




Nonlinear Relationship between Public Debt and Environmental Debt with Regard to the Role of Institutional Quality

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Abstract

On the one hand, public debt can help reduce environmental debt by financing projects that promote environmental sustainability. On the other hand, the high level of public debt often limits investment in renewable energy and puts pressure on natural resources, thereby aggravating the environmental debt. Therefore, examining the nonlinear relationship between public debt and environmental debt is important. However, this nonlinear relationship may be affected by factors such as the quality of debt management. Accordingly, the main objective of this study is to investigate the role of institutional quality in the nonlinear relationship between public debt and environmental debt in developing countries during the period 1996-2022. For this purpose, panel cointegration analyses with cross-sectional dependence and the cross-sectionally augmented autoregressive distributed lag (CS-ARDL) have been used. The empirical results indicate that, as the public debt-to-GDP ratio increases, per capita environmental debt initially decreases, but after reaching a certain level, it increases. This result confirmed the U-shaped relationship hypothesis between the two debts in developing countries with a threshold level of 67.5 percent. Additionally, according to the results, an increase (decrease) in institutional quality raises (lowers) the threshold level of public debt and, as a result, increases (decreases) the effectiveness of public debt in reducing environmental debt. The robustness of the empirical results has also been confirmed using the PMG-ARDL method.

Keywords: Public Debt, Environmental Debt, Institutional Quality, Nonlinear Relationship, Cross-Sectionally Augmented Autoregressive Distributed Lag.

JEL Classification: C32, Q56, H6, E02.

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1. Introduction

In recent decades, stemming the rising environmental and public debt has been the two distinguishing characteristics of achieving sustainable development in global prospects. (Biswal et al., 2025). As per the Global Footprint Network (2023) report, the global per capita ecological deficit is 1.17 Gha, and the cumulative sum of this ecological biodiversity deficit is known as environmental debt. Environmental debt is defined as the accumulation of past environmental impacts of natural resource depletion and environmental degradation, owed to future generations. It is measured by the costs required to restore the environmental damage that is economically and technically restorable (Jernelöv & Edenmark, 1992). A reasonable and sustainable level of public debt can lead to a reduction in environmental debt by financing projects that contribute to environmental sustainability. Conversely, high and unsustainable levels of public debt often limit investment in renewable energy, put pressure on natural resources, and thereby exacerbate environmental debt. Therefore, examining the nonlinear relationship between public debt and environmental debt is important. However, this nonlinear relationship may be affected by factors such as the quality of debt management. Accordingly, the main objective of this study is to investigate the role of institutional quality in the nonlinear relationship between public debt and environmental debt in developing countries during the period 1996-2022.

2. Theoretical framework

Both “benediction” and “curse” perspective, public debt affects the environment. The benediction perspective of public debt is based on assumption that the government uses public debt to fund environmental sustainability initiatives by investing in renewable energy projects and giving grants for environmentally friendly R&D that ultimately assist in improving the environment quality. However, “curse” perspective believes that a large amount of public debt can prevent funding for renewable energy projects while also limiting the ability of governments to offer funds for research into renewable energy technologies. Additionally, a rising level of debt may push the government to cut back on investments and spending to bridge the budget deficit (Farooq et al., 2023; Biswal et al., 2025). By combining the benediction and curse hypotheses, a nonlinear U-shaped relationship can be imagined between public debt and environmental quality, which depends on various variables such as institutional quality (Golkhandan, 2024). Institutional quality not only directly influences the environment quality but also impacts the linkage between public debt and environmental performance. Good institutions use the government debt effectively to finance environment-friendly projects and research funds for the development of clean energy technologies such as renewable energy plans (Farooq et al., 2023). In fact, institutional quality plays an important role in the effectiveness of public debt in reducing environmental debt.

3. Methodology

To measure the non-linear effect of public debt on environmental debt considering the role of institutional quality, the following basic econometric equation is written as:

$$ED_{it} = \Psi_0 + \Psi_1 PD_{it} + \Psi_2 (PD_{it})^2 + \Psi_3 IQ_{it} + \Psi_4 (PD_{it} * IQ_{it}) + \Psi_5 GDP_{it} + \Psi_6 REC_{it} + \Psi_7 FDI_{it} + \epsilon_{it}$$

Here i and t represent the country and time period, respectively, Ψ_0 represents the intercept, Ψ_i indicates the slope coefficient, and ϵ represents the error term. The unit of measurement, description, and source of data is depicted in Table 1.

Table 1. Variables sources and units

Variable	Description	Units	Sources
ED	Environmental Debt	Per Capita	Authors' own calculation from Global Footprint Network (GFN) Data
PD	Public Debt	% of GDP	International Monetary Fund (IMF)
IQ	Institutional Quality	Good Governance Index, measured on a scale of (-2.5)–(+2.5)	Worldwide Governance Indicators (WGI)
GDP	GDP Per Capita	Constant US \$ 2015	World Development Indicators (WDI)
RER	Renewable Energy	% of Total Energy	Our World in Data (OWID)
FDI	FDI Inflows	% of GDP	WDI

This research employs the cross-sectional augmented autoregressive distributive lag (CS-ARDL) framework offered by Chudik and Pesaran (2015) to evaluate the long-term estimates. The primary motivation of this approach is Pooled Mean Group (PMG)-ARDL, which was proposed by Pesaran et al. (1999). This technique has many features that provide various benefits and other attributes. For instance, it is a consistent estimator while dealing with variables with different integration orders, such as $1(0)$ or $1(1)$. Additionally, the short and long-run CD may lead to the wrong estimation.

4. Discussion

The empirical results indicate that, as the public debt-to-GDP ratio increases, per capita environmental debt initially decreases, but after reaching a certain level, it increases. This result confirmed the U-shaped relationship hypothesis between the two debts in developing countries with a threshold level of 67.5 percent. Additionally, according to the results, an increase (decrease) in institutional quality raises (lowers) the threshold level of public debt and, as a result, increases (decreases) the effectiveness of public debt in reducing environmental debt. The robustness of the empirical results has also been confirmed using the PMG-ARDL method.

5. Conclusion and Suggestion

The study underscores that from the high level of public debt needs to be managed efficiently by converting its effect from “Curse” to “Benediction” for the ecology.

6. Ethical Considerations

6.1. Compliance with Ethical Guidelines

The author of the article declares that research ethics have been observed in this article.

6.2. Funding

The author of the article has not received any budget from any organization or company to conduct the research.

6.3. Authors' Contribution

The author of the article declares that all aspects of this research have been conducted by them.

6.4. Conflict of Interest

The author of the article declares that there is no conflict of interest in this research.

6.5. Acknowledgments

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