model is robust. This outcome aligns with recent findings by Erdogan *et al.* (2020). The D-H causality test (Table 8) suggests on way causal effect from the direction of LGDP to LCO2 and LPST with no feedback effect. We also find there is a bidirectional causality between LRQY and LPST. Further, LCO2 homogeneously causes LRQY, with no rebound effect.

Table 8. *Dumitrescu Hurlin (D-H) Panel Causality Tests*

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.	Decision
LGDP does not homogeneously cause LCO2	3.76496	2.41401	0.0158*	Rejected
LCO2 does not homogeneously cause LGDP	1.26035	-1.12976	0.2586	
LPST does not homogeneously cause LCO2	2.84394	1.11086	0.2666	
LCO2 does not homogeneously cause LPST	2.49688	0.61981	0.5354	
LR&D does not homogeneously cause LCO2	5.10855	4.31505	2.E-05	
LCO2 does not homogeneously cause LR&D	2.89054	1.17679	0.2393	
LRQY does not homogeneously cause LCO2	2.12623	0.09538	0.9240	
LCO2 does not homogeneously cause LRQY	3.58891	2.16491	0.0304*	Rejected
LPST does not homogeneously cause LGDP	1.10312	-1.35222	0.1763	
LGDP does not homogeneously cause LPST	3.51994	2.06733	0.0387*	Rejected
LR&D does not homogeneously cause LGDP	2.79745	1.04508	0.2960	
LGDP does not homogeneously cause LR&D	2.75078	0.97905	0.3276	
LRQY does not homogeneously cause LGDP	2.08699	0.03985	0.9682	
LGDP does not homogeneously cause LRQY	2.70698	0.91707	0.3591	
LR&D does not homogeneously cause LPST	1.87531	-0.25965	0.7951	
LPST does not homogeneously cause LR&D	1.18013	-1.24326	0.2138	
LRQY does not homogeneously cause LPST	4.20124	3.03130	0.0024*	Rejected
LPST does not homogeneously cause LRQY	4.23227	3.07520	0.0021*	Rejected
LRQY does not homogeneously cause LR&D	3.05777	1.41341	0.1575	
LR&D does not homogeneously cause LRQY	3.02812	1.37146	0.1702	

5. Discussions of Results

We have empirically assessed the effects of economic and environmental factors on social sustainability in Eastern European economies with data from 1998Q4 to 2017Q4. Two variables were added to the traditional determining factors of sustainable development for the econometric estimation (i.e., environment, economic and social). We conducted these tests: CADF/CIPS Unit root, Pedroni and

Kao panel cointegration, CCEMG estimation and Dumitrescu Hurlin panel causality. The results of the CCEMG estimates indicate that in the short-run LGDP growth has significant negative effects on LCO2 emissions. But the long run estimates show LGDP growth and social capital improvements, Regulatory quality and Improved Research and development reduce LCO2 emissions. Additionally, the Dumitrescu Hurlin Panel causality estimates indicate LGDP has one-way causal effects on LCO2 emissions and social sustainability with no rebound effect. The outcomes also indicate a bidirectional causality between social sustainability and research and development. Finally, we find there is unidirectional causal relations from regulatory quality to social sustainability.

Chandy *et al.* (2012) investigated community perceptions about environmental and socioeconomic impacts of mega hydropower project in 3 rural areas. The results indicated though short-term benefits such as employment accrued to the rural community, variations in land use and traditional occupations have adverse future livelihoods impacts. Additionally, the results on the effects of economic growth on social development are significant because they confirm EKC hypothesis (Grossman and Krueger, 1991), which claims, growth causes environmental and social problems initially and corrects this problem over the long term. This explains why the literature on economic sustainability (growth) and its effect on social and sustainability remains immensely unexplored (Alshuwaikhat and Mohammed, 2017).

The outcome the of significant short- and long-term impacts of research & development and environmental sustainability on social development is worthy of note. The is because these findings support the work of Song *et al.* (2017) found in their studies on big data, that evolving research and development of big data is useful to scientists, policy makers, and city planners deal with environmental and health burdens on human society.

Additionally, the outcome indicates a bidirectional causality between social development and regulatory quality are significant. Specially revealing is the special relationship between regulatory quality and social sustainability. An assessment of regulations on microfinance firms in Nigeria and Zambia indicated that regulations in the two economies positive impacts on the sector, but these did not reflect on social development (Siwale *et al.*, 2017). Similarly, an assessment of regulatory effects of public transport on social development in 88 world cities by Currie *et al.* (2018) indicated an increase social sustainability performance and the reverse was true.

6. Conclusion and Recommendation

This study has empirically explored effects of economic and environmental factors on social sustainability in Eastern European economies with data from 1998Q4 to 2017Q4. Two variables were added to the traditional determining factors of sustainable development for the econometric estimation (i.e., environment, economic and social). The study employed these estimators: CADF/CIPS Unit root, Kao (2004) and Pedroni (2004) cointegration, CCEMG estimation and Dumitrescu Hurlin panel causality.

Based on the results of the CCEMG test, CO_2 emissions have significant negative effects on social sustainability. However, economic growth, regulatory quality as well as R&D exert positive influence on social capital. Dumitrescu Hurlin panel causality tests indicate a bidirectional causality between social development and regulatory quality. On social development, authors suggest further academic research and increased policy focus. To prevent backfire effects, authors suggest regulatory policies relating to growth and environmental sustainability must be improved, but handled carefully.

These findings are a leap forward in solutions for innovative calls for sustainable development delivery pathways for emerging economies (Sepulveda *et al.,* 2020; Mensah and Casadevall, 2019). This was obvious in the results of Pedron and Kao (2004) cointegration test performed which suggest variables are integration. These findings additionally suggest special attention should be placed on research and development as well as regulation quality by emerging economies as they look for sustainable development frameworks useful in guiding policy and corporate actions.

These outcomes confirm existing theories identified under the literature review, namely: stakeholder framework (Coase, 1937; Gunarathne and Lee, 2019). Based on the findings, this research has extracted significant insights for social policy making, corporate decisions, especially on social and environmental management in emerging economies. To better understand the implications of these results, future studies should the interlinkages between the determinants of social sustainability for regional and local economies; they are also urged to investigate the relationship between the traditional determinants and the two new determining variables of sustainable development for emerging economies.

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