Research Article

Income Disparity, Institutional Effectiveness, and Environmental Decline in Post-Soviet Economies: Insights from VEC and VAR Causality Methods

Nermin YAŞAR BAŞKARAAĞAÇ[1]

[1] Asst. Prof., Dr., Çankaya University, FEAS, nerminyasar@cankaya.edu.tr, ORCID: 0000-0002-4159-4146

Abstract: This research investigates how income distribution, and the quality of institutions influence environmental damage in post-Soviet economies from 1996 to 2020, employing advanced panel estimation techniques. To test Granger causality, we utilize two alternative methodological procedures: The VECM and the augmented level VAR model with integrated and co-integrated procedures of arbitrary orders suggested by Toda & Yamamoto (1995). Our primary finding suggests that although the VECM results do not uncover a causal relationship running from income distribution and institutional quality to CO_2 emission, the Toda-Yamamoto approach indicates causality from the Gini index and the majority of the evaluated institutional quality indicators—such as control of corruption, government effectiveness, regulatory quality, and rule of law—to carbon dioxide emissions. Strong institutions bolster the enforcement of environmental policies, encourage sustainability, and mitigate emissions by ensuring compliance with regulations and responsible resource utilization. Addressing income inequality in observed countries is vital as it leads to consumption disparities and limited access to clean technologies, resulting in heightened carbon emissions and environmental degradation, especially pertinent in post-Soviet economies where adopting equitable economic policies alongside robust environmental regulations and governance is imperative.

Keywords: Income disparity, Institutional effectiveness, CO2 emission, ARDL, VEC, VAR, Toda-Yamamoto approach
Jel Codes: C23, D31, E02

Sovyet Sonrası Ekonomilerde Gelir Eşitsizliği, Kurumsal Etkinlik ve Çevresel Gerileme: VEC ve VAR Nedensellik Yöntemlerinden Çıkarımlar

Öz: Bu çalışma, gelişmiş panel veri tekniklerini kullanarak 1996-2020 dönemi için post-Sovyet ekonomilerinde gelir eşitsizliği ve kurumsal etkinlik ile çevresel bozulma arasındaki nedensellik ilişkisini incelemektedir. Granger nedensellik sürecinin araştırılması için iki alternatif yöntem olarak Vektör Hata Düzeltme (VHD) modeli ve Toda & Yamamoto (1995) tarafından geliştirilen VAR modeli kullanılmıştır. Temel bulgumuz, VHD modeli sonuçlarına göre gelir eşitsizliği ve kurumsal kalite ile karbondioksit emisyonu arasında nedensel bir ilişki ortaya çıkmamasına rağmen Toda-Yamamoto yaklaşımı, Gini endeksinden ve yolsuzluk kontrolü, hükümet etkinliği, düzenleyici kalite ve hukukun üstünlüğü gibi kurumsal kalite göstergelerinden karbondioksit emisyonuna doğru ilerleyen bir nedensellik ilişkisinin bulunduğunu öne sürmektedir. Elde ettiğimiz sonuçlara esasen, gözlemlenen ülkelerde güçlü kurumlar, çevre politikalarının uygulanmasını destekler, sürdürülebilirliği teşvik eder ve düzenlemelere uyumu ve sorumlu kaynak kullanımını sağlayarak emisyonları azaltır. Diğer yandan, gelir eşitsizliği tüketim farklılıklarına ve temiz teknolojilere sınırlı erişime yol açarak karbon emisyonlarının artmasına ve çevresel bozulmaya neden olabilmektedir. Bu durum, sağlam çevre düzenlemeleri ve yönetişimin yanı sıra adil ekonomik politikaların benimsenmesinin zorunlu olduğu Sovyet sonrası ekonomiler için geçerli olmaktadır.

Anahtar Kelimeler: Gelir eşitsizliği, Kurumsal etkinlik, CO2 emisyonu, ARDL, VEC, VAR, Toda-Yamamoto yaklaşımı
Jel Codes: C23, D31, E02

Cite: Başkaraağaç Yaşar, N. (2025). Income disparity, institutional effectiveness, and environmental decline in post-soviet economies: insights from VEC and VAR causality methods. *Fiscaoeconomia, 9*(1), 1-12. https://doi.org/10.25295/fsecon.1512817

Submitted: 09.07.2024
Accepted: 29.07.2024

1. Introduction

In a circumstance of environmental degradation stemming from economic endeavours and mounting apprehensions over sustainability, the United Nations General Assembly took a significant stride in 2015 by supporting the 17 Sustainable Development Goals. These goals hold relevance for all nations, irrespective of their developmental status, and are grounded in the principle of promoting equality and preventing the marginalization of any society in the quest for economic, social, and environmental progress. In this context, it can be argued that sustainable development encompasses an economic growth paradigm which strives to be attained without exacerbating environmental degradation, poverty, and ultimately income disparity.

Comprehending and addressing the emerging environmental challenges in developing economies within the post-Soviet region necessitates an examination of the influence of income distribution and institutional quality on ecological pollution, with a specific focus on the unique characteristics of the old socialist structure. Understanding these causal relationships is crucial for designing effective policies that simultaneously address wealth disparity, enhance governance quality, and reduce CO2 emissions. In pursuit of this aim, two distinct methodological frameworks are employed to examine Granger causality: The Vector Error Correction Model (VECM) and the augmented Vector Autoregressive (VAR) model at the level with integrated and co-integrated processes of arbitrary orders, established by Toda & Yamamoto (1995).

The rest of this study is structured as follows: In the subsequent section, we present a brief overview of selected studies. The third section suggests the concise summary of former USSR countries. Following that, we outline data on observed countries, the applied estimation method, and our empirical findings. Finally, the concluding section summarizes our findings and offers concluding remarks.

2. Brief Overview of Selected Studies

Income inequality, typically indicative of disparities in measured earnings, wages, or overall income levels among different socioeconomic groups or percentiles, denotes the uneven allocation of income within a particular population or society. As proposed by Kuznets (1995) neoclassical economics posits an inverted U-shaped relationship among economic advancement and disparity. During the early phase of economic growth, income inequality tends to rise with increasing wealth. However, once a certain threshold of wealth is attained, income inequality is expected to decline, thus there is the inverted U-shaped relationship between economic growth and income inequality. Drawing on this hypothesis, Grossman & Krueger (1991) formulated the Environmental Kuznets Curve Hypothesis (EKC), suggesting that ecological deterioration incline to escalate in the initial stages of economic growth. However, beyond a certain inflection point, environmental degradation is anticipated to diminish as economic prosperity continues to increase. The effectiveness of EKC hypothesis has been extensively challenged and has been a focal point of numerous academic inquiries, with empirical investigations yielding divergent outcomes. Following Perman et al. (2003), the validity of the hypothesis holds significant implications for the strategies that policymakers ought to pursue. In an economy where the EKC hypothesis is valid, wherein growth contributes to enhanced environmental quality, there exists no necessity to curtail growth to safeguard the environment. Conversely, in scenarios where economic growth exacerbates environmental pollution, it is imperative to implement public policies aimed at constraining growth.

Kim & Baek (2011) contend that factors beyond income could also be crucial determinants of environmental outcomes. Moreover, earlier studies may be vulnerable to omitting variable bias, potentially influencing the accuracy of their findings. While recent EKC literature has highlighted numerous variables, such as energy usage and FDI, as influential factors on environmental outcomes, one less acknowledged variable is income inequality. Hao et al. (2016) propose that the impact combined CO_2 emissions and, by

extension, environmental quality, is not solely determined by income level but also by its distribution within a given population. One of the pioneering studies in theoretical analysis investigating the correlation among income distribution and environmental well-being is Boyce (1994). This research presents a novel method, known as the political economic approach, to analyze how income inequality affects environmental pollution. It concludes that a notable disparity between authority and earnings could result in a deterioration of individual environmental integrity. In societies marked by high levels of income inequality, environmental degradation may escalate, as political elites could facilitate the approval of environmentally harmful projects while impeding inspection processes. Following Yang et al. (2022), another approach, demonstrating how income distribution can affect emission levels, is based on marginal emission propensity. This approach suggests that emissions vary based on the distribution of income. Conversely, the final approach contends that elevated income inequality fosters competition in consumption, leading to heightened energy usage and, consequently, increased CO_2 emissions.

While the correlation between income distribution and environmental pollution has garnered significant attention in recent academic studies, a unanimous conclusion remains elusive. These investigations have yielded diverse findings, contributing to a lack of consensus on the matter. While certain studies, such as those by Heerink et al. (2001), Borghesi (2006), and Hübler (2017), discover a has identified a reverse relationship among income disparity and CO_2 emissions, a potential trade-off between fostering parity and improving ecological integrity, Golley & Meng (2012) propose a direct correlation among these variables.

Beyond, income distribution intuitional quality plays a pivotal role in addressing unwanted emissions into the environment and their associated economic and social impacts. According to Chhabra (2023), robust institutions, characterized by stringent and efficacious environmental policies, facilitate the utilization of sustainable energy resources, fostering the advancement of green technologies and facilitating knowledge diffusion. Consequently, they contribute to the mitigation of environmental degradation. Empirical studies validate that well-functioning institutions enact policies conducive to environmental preservation, thereby diminishing carbon emissions and fostering environmental sustainability.

Various studies have employed numerous substitutes for institutional arrangements and ecological state quality, resulting in contradictory findings and a blend of outcomes that fail to provide a comprehensive result. Carlsson & Lundstrom (2003) examined the influence of political and economic liberties on carbon dioxide emissions. Their findings suggest that democracy does not exert a significant influence on improving environmental quality. Scruggs & Rivera (2008) offer a valuable contribution to the literature discourse on the correlation among democracy and environmental improvement which finds no significant association between these variables. Gallagher & Thacker (2008) have contended that there exists an injurious correlation among democratic quality and ecological condition. Conversely, Barbier (2015) posits that democracy exerts a beneficial influence on environmental quality through mechanisms such as the provision of political rights and freedom of information. Democratic systems may foster heightened public awareness, leading to more informed decision-making regarding the sustainable utilization of natural resources. Gani (2012) explores the correlation amid five dimensions of effective governance CO_2 emissions across various emerging economies. The findings indicate that political stability, the rule of law, and anti-corruption measures exhibit a statistically significant negative correlation with CO_2 emissions per capita. Osabuohien et al. (2014) identifies a long-run association among CO_2 and particulate matter emissions, income levels, and other indicators, including institutional factors and trade. Azam et al. (2021) develops an institutional quality index encompassing three key dimensions: Political robustness, administrative effectiveness, and democratic responsibility. Results obtained through the generalized method of moments framework indicate that the quality

of institutions demonstrates a beneficial impact on various environmental metrics, encompassing CO_2 emissions, CH_4 emissions, and forest coverage. Abduqayumov et al. (2020) investigate the consequences of institutional quality on environmental effectiveness within 15 former USSR countries. Their findings underscore a significant strong association between institutional quality and environmental efficiency, indicating the necessity for these economies to cultivate improved institutions to sustain an environment conducive to the well-being of future generations.

The literature review suggests that income distribution and institutional quality constitute crucial elements capable of notably influencing environmental integrity.

3. A Compact Overview of Income Disparity, Institutional Effectiveness in Post-Soviet States

Post-Soviet countries are the states that arose following the breakup of the Soviet Union in 1991. There are 15 independent countries that were formerly part of this structure which have each developed unique identities and faced their own challenges in the decades since gaining independence. Following the dissolution of the Soviet Union, post-Soviet countries embarked on a transition from socialist economies to market-oriented systems. This shift involved significant economic restructuring, characterized by the privatization of state-owned enterprises, the liberalization of trade, and the establishment of market-driven regulatory frameworks. Common economic features during this transition included initial economic contraction, inflation, and rising unemployment as markets adjusted. Additionally, the institutional economic structure of these countries had been dominated by state institutions and organizations during the Soviet period, resulting in a centralized and often inefficient bureaucracy. The challenge for these nations was to dismantle the old, centralized structures and build new institutions that could support a functioning market economy, enforce property rights, and encourage private enterprise. The success of this transition varied widely across the region, influenced by the extent of reforms and the establishment of robust legal and institutional frameworks.

As Ağçakaya (2009) states the primary policy objectives during the economic transition process in most of these states have focused on price liberalization, privatization, and economic stability. Consequently, eligible fiscal policies have been overlooked in this process, resulting in unresolved issues concerning growth and income distribution. This fact is clear from Figure 1, which illustrates the increasing disparity in income inequality during the initial phase of the transition process. The rise in inequality is evident across the region, as indicated by the number of countries positioned above the diagonal line.

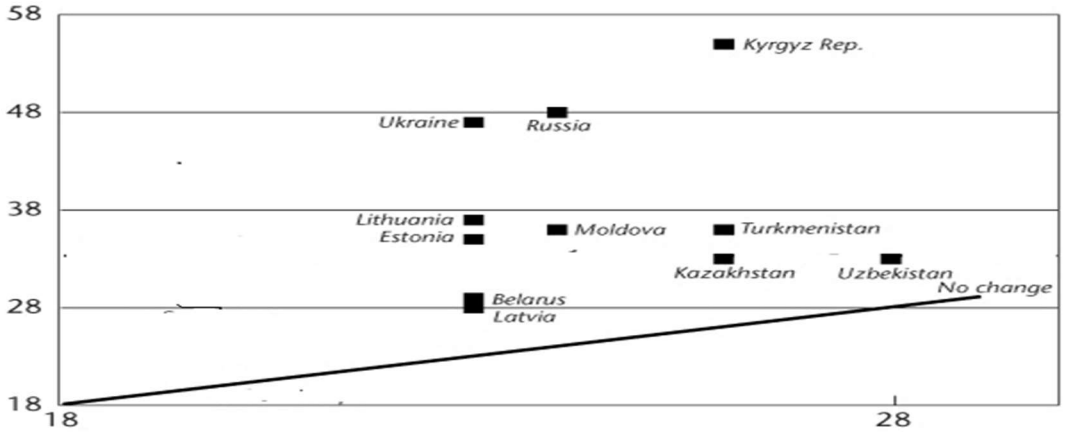

Figure 1. Gini Coefficients in 1994–1995 in Observed Former USSR Economies (**Source:** https://www.elibrary.imf.org/display/book/9781589060135/ch12.xml#ch12ref06)

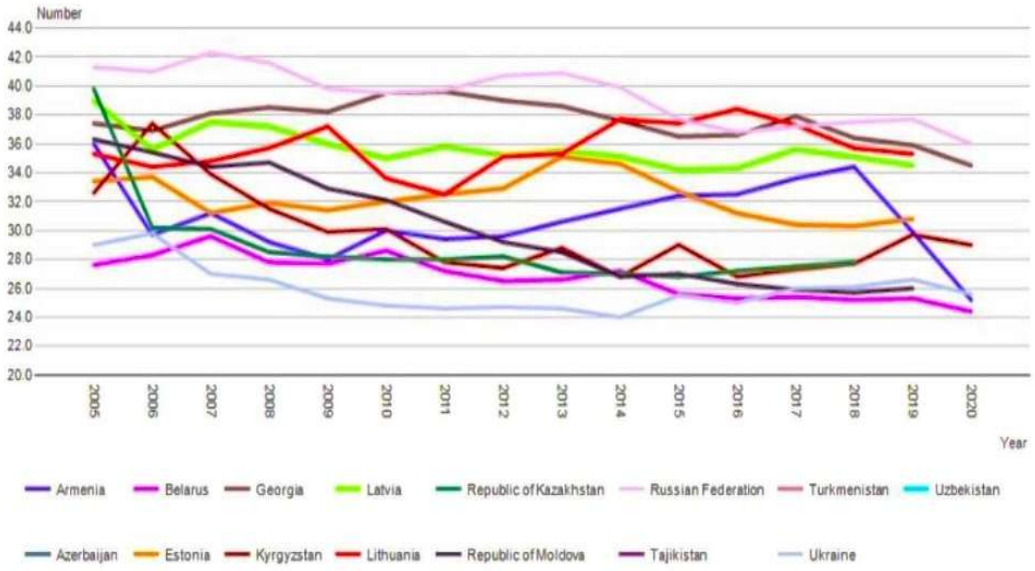

Figure 2. Gini Coefficients by Former USSR Countries and Year (**Source:** https://px.web.ined.fr/GGP/pxweb/en/2%20Economy//2.4_GC_WB.px/chart/chartViewLine/)

According to the Figure 2, which demonstrates the Gini Index over time by post-communist economies, the utmost Gini values are noticed in Russia, Georgia, Latvia, and Lithuania while the lowest are found in Ukraine, Belarus, and Kazakhstan. For countries with unequal income distribution, this situation often arises due to the underdevelopment of the business sector, corruption, and the failure to establish and meticulously implement appropriate economic policies. The highest Gini index value was recorded in the Russian Federation in 2008, coinciding with a recession in the Russian financial markets and an economic downturn exacerbated by political tensions following the war with Georgia, along with a significant drop in the value of Urals heavy crude oil. The most notable change has been observed in Armenia, where the high Gini index value has experienced a dramatic decrease in recent years. According to Tonoyan (2005), multifaceted reasons behind poverty in Armenia, may be attributed to a combination of non-economic factors, social relations, decision-making processes of various social groups and institutions, and individual behaviors. However, the primary cause of income inequality in Armenia is associated with the transitional period's shocks. Specifically, poverty is mainly attributed to the reduction in gross product, resulting in decreased real consumption levels, and an increase in inequality in its distribution structure.

Yet another socio-economic challenge experienced by these newly independent countries during the transition period in the post-Soviet era was the presence of low institutional quality. After the collapse of the Soviet Union, these states embarked on divergent trajectories concerning political and economic integration. For instance, the Baltic states historically intertwined with Europe and forcibly absorbed into the Soviet Union, swiftly pursued integration with Western institutions. These countries have successfully navigated the arduous and intricate paths of the transition process, surpassing expectations with their performance, while most other countries continue to make progress toward democracy. However, the remaining former Soviet republics convened to establish the Commonwealth of Independent States (CIS) in December 1991. CIS emerged as a loose confederation, primarily aimed at facilitating cooperation among its member states across various domains such as economy, defense, and security. As Naplava (2020) indicates, while some Baltic countries have embraced the "Western route"

characterized by democratification, improved institutional quality, and consequently, stronger economic performance, others have seemingly reverted to Soviet-era ideologies, particularly evident in Belarus and the Russian Federation. As Bernhard & Jung (2017) summarizes, the collapse of communism led to three primary patterns of post-communist development. Firstly, countries with strong civil societies transitioned more directly and rapidly to western institutions, liberal-democratic politics, and market economies. This pattern, exemplified by the Baltic states, was driven by domestic movements for reform. Secondly, some countries achieved a similar trajectory with outside assistance, moving towards liberal democracy and market-oriented reform, albeit with some ambiguity and influence from clientelism and authoritarian tendencies. Finally, weaker civil societies at the outset allowed for the establishment of neo-authoritarian governments, characterized by alliances between political and economic elites and a focus on elite enrichment, particularly in energy-rich economies.

4. Data, Empirical Methodology and Results

This research examines the causal link extending from disparities in income and institutional effectiveness to environmental deterioration in post-Soviet economies from 1996 to 2020. The investigation utilizes CO_2 emissions as a substitute for environmental contamination, fulfilling the role of the dependent variable in the analytical framework. The Gini Index quantifies income inequality, whereas institutional quality is assessed through multiple indicators: (i) control of corruption, (ii) government effectiveness, (iii) political stability and absence of violence/terrorism, (iv) regulatory quality, (v) rule of law, and (vi) voice and accountability. The yearly data for these variables are sourced from the World Development Indicators and the Worldwide Governance Indicators, both released by the World Bank.

In the study, the first step involved conducting a stationarity test to determine whether the series contained unit roots. Following this, an Autoregressive Distributed Lag (ARDL) model was developed to examine the co-integration relationship between the series. Additionally, a Vector Error Correction (VEC) model was implemented to explore the dynamics of both long-term and short-term relationships between the co-integrated series (for details see Yasar (2021)). The F-statistics employed in the Granger causality test may become invalid when it deviates from the normal distribution, particularly in the presence of a co-integration relationship among the variables. To address this limitation, Toda & Yamamoto (1995) introduced the causality analysis which rooted in the VAR model and enables the estimation of causal relationships between variables using the WALD test with level values. Hence, in this research, alongside the conventional Granger causality approach, we utilize the comparatively recent Toda and Yamamoto causality examination to explore the connections among income inequality, institutional quality, and environmental degradation within the studied nations.

First, it is essential to test the stationarity features of the series. As Toda and Phillips (1993) indicates employing non-stationary data in causality tests may lead to Erroneous and deceptive results due to the non-standard distribution of the test statistics. Our stationarity testing procedure includes first-generation panel stationarity tests as proposed by Breitung (2000), Levin et al. (2022), Im et al. (2003), Maddala & Wu (1999), and Choi (2001) which are used to assess the stationarity of panel data.

Table 1. Panel Unit Root Tests Results

	Levin et al. (2002)		Im et al. (2003)		ADF-Fisher		PP-Fisher		Breitung (2000)
	Intercept	*Intercept +Trend*	*Intercept*	*Intercept +Trend*	*Intercept*	*Intercept +Trend*	*Intercept*	*Intercept +Trend*	*Intercept +Trend*
CO2	0,339	-0,442	0,745	-0,158	27,497	33,501	28,767	29,534	0,148
Δ CO2	-6,800*	-10,220*	-7,896*	-13,613*	119,318*	193,479*	203,902*	2204,140*	-6,831*
GI	-0,587	0,823	-0,078	0,665	18,295	16,045	23,568	34,122	-1,036
ΔGI	-4,934*	-3,380*	-6,913*	-4,703*	90,097*	63,002*	180,784*	132,597*	-2,844*
CC	1,883	0,414	1,495	0,1297	31,657	34,978	37,590	38,031	3,260
ΔCC	-3,620*	-1,089	-6,907*	-4,579*	108,647*	87,577*	260,775*	426,620*	-3,719*
GE	0,254	-0,702	0,090	-0,226	33,971	37,905	36,702	49,475	0,662
ΔGE	-8,610*	-7,042*	-8,378*	-5,332*	132,964*	104,517*	268,731*	370,473*	-5,271*
PS	-0,943	-2,555**	-0,778	-2,573**	37,256	58,498**	49,746	69,763*	-1,564****
ΔPS	-7,172*	-4,659*	-10,018*	-6,101*	162,644*	120,966*	316,598*	507,094*	-1,753**
RQ	-0,355	-0,105	0,603	-0,235	28,374	36,743	48,003**	58,923**	1,705
ΔRQ	-4,517*	-3,015**	-5,726*	-2,836**	96,791*	66,725*	221,051*	188,659*	-1,466***
RL	1,448	1,749	1,600	0,913	18,223	21,563	18,694	29,824	1,963
ΔRL	-2,843**	0,695	-6,128	-3,243*	96,512	66,375*	227,528	202,211*	-2,281
VA	0,902	-0,066	2,549	0,740	10,649	26,714	15,383	34,437	2,349
ΔVA	-6,105	-4,060*	-6,395*	-3,442*	108,312*	81,104*	205,502*	203,352*	0,705

Note: The null hypothesis of a unit root is refuted at the significance levels of 1%, 5%, and 10%, denoted by *, **, and ***, correspondingly.

The results presented in Table 1 reveal mixed findings for the observed countries. Some test results indicate that certain variables, such as political stability, are stationary at level I (0). However, other panel unit root test findings show that the series contain a unit root and follow a first-order stationary process, leading to inconsistent conclusions about the order of integration of the series. Once the series fulfil the requisite stationarity criteria, typically denoted as I (1) series, we proceed to examine their cointegration properties. This condition denotes a scenario where two or more time series are intertwined in such a manner that they maintain a long-term relationship. To investigate the presence of cointegration among variables, we employ the ARDL technique proposed by Pesaran et al. (2001). Crucially, this approach is applicable irrespective of whether the series under examination are integrated at the same level.

To investigate the null hypothesis of no long-term correlation among the series, we conducted the bounds (ARDL) test, and the findings are presented in Table 2. The relevant lag lengths are determined according to the Akaiki information criterion (AIC).

Table 2. ARDL Bound Test Results

Direction of ARDL	F-statistic
GI → CO2	8,392* (0,0003)
CO2 → GI	0,215 (0,806)
CC→ CO2	1,607 (0,202)
CO2 → CC	1,738 (0,177)
GE → CO2	7,840* (0,0005)
CO2 → GE	4,774* (0,009)
PS → CO2	9,187* (0,0001)
CO2 → PS	8,188* (0,0004)
RQ → CO2	7,139* (0,001)
CO2→ RQ	3,963** (0,020)
RL → CO2	7,807* (0,0005)
CO2 → RL	1,564 (0,211)
VA → CO2	9,061* (0,0002)
CO2 → VA	5,566* (0,004)

Note: *, ** signify significance at the 1% and 5% thresholds, respectively.

The outcomes depicted in the table above suggest that there is a long-term association for the equations computed for all variables except for the control of corruption. Once co-integration is established among the variables, the next step involves constructing an error correction mechanism to model the dynamic relationship. The VECM serves to indicate the speed at which the system adjusts from short-term disequilibrium to long-term equilibrium. The outcomes of this examination are displayed in Table 3. Moreover, the efficacy of the VECM is notably influenced by the choice of the most suitable lag length. Hence, the requisite lag length for the observed series is determined using the Akaike Information Criterion (AIC).

Table 3. VECM-Granger Causality Analyses Results

Direction of VECM	ECT t-statistic	Short-run F-statistic
GI → CO2	64,309* (0,000)	10,559 (0,000)
GE → CO2	110,567* (0,000)	2,805** (0,026)
CO2 → GE	-3,360* (0,0009)	1,228 (0,299)
PS → CO2	-3,478* (0,0006)	0,739 (0,478)
CO2 → PS	-4,020* (0,0001)	0,158 (0,924)
RQ → CO2	-3,107* (0,002)	3,344 (0,036)
CO2 → RQ	-2,819* (0,005)	0,682 (0,563)
RL→ CO2	-3,129* (0,001)	0,843 (0,471)
CO2 → RL	-1,185 (0,237)	0,882 (0,450)
VA → CO2	-2,894* (0,004)	0,721 (0,487)
CO2 → VA	-3,564* (0,0004)	1,114 (0,343)

Note: *, ** represent significance at the 1% and 5% levels, respectively

According to the table above, the significance of the error correction term for all co-integrated series confirms the existence of a long-term relationship at the 1% significance level. Examining the VECM-based Granger causality test results in the table reveals a unidirectional causal relationship at the 5% significance level, running from government effectiveness to carbon dioxide emissions in former Soviet countries during the observed period.

A significant criticism of the Granger causality analysis is its high sensitivity to the selected lag length. To address this issue, Toda & Yamamoto (1995) developed an approach that mitigates this sensitivity. Unlike Granger's method, this test is based on the standard VAR model and can be applied to all series regardless of their stationarity properties, whether they are I (0) or I (1). The Toda-Yamamoto causality methodology is based on the following regression model:

$$Y_t = w + \sum_{i=1}^{k} \alpha_{1i} X_{t-1} + \sum_{i=1}^{k} \beta_{1i} Y_{t-i} + \sum_{j=k+1}^{dmax} \delta_{1i} X_{t-i} + \sum_{j=k+1}^{dmax} \theta_{1i} Y_{t-i} + \epsilon_{1t} \quad (1)$$

$$Y_t = f + \sum_{i=1}^{k} \alpha_{2i} X_{t-1} + \sum_{i=1}^{k} \beta_{2i} Y_{t-i} + \sum_{j=k+1}^{dmax} \delta_{2i} X_{t-i} + \sum_{j=k+1}^{dmax} \theta_{2i} Y_{t-i} + \epsilon_{2t} \quad (2)$$

Here, the appropriate lag length for the VAR model (k) should be determined as the maximum lag length of the series. The degree of integration (dmax) is then should be added to this lag length, resulting in a modified lag length of (k+dmax). For a valid model, k must exceed or equal dmax, i.e., k≥dmax. Subsequently, causality directions are investigated employing a modified Wald (MWALD) test on the augmented VAR specification. Pittis (1999) suggests that this method offers the advantage of loosening restrictions on the parameters of the VAR model while maintaining its asymptotic chi-square distribution.

Table 4. Granger Causality Test Results Based on the Toda-Yamamoto Procedure

Direction of Toda-Yamamoto VAR Model	Appropriate Lag Lenth (k)	D-max	k + Dmax	Chi-square
GI → CO2	1	1	2	4,523** (0,033)
CO2 → GI	1	1	2	0,173 (0,677)
CC → CO2	1	1	2	5,258** (0,021)
CO2 → CC	1	1	2	1,957 (0,539)
GE → CO2	1	1	2	0,539*** (0,062)
CO2 → GE	1	1	2	6,573** (0,010)
PS → CO2	1	1	2	2,002 (0,157)
CO2 → PS	1	1	2	0,142 (0,705)
RQ → CO2	1	1	2	9,262* (0,002)
CO2 → RQ	1	1	2	8,572 (0,304)
RL → CO2	1	1	2	6,363** (0,038)
CO2 → RL	1	1	2	5,614** (0,017)
VA → CO2	1	1	2	6,562 (0,400)
CO2 → VA	1	1	2	2,705 (0,611)

Note: *,**,*** denote significance at the 1%, 5%, and 10% levels, respectively.

As indicated in the above table, our findings illustrate that income inequality is a Granger cause of increasing CO_2 emissions in the examined economies. While the VECM outcomes do not exhibit a causal link between income disparities and carbon dioxide emissions, the Toda-Yamamoto method indicates a unidirectional causality from the Gini index to CO_2 emissions. Moreover, despite the lack of a causal association between institutional quality and carbon dioxide emissions in the VECM results, the Toda-Yamamoto approach reveals causality extending from control of corruption, government effectiveness, regulatory quality, and rule of law to CO_2 emissions.

5. Concluding Remarks

This research examines the influence of income distribution and institutional quality on environmental pollution in post-Soviet economies from 1996 to 2020, utilizing advanced panel estimation techniques. To assess causality, we employ two alternative methodological approaches: the VECM and the augmented VAR model with integrated and co-integrated processes of arbitrary orders developed by Toda & Yamamoto (1995).

Our main finding suggests that although the VECM outcomes do not uncover a causal relationship running from disparities in income and institutional effectiveness to carbon dioxide emission, the Toda-Yamamoto approach suggests causality from the Gini index and the majority of the evaluated institutional quality indicators - including control of corruption, government effectiveness, regulatory quality, and rule of law - to carbon dioxide emissions.

These findings align with Abduqayumov et al. (2020) and Yang et al. (2022), which concluded that robust institutions enhance environmental quality and reduce inequality in developing economies. Moreover, poor institutional quality—characterized by high corruption, ineffective government, weak regulatory frameworks, and inadequate rule of law—leads to higher carbon dioxide emissions and greater environmental degradation.

Conversely, strong institutions support the effective implementation and enforcement of environmental policies, promote sustainable practices, and reduce emissions by ensuring that laws and regulations are followed and that resources are used efficiently and responsibly.

On the other hand, income inequality in observed countries leads to disparities in consumption patterns and access to clean technologies, resulting in higher carbon dioxide emissions and increased environmental degradation. Addressing these challenges in post-soviet economies it is important to adopt equitable economic policies that provide access to sustainable technologies and practices across all income levels, alongside stronger environmental regulations, and governance.

References

Abduqayumov, S., Arshed, N. & Bukhari, S. (2020). Economic impact of institutional quality on enviromental performance in Post - Soviet Countries. *Transition Studies Review, 27*(3), 13-24.

Ağcakaya, S. (2009). Geçiş ekonomilerinden Orta Asya Türk Cumhuriyetleri'nde bütçe yönetimi ve mali disiplin. *Akademik Bakış, 16*.

Barbier, E. B. (2015). Climate change impacts on rural poverty in low-elevation coastal zones. *Estuarine, Coastal and Shelf Science, 165,* 1-13.

Borghesi, S. (2006). Income inequality and the environmental Kuznets curve. *Environment, Inequality, and Collective Action, 33*.

Boyce, J. (1994). Inequality as a cause of environmental degradation. *Ecological Economics, 11*(3), 168-179.

Breitung, J. (2000). The local power of some unit root tests for panel data. B. H. Baltagi, T. B. Fomby & R. Carter Hill (Ed.), *Nonstationary panels, panel cointegration, and dynamic panels* (p. 161-177). Emerald Group Publishing Limited, Leeds.

Carlsson, F. &. Lundstöm, S. (2003). The effects of economic and political freedom on CO2 emissions. Göteborg University Department of Economics *Working Papers in Economics, 29*.

Chhabra, M. G. (2023). Do trade openness and institutional quality contribute to carbon emission reduction? Evidence from BRICS countries. *Environ Sci Pollut Res, 30*, 50986–51002.

Choi, I. (2001). Unit root tests for panel data. *Journal of International Money and Banking, 20*(2), 249-272.

Demir, C., Cergibozan, R. & Gok, A. (2019). Income inequality and CO2 emissions: Empirical evidence from Turkey. *Energy and Environment, 30*(3), 444-461.

Destek, M. (2019). An investigation on the impact of income distribution on environmental pollution. *Gaziantep University Journal of Social Sciences, 18*(4), 1477-1488.

Gallagher, K. P. (2008). Democracy, income, and environmental quality. University of Massachussets Amherst. *PERI Working Paper 164*.

Gani, A. (2012). The relationship between good governance and carbon dioxide emissions: Evidence. *Journal of Economic Development, 37*(1), 77-93.

Golley J, M. X. (2012). Income inequality and carbon dioxide emissions: the case of Chinese urban households. *Energy Economics, 34*(6), 1864–1872.

Grossman, G. M. (1991). *Environmental impacts of a North American free trade agreement.* National Bureau of Economic Research, Cambridge.

Hao Y, Chen, H. & Zhang, Q. (2016). Will income inequality affect environmental quality? Analysis based on China's provincial panel data. *Ecological Indicators 67*, 533-542.

Harbaugh, W. T., Levinson, A. & Wilson, D. M. (2002). Reexamining the empirical evidence for an environmental Kuznets curve. *The Review of Economics and Statistics, 84*(3), 541-551.

Heerink N, Abay, M. & Erwin, B. (2001). Income inequality and the environment: aggregation bias in environmental Kuznets curves. *Ecological Economics, 38*(3), 359–367.

Hübler, M. (2017). The inequality-emissions nexus in the context of trade and development: a quantile regression approach. *Ecological Economics*, *134*, 137-185.

Im, K. P. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*(1), 53-74.

Kim, H. S. & Baek, J. (2011). The environmental consequences of economic growth revisited. *Economics Bulletin, 31*, 1198-1211.

Kuznets, S. (1995). Economic growth and income inequality. *American Economic Review, 45*(1), 1-28.

Levin, A. C. (2022). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics, 108*(1), 1-24.

Maddala, G. a. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics,* (Special Issue), 631-652.

Michael Bernhard, D.-J. J. (2017). Civil society and income inequality in post-communist Eurasia. *Comparative Politics, 49*(3), 373-90.

Muhammad Azam, L. L. (2021). Impact of institutional quality on environment and energy consumption: evidence from developing world. *Environment, Development and Sustainability, 23*, 1646–1667.

Náplava, R. (2020). Institutional quality and income inequality: Evidence from Post-Soviet countries. *European Journal, 6*(2), 100-112.

Osabuohien, E. S. (2014). Beyond the environmental Kuznets curve in Africa: Evidence from panel cointegration. *Journal of Environmental Policy and Planning, 14*(4), 517-538.

Pesaran, M. S. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289-326.

Pittis, N. (1999). Efficient estimation of cointegrating vectors and testing for causality in vector autoregressions. *Journal of Economic Surveys, 13*(1), 1-35.

Roger Perman, Y. M. (2003). *Natural resource and environmental economics*. Pearson Education Limited.

Scruggs, L. A. (2008). Political regimes, democratic institutions, and environmental sustainability: A cross-national analysis. In *Proceedings of the Midwest Political Science Association Meeting in Chicago, 36*, Chicago, IL, USA.

Toda, H. Y. & Phillips, P. (1993). The spurious effect of unit roots on vector autoregressions. *Journal of Econometrics, 59*(3), 229-255

Toda, H. Y. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics, 66*(1-2), 225-250.

Tonoyan, T. (2005). Poverty, inequality and health: A case study of Armenia. Beitrag Nr. 124 / Issued No. 124.

Yang, Bo, Ali, M., Hashmi, S. H. & Jahanger, A. (2022). Do income inequality and institutional quality affect CO2 emissions?. *Environmental Science and Pollution Research, 29*, 42720–42741.

Yasar, N. (2021). The causal relationship between foreign debt and economic growth: Evidence from commonwealth independent states. *Foreign Trade Review, 56*(4), 415-429.

Conflict of Interest: None.

Funding: None.

Ethical Approval

Author Contributions: Nermin YAŞAR BAŞKARAAĞAÇ (100%)

Çıkar Çatışması: Yoktur.

Finansal Destek: Yoktur.

Etik Onay: Yoktur.

Yazar Katkısı: Nermin YAŞAR BAŞKARAAĞAÇ (%100)