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**THE IMPACT OF FISCAL DECENTRALIZATION ON
SUSTAINABLE DEVELOPMENT – THE ROLE OF GREEN
INNOVATION AND GEOPOLITICAL RISKS**

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CHAPTER 1: INTRODUCTION

1.1. REASON FOR CHOOSING THE TOPIC

In recent years, the excessive consumption of natural resources, environmental degradation, and socioeconomic imbalances have prompted the international community – through the United Nations’ 2030 Agenda – to pursue the goal of Sustainable Development (SD). The concept of SD, classically defined in the Brundtland Report (1987) as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987), emphasizes the integration of three interrelated pillars: economic, social, and environmental (UNCED, 1992).

One of the key mechanisms of public governance in modern economies is fiscal decentralization (FD), which refers to the allocation of responsibilities, revenues, and expenditures between central and subnational governments. Numerous studies have shown that decentralization enables local governments to better understand regional needs and respond more flexibly to local environmental and developmental issues. Through this mechanism, FD can exploit the informational advantages of local authorities and improve overall economic efficiency (Cheng, 2019; Fredriksson & Millimet, 2002; Konisky, 2007). However, other studies have highlighted several challenges and inefficiencies associated with fiscal decentralization.

The current global context further amplifies the complexity of the issue, particularly when considering the roles of green innovation (GI) and geopolitical risk (GPR). Green innovation, or eco-innovation, is defined as “any form of innovation that leads to or is intended to achieve significant and demonstrable progress toward the goal of sustainable development” (Carrillo-Hermosilla et al., 2010). It has been widely recognized as a crucial pathway toward achieving SD (Du et al., 2019; Li & Xu, 2023). Therefore, examining how FD can optimize the amplifying effect of GI on SD is essential.

In summary, sustainable development and its driving factors have become central themes of scholarly interest in recent years. However, most existing studies use indicators such as CO₂ emissions, greenhouse gas (GHG) emissions, or the ecological

footprint to represent environmental sustainability (Ji et al., 2021; Khan et al., 2021; Lingyan et al., 2022; Fang & Fang, 2023). In contrast, SD must be considered comprehensively, encompassing three tightly interlinked pillars: social, environmental, and economic sustainability. A review of the literature reveals that very few studies approach sustainability from such an integrated, multidimensional perspective.

Based on these theoretical and practical considerations, the author has selected the topic “*The impact of fiscal decentralization on sustainable development – the moderating roles of green innovation and geopolitical risk*” for this doctoral dissertation. The study aims to systematize the theoretical framework related to SD, FD, GI, and GPR, and to empirically assess the impact of FD on SD - considering the moderating effects of GI and GPR – across 31 countries, divided into developed and developing groups, during the 2010–2022 period. By employing Bayesian regression techniques, the research seeks to investigate the differentiated impacts of FD on SD between these two groups of countries. Based on the empirical findings, the author will propose policy implications relevant to enhancing sustainable development in the context of fiscal decentralization, green innovation, and geopolitical risk.

1.2. RESEARCH OBJECTIVES AND QUESTIONS

1.2.1. Research objectives

- **General objectives:** The overall objective of this dissertation is to analyze the impact of fiscal decentralization (FD) on sustainable development (SD), taking into account the moderating roles of green innovation (GI) and geopolitical risk (GPR). The research findings are expected to provide a scientific foundation for proposing policy implications related to fiscal decentralization, green innovation, and the mitigation of geopolitical risks, thereby promoting sustainable development across nations.

- **Specific objectives:** Based on the general objective, the dissertation aims to achieve the following specific objectives:

+ To analyze the impact of fiscal decentralization on sustainable development in developed and developing countries.

+ To examine the potential inverted U-shaped relationship between fiscal decentralization and sustainable development across the two groups of countries.

- + To assess the moderating roles of green innovation and geopolitical risk in the relationship between fiscal decentralization and sustainable development in both developed and developing nations.

- + To propose relevant policy implications regarding fiscal decentralization, green innovation, and geopolitical risk in order to promote sustainable development.

1.2.2. Research questions

To achieve these objectives, the dissertation seeks to answer four main research questions:

(1) How does fiscal decentralization affect sustainable development in developed and developing countries?

(2) Do green innovation and geopolitical risk moderate the relationship between fiscal decentralization and sustainable development in these two groups of countries?

(3) Is there an inverted U-shaped relationship between fiscal decentralization and sustainable development across developed and developing nations?

(4) What policy solutions related to fiscal decentralization, green innovation, and geopolitical risk can be proposed to enhance sustainable development in these two country groups?

1.3. RESEARCH OBJECT AND SCOPE

1.3.1. Research object

The research focuses on:

- + The impact of fiscal decentralization on sustainable development; and
- + The moderating roles of green innovation and geopolitical risk in the relationship between fiscal decentralization and sustainable development.

1.3.2. Research scope

The study is conducted across 31 countries, divided into two groups: 19 developed countries and 12 developing countries (including Vietnam), over the period 2010–2022.

Data are collected from the official databases of the World Bank, IMF, and OECD. Missing data on fiscal decentralization are supplemented by the statistical

yearbooks of individual countries. Data on the geopolitical risk index (GPR) are obtained from the website www.matteoiacoviello.com.

1.4. RESEARCH METHODOLOGY

To achieve the research objectives – analyzing the impact of fiscal decentralization on sustainable development in 31 developed and developing countries – the dissertation employs a combination of qualitative and quantitative analytical methods.

- **Qualitative methods:** Synthesis, descriptive, and explanatory analyses are used to clarify the theoretical framework and research objectives.

- **Quantitative methods:** Unlike previous studies that primarily employ frequentist econometric techniques, this dissertation adopts a Bayesian statistical approach, which provides a robust and flexible framework for parameter estimation and model inference. Additionally, the System-GMM method is applied to test the robustness of the research model.

1.5. NOVEL CONTRIBUTIONS AND FINDINGS

1.5.1. Theoretical contributions

First, the dissertation systematizes and clarifies the theoretical foundations of the concepts and relationships among sustainable development, fiscal decentralization, green innovation, and geopolitical risk.

Second, it develops and proposes a comprehensive research model comprising two key components: (i) a model assessing the direct impact of fiscal decentralization on sustainable development, and (ii) a model examining the moderating effects of green innovation and geopolitical risk on this relationship.

Third, by employing the Bayesian approach – a modern and highly reliable method in econometric analysis – the dissertation identifies a nonlinear inverted U-shaped relationship between fiscal decentralization and sustainable development.

Fourth, the research provides empirical evidence confirming the positive effects of GDP growth, trade liberalization, and government size on sustainable development, thereby reinforcing the theoretical arguments of sustainable growth and open-economy theories.

1.5.2. Practical contributions

The dissertation proposes optimal fiscal decentralization thresholds for sustainable development in both groups of countries under study. Furthermore, the findings provide valuable insights for policymakers to better understand the roles of fiscal decentralization, green innovation, and geopolitical risk in promoting sustainable development, thereby informing appropriate policy designs tailored to each country group.

1.6. STRUCTURE OF THE DISSERTATION

To achieve its objectives, the dissertation is organized into five chapters as follows:

Chapter 1: Introduction

Chapter 2: Literature review on sustainable development, fiscal decentralization, green innovation, and geopolitical risk

Chapter 3: Research model and methodology

Chapter 4: Empirical results

Chapter 5: Conclusion and policy implications for enhancing the effectiveness of fiscal decentralization in promoting sustainable development

CHAPTER 2: OVERVIEW OF SUSTAINABLE DEVELOPMENT, FISCAL DECENTRALIZATION, GREEN INNOVATION, AND GEOPOLITICAL RISK

2.1. OVERVIEW OF SUSTAINABLE DEVELOPMENT, FISCAL DECENTRALIZATION, GREEN INNOVATION, AND GEOPOLITICAL RISK

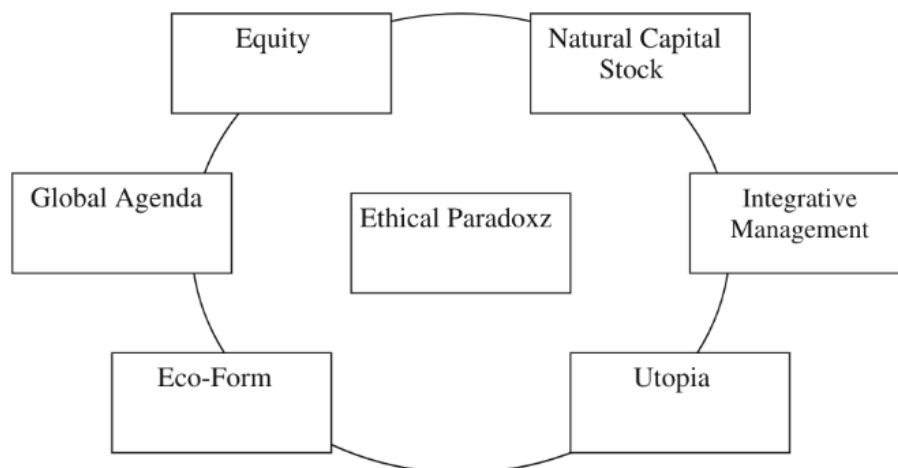
2.1.1. Overview of sustainable development

2.1.1.1. Definition of sustainable development

According to the World Commission on Environment and Development (WCED), sustainable development (SD) is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987).

2.1.1.2. Theoretical framework of sustainable development

Figure 0.1. Theoretical framework of sustainable development



Source: Jabareen (2008)

2.1.1.3. The three pillars of sustainable development

- Economic Sustainability: Aims to promote growth, create prosperity and stability, and ensure the efficient and equitable use of resources.
- Social Sustainability: Focuses on improving the quality of life for all individuals by ensuring access to essential services such as education, healthcare, housing, and sanitation.

– Environmental Sustainability: Seeks to conserve and restore natural resources, biodiversity, and the health of the planet for both current and future generations.

2.1.1.4. Sustainable Development Goals

Today, the concept of sustainable development is closely associated with the United Nations' Sustainable Development Goals (SDGs) – a set of 17 global objectives that include: No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Reduced Inequalities, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace, Justice and Strong Institutions, Partnerships for the Goals.

2.1.1.5. Measuring sustainable development

Sustainable development can be measured through composite indicators such as the Human Development Index (HDI), the Sustainable Development Goals Index (SDGI), and the Green Growth Index (GGI).

2.1.2. Overview of fiscal decentralization

2.1.2.1. Definition of fiscal decentralization

According to the World Bank (2013), fiscal decentralization (FD) refers to the process of transferring financial authority and responsibilities from the central government to lower levels of government or, in some cases, to the private sector.

2.1.2.2. Theories of fiscal decentralization

Several theories form the foundation of fiscal decentralization, including Tiebout's Model of Decentralization, Musgrave's Theory of Public Finance (1959), Olson's Fiscal Equivalence Model (1969), Stigler's Model, and Oates' Decentralization Theorem (1972).

2.1.2.3. Components of fiscal decentralization

According to Martinez-Vazquez (2004), FD consists of four main components: Revenue decentralization, Expenditure decentralization, Intergovernmental fiscal transfers, Borrowing autonomy.

2.1.2.4. *Benefits of fiscal decentralization*

Enhancing resource utilization efficiency: Fiscal decentralization (FD) allows local governments, with their superior access to local information, to design revenue–expenditure policies that better reflect regional characteristics.

Strengthening accountability and transparency: When fiscal authority is delegated to local administrative units that are closer to citizens, it facilitates monitoring, inspection, and dialogue between government and communities, thereby improving fiscal transparency and public trust.

Reducing regional inequality: FD enables adjustments to disparities in revenue-generating capacities across regions, contributing to a more equitable allocation of fiscal resources.

Promoting community participation: By placing fiscal decision-making closer to citizens, FD encourages public participation and engagement in discussions and decisions regarding local revenue and expenditure issues.

2.1.2.5. *Risks of fiscal decentralization*

While FD offers numerous opportunities for development, it also entails certain risks that require prudent management:

Fiscal inequality risk: Although FD aims to reduce interregional disparities, without an appropriate equalization mechanism, it may exacerbate fiscal imbalances between regions.

Management and transparency risk: FD requires local governments to possess sound financial management capacity. In the absence of effective internal control and oversight systems, fiscal resources may be misallocated, wasted, or even diverted for illicit purposes such as tax evasion.

Political motivation and rent-seeking risk: Delegating fiscal authority to subnational governments can give rise to political opportunism and rent-seeking behaviors, where fiscal resources are allocated to serve the interests of specific groups or individuals rather than the broader community.

Coordination and consistency risk: Without effective coordination from the central government, fiscal revenue and expenditure policies between national and local levels may become misaligned, reducing overall policy coherence.

2.1.2.6. Measuring fiscal decentralization

❖ *Share of local government revenue:* Measured as the ratio of total local government revenue to total national fiscal revenue, excluding central government transfers to avoid double-counting.

$$\text{❖ Local revenue share} = \frac{\text{Total local government revenue}}{\text{Total government fiscal revenue}}$$

❖ *Share of local government expenditure:* Defined as the ratio of total local government expenditure to total national fiscal expenditure.

$$\text{Local expenditure share} = \frac{\text{Total local government expenditure}}{\text{Total government fiscal expenditure}}$$

2.1.3. Overview of green innovation

2.1.3.1. Concept of green innovation

Green innovation – also known as eco-innovation or sustainable innovation – refers to the research, development, and implementation of new technologies, products, processes, and business models that address environmental challenges, reduce ecological footprints, and promote sustainability across economic, social, and environmental dimensions.

2.1.3.2. Components of green innovation

Based on the preceding definitions, green innovation encompasses several dimensions: technological innovation, product innovation, process innovation, business model innovation, policy and regulatory innovation, social and behavioral innovation, collaborative innovation, and digital or information technology innovation..

2.1.3.3. Measuring green innovation

To assess green innovation, various international organizations employ specific indicators or composite indices, such as R&D expenditure and patent or intellectual property indicators, which reflect innovation inputs and outcomes.

2.1.4. Overview of geopolitical risk

2.1.4.1. Concept of geopolitical risk

Geopolitical risk (GPR) refers to risks and uncertainties arising from political, social, and economic factors at the regional or global level (Caldara & Iacoviello, 2022). At the macro level, GPR stems from social instability and humanitarian crises, which often result in displacement, poverty, social unrest, and various forms of inequality (Syed et al., 2021).

2.1.4.2. Impacts of geopolitical risk

GPR has been identified as a major source of adverse effects on global economic, political, and security systems. Geopolitical tensions – such as conflicts or major political shifts – often increase market volatility. Such tensions may lead to trade barriers, including tariffs, sanctions, or embargoes, which disrupt international trade flows and raise costs for both consumers and businesses. Empirical studies have shown that heightened GPR discourages foreign direct investment (FDI) and slows economic growth. GPR also influences national policy decisions, often leading governments to prioritize defense and security spending over socio-economic programs. Conflicts and political instability frequently trigger large-scale migration and refugee crises. Furthermore, geopolitical tensions tend to increase military spending and spur arms races, while shaping international alliances and global political alignments.

2.1.4.3. Measuring geopolitical risk

One of the most widely accepted measures of GPR is the Geopolitical Risk Index (GPR Index) developed by Caldara and Iacoviello. This index is constructed through automated searches of keywords such as “war,” “tension,” “terrorism,” “military,” and “geopolitical” within the digital archives of ten major newspapers: Financial Times, The Wall Street Journal, The Globe and Mail, Chicago Tribune, The Guardian, The Los Angeles Times, USA Today, The Daily Telegraph, The Washington Post, and The New York Times.

2.1.5. Relationship between fiscal decentralization and sustainable development

The relationship between FD and sustainable development (SD) is grounded in several theoretical frameworks, notably the Fiscal Federalism Theory and the Public

Choice Theory, which explain how decentralized fiscal systems can influence sustainable economic, social, and environmental outcomes.

2.1.6. The moderating role of green innovation in the relationship between fiscal decentralization and sustainable development

The moderating effect of green innovation in the FD–SD nexus can be explained through several theoretical perspectives. According to the Resource-Based View (RBV), FD enables local governments to effectively mobilize and utilize green innovation capabilities to achieve sustainable competitive advantages. The Innovation Diffusion Theory suggests that FD accelerates the dissemination of green technologies and initiatives across regions, thereby enhancing the positive impact of FD on SD. Meanwhile, the Theory of Planned Behavior (TPB) emphasizes that fiscal autonomy and successful green innovation strengthen local leaders’ intentions and capabilities to pursue sustainable development objectives.

2.1.7. The moderating role of geopolitical risk in the relationship between fiscal decentralization and sustainable development

Based on Institutional Theory, FD can strengthen local institutions by granting autonomy and resources; however, under high GPR, these institutions may become fragile, corrupt, or inefficient, thereby diminishing the positive effects of FD on SD. According to Public Choice Theory, in high-risk environments, local leaders may pursue short-term or self-serving interests, distorting policy incentives and increasing corruption – thus weakening FD’s contribution to SD. Finally, the Resource Dependence Theory posits that FD enhances local governments’ ability to attract and manage financial resources, especially FDI; however, heightened GPR can disrupt capital inflows and hinder resource mobilization for sustainable development goals.

2.2. RELATED EMPIRICAL STUDIES

2.2.1. Studies on the impact of fiscal decentralization on sustainable development

Empirical studies examining the impact of FD on SD can be grouped into two main strands. The first group, including Cheng (2019), Fredriksson and Millimet (2002), Konisky (2007), and Levinson (2003), supports the positive impact of FD on environmental quality. In contrast, the second group – comprising Millimet (2003),

Batterbury and Fernando (2006), Sigman (2014), Fell and Kaffine (2014), Yang et al. (2020), Chen and Liu (2020), and Yang et al. (2021) – presents a more pessimistic view of FD's environmental effects.

More recently, scholars have examined SD more comprehensively, beyond the environmental dimension. Hui and Martinez-Vazquez (2021) employed 2SLS and System-GMM methods to investigate the relationship between FD and SD across 52 countries from 1991 to 2016. Their results reveal an inverted U-shaped (hump-shaped) relationship between FD and SD in both the short and long term. In other words, either excessively high or low fiscal decentralization weakens the efficiency of public service delivery, thereby negatively affecting a country's sustainable development performance.

2.2.4. Studies on the impact of fiscal decentralization on sustainable development considering the roles of green innovation and geopolitical risk

Recent studies have begun to explore the moderating roles of green innovation and geopolitical risk (GPR) in the FD–SD relationship, yet findings remain inconsistent. Satrovic et al. (2024) demonstrated that green innovation mitigates the negative environmental effects of FD, whereas Yi et al. (2023) found that FD stimulates green innovation. Using data from China, Li and Xu (2023) revealed that FD hinders green economic development, and green innovation amplifies this adverse effect. Conversely, Pan et al. (2023) argued that FD, when combined with green innovation, enhances ecological efficiency. Furthermore, Hoang et al. (2024) confirmed that GPR weakens the relationship between FD and ecological footprint, implying that geopolitical tensions can obstruct the positive influence of fiscal decentralization on sustainable development.

2.3. Research gaps

Despite extensive research on the impact of FD on SD, empirical findings remain inconclusive. First, the direction and magnitude of FD's impact on SD are still ambiguous. Second, most studies have primarily focused on the environmental dimension of SD, overlooking the economic and social pillars. Third, the moderating roles of green innovation and geopolitical risk (GPR) have received limited empirical validation, despite their theoretical significance. In addition, previous studies have relied mainly on traditional econometric techniques, while few have utilized Bayesian

regression, which offers superior flexibility in handling complex data structures and model uncertainty. These limitations underscore the need for a comprehensive and modern analytical approach to more accurately assess the impact of FD on SD in the contemporary global context.

CHAPTER 3: RESEARCH MODEL AND METHODOLOGY

3.1. RESEARCH DESIGN

The research process undertaken by the author consists of the following steps:

Step 1: Develop the theoretical framework and review related studies.

Step 2: Formulate hypotheses and construct the research model.

Step 3: Conduct quantitative analysis using Bayesian regression.

Step 4: Analyze and discuss empirical results.

Step 5: Draw conclusions and propose policy implications.

3.2. RESEARCH HYPOTHESES AND MODEL

3.2.1. Research hypotheses

H1: Fiscal decentralization has a positive impact on sustainable development.

H2: There exists an inverted U-shaped relationship between fiscal decentralization and sustainable development.

H3: Green innovation amplifies the positive effect of fiscal decentralization on sustainable development.

H4: Geopolitical risk weakens the positive effect of fiscal decentralization on sustainable development.

3.2.2. Research Model

Model 1: Examining the impact of fiscal decentralization on sustainable development:

$$SDGI_{i,t} = \beta_i + \beta_1 FD_{i,t} + \beta_2 Z_{i,t} + \varepsilon_{i,t} \quad (1)$$

Model 2: Testing the inverted U-shaped relationship between fiscal decentralization and sustainable development:

$$SDGI_{i,t} = \beta_i + \beta_1 FD_{i,t} + \beta_2 FD_{i,t}^2 + \beta_3 Z_{i,t} + \varepsilon_{i,t} \quad (2)$$

Model 3: Investigating the impact of fiscal decentralization on sustainable development with the moderating role of green innovation and geopolitical risk:

$$SDGI_{i,t} = \beta_i + \beta_1 FD_{i,t} + \beta_2 FD_{i,t} \times GI_{i,t} + \beta_3 FD_{i,t} \times GPR_{i,t} + \beta_4 Z_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where $i=1, 2, \dots, N$ denotes the country and $t = 1, 2, \dots, T$ represents the time period.

The variables incorporated into the research models are specified as follows:

Dependent variable: Sustainable Development (SDGI)

Independent variable: Fiscal Decentralization (FD), including Expenditure Decentralization (ED) and Revenue Decentralization (RD)

Moderating variables: Green Innovation (GI) and Geopolitical Risk (GPR)

Control variables: Economic Growth (GDP), Trade Openness (TO), Foreign Direct Investment (FDI), Urbanization (URBAN), and Government Size (SIZE).

3.3. METHODOLOGY

This dissertation employs Bayesian regression, which assumes that the observed data sample is fixed while the model parameters are random. The posterior distribution of the parameters is estimated based on the observed sample and the prior distribution, and the results are interpreted accordingly. To ensure the robustness of the findings, the study further employs the System-GMM (Generalized Method of Moments) estimation technique as a robustness check.

3.4. RESEARCH DATA

Due to data limitations, the dissertation utilizes a balanced panel dataset of 31 countries over the period 2010–2022, divided into two groups: 19 developed countries and 12 developing countries.

Data were collected from official sources including the World Bank, IMF, and OECD. Missing data related to fiscal decentralization were supplemented using national statistical yearbooks of the respective countries. The Geopolitical Risk Index (GPR) data were obtained from the official website: www.matteoiacoviello.com

CHAPTER 4: RESEARCH RESULTS

4.1. OVERVIEW OF SUSTAINABLE DEVELOPMENT, FISCAL DECENTRALIZATION, GREEN INNOVATION, AND GEOPOLITICAL RISK (2010–2022)

4.1.1. Current status of sustainable development

Across the 31 countries in the research sample, the average Sustainable Development Goal Index (SDGI) during 2010–2022 was 71.5, showing a gradual increase over time.

In contrast to the global decline in sustainable development in the post–COVID-19 period, the countries in the research sample maintained relative stability in their SDG Index scores. This can be explained by the fact that the sample consists mainly of advanced and emerging economies, which were less severely affected by the pandemic compared with developing and least-developed countries.

Nevertheless, it is notable that during the post–COVID-19 period (2021–2022), the level of sustainable development in these countries increased only marginally, indicating a slow recovery pace.

4.1.2. Current status of fiscal decentralization

During the period 2010–2022, fiscal decentralization among the 31 countries remained relatively stable, particularly in terms of revenue decentralization, which fluctuated slightly around 25%.

Among the sample, China, Canada, Denmark, Switzerland, and Sweden exhibited the highest levels of expenditure decentralization. Regarding revenue decentralization, China and Canada continued to lead, maintaining a share exceeding 50% throughout the study period.

4.1.3. Current status of green innovation

The degree of green innovation across the studied countries was relatively stable between 2010 and 2022. In recent years, green innovation has received increasing attention as a critical pathway toward achieving sustainable development goals (SDGs).

Governments and enterprises have been integrating green technologies and sustainable practices into production, investment, and consumption, highlighting the central role of innovation in fostering sustainable economic transitions.

4.1.4. Current status of geopolitical risk

Historically, the highest levels of geopolitical risk (GPR) were recorded during the two World Wars. Apart from these periods, GPR spikes are clearly observed during major geopolitical events such as: The Chinese Civil War (peaking in 1949), The Korean War (1950–1952), The Cold War (1960s–1970s), The dissolution of the Soviet Union (1991), and the global war on terror (2000–2004), marked by the September 11 attacks in the United States. Periods considered relatively “safe” in terms of geopolitical stability include the pre–World War I era, the interwar period, the late 20th century, and the post-2004 period. Therefore, the GPR Index provides a remarkably accurate reflection of major global geopolitical events and tensions throughout modern history.

4.2. EMPIRICAL RESULTS FOR DEVELOPED AND DEVELOPING COUNTRIES

4.2.1. The impact of fiscal decentralization on sustainable development

4.2.1.1. Developed countries

Table 0.1. Bayesian regression results on the impact of expenditure decentralization on sustainable development among developed countries

SDGI	Mean	Std. Dev.	MSCE	Median	Equal-tailed [95% cred. interval]	
ED	0,08051	0,01732	0,00017	0,08051	0,04644	0,11403
GDP	0,00411	0,00780	0,00008	0,00413	-0,01136	0,01938
FDI	-0,04228	0,02952	0,00030	-0,04236	-0,10044	0,01644
URBAN	-0,05344	0,03083	0,00031	-0,05382	-0,11410	0,00693
TO	0,01037	0,00711	0,00007	0,01038	-0,00362	0,02433
SIZE	0,30890	0,02742	0,00027	0,30883	0,25529	0,36338
_cons	4,20152	0,07625	0,00076	4,20104	4,05429	4,35193

<i>Avg. acceptance rate</i>	<i>0,8947</i>	<i>Avg. efficiency: min</i>	<i>0,0613</i>
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Source: Author's calculations

The results presented in Table 4.1 indicate that expenditure decentralization in developed countries exerts a positive impact on sustainable development. In addition, GDP growth, trade openness (TO), and government size (SIZE) are identified as key drivers of sustainable development, whereas foreign direct investment (FDI) and urbanization (URBAN) appear to have negative effects.

4.2.1.2. Developing countries

Table 0.2. Bayesian regression results on the impact of expenditure decentralization on sustainable development among developing countries

SDGI	Mean	Std. Dev.	MSCE	Median	Equal-tailed [95% cred. interval]	
ED	-0,08177	0,02943	0,00029	-0,08182	-0,14030	-0,02435
GDP	0,04465	0,00846	0,00009	0,04465	0,02800	0,06121
FDI	0,00325	0,03502	0,00035	0,00350	-0,06544	0,07247
URBAN	-0,03436	0,04936	0,00049	-0,03407	-0,13265	0,06167
TO	0,05534	0,01561	0,00016	0,05536	0,02428	0,08548
SIZE	0,23433	0,05133	0,00051	0,23424	0,13346	0,33529
_cons	3,80488	0,07581	0,00076	3,80362	3,65673	3,95419
<i>Avg. acceptance rate</i>			<i>0,8928</i>	<i>Avg. efficiency: min</i>		<i>0,0355</i>

Source: Author's calculations

In developing countries, expenditure decentralization exhibits a negative effect on sustainable development, similar to the impact of urbanization (URBAN). Meanwhile, GDP growth, FDI, trade openness (TO), and government size (SIZE) contribute positively to sustainable development.

4.2.2. Testing the inverted U-shaped relationship between fiscal decentralization and sustainable development

4.2.2.1. Developed countries

In developed economies, the relationship between fiscal decentralization (FD) and sustainable development (SD) follows an inverted U-shaped pattern, with the threshold

level of expenditure decentralization estimated at 51.55% and revenue decentralization at 31.72%.

4.2.2.2. *Developing countries*

For developing economies, the relationship between FD and SD takes the form of a U-shaped curve, with the threshold of expenditure decentralization estimated at 61.33% and the threshold of revenue decentralization at 27.12%.

4.2.3. *The impact of fiscal decentralization on sustainable development: the moderating roles of green innovation and geopolitical risk*

4.2.3.1. *Developed countries*

Table 0.3. Impact of expenditure decentralization on sustainable development considering the roles of green innovation and geopolitical risk

SDGI	Mean	Std. Dev.	MSCE	Median	Equal-tailed [95% cred. interval]	
ED	-0,00515	0,03454	0,00035	-0,00517	-0,07388	0,06187
EDxGI	0,47800	0,16079	0,00161	0,47820	0,16206	0,79388
EDxGPR	-0,01760	0,01083	0,00011	-0,01754	-0,03895	0,00363
GDP	0,01631	0,00842	0,00008	0,01632	-0,00040	0,03271
FDI	-0,04078	0,02890	0,00029	-0,04091	-0,09771	0,01536
URBAN	-0,07677	0,03123	0,00031	-0,07714	-0,13866	-0,01464
TO	0,01151	0,00748	0,00008	0,01145	-0,00332	0,02631
SIZE	0,25236	0,03122	0,00031	0,25288	0,18986	0,31221
_cons	4,12361	0,07776	0,00078	4,12353	3,97266	4,27633
<i>Avg. acceptance rate</i>		<i>0,7972</i>	<i>Avg. efficiency: min</i>		<i>0,1022</i>	

Source: Author's calculations

In developed countries, the combination of revenue decentralization and green innovation has a positive effect on sustainable development. Conversely, fiscal decentralization in an environment characterized by geopolitical risk (GPR) tends to undermine sustainable development performance.

4.2.3.2. Developing countries

Table 0.4. Impact of expenditure decentralization on sustainable development considering the roles of green innovation and geopolitical risk

SDGI	Mean	Std. Dev.	MSCE	Median	Equal-tailed [95% cred. interval]	
ED	-0,15872	0,04192	0,00042	-0,15855	-0,24015	-0,07661
EDxGI	0,30421	0,26604	0,00266	0,30564	-0,22396	0,81808
EDxGPR	0,07951	0,02293	0,00023	0,07929	0,03348	0,12425
GDP	0,03809	0,00851	0,00009	0,03801	0,02162	0,05477
FDI	0,00845	0,03377	0,00034	0,00850	-0,05750	0,07454
URBAN	-0,01718	0,04829	0,00048	-0,01713	-0,11173	0,07730
TO	0,06581	0,01560	0,00016	0,06583	0,03511	0,09622
SIZE	0,19438	0,05468	0,00056	0,19433	0,08722	0,30227
_cons	3,86136	0,07724	0,00077	3,86111	3,71024	4,01168
<i>Avg. acceptance rate</i>		<i>0,8176</i>	<i>Avg. efficiency: min</i>		<i>0,0736</i>	

Source: Author's calculations

The findings indicate that in developing countries, both expenditure and revenue decentralization, when combined with green innovation, contribute to enhancing sustainable development. Moreover, fiscal decentralization under conditions of geopolitical risk also plays a supportive role in promoting sustainable growth in these countries.

4.2.4. Robustness test of the research model

To verify the robustness of the model, the Human Development Index (HDI) was employed as an alternative proxy for sustainable development. The results demonstrate that the direction of variable impacts remains consistent, confirming the model's stability and reliability. Specifically, in developed countries, an inverted U-shaped relationship exists between fiscal decentralization and sustainable development. Green innovation positively influences sustainable development and enhances the positive effect of fiscal decentralization, whereas geopolitical risk weakens both sustainable development and the effect of decentralization. In contrast, in developing countries, the

relationship between fiscal decentralization and sustainable development exhibits a U-shaped pattern, with both green innovation and geopolitical risk serving as drivers of sustainable development. The MCMC diagnostics confirm that the Bayesian models meet reliability standards, and the results from the System-GMM estimations are consistent, further validating the robustness and credibility of the research findings.

CHAPTER 5: CONCLUSION AND POLICY IMPLICATIONS FOR ENHANCING THE EFFECTIVENESS OF FISCAL DECENTRALIZATION IN PROMOTING SUSTAINABLE DEVELOPMENT

5.1. CONCLUSION

The Bayesian regression results reveal significant differences between the two country groups. In developed countries, fiscal decentralization has a positive impact on sustainable development, following an inverted U-shaped relationship with expenditure and revenue thresholds of 51.55% and 31.72%, respectively. Green innovation promotes sustainable development, while geopolitical risk exerts negative effects on both sustainable development and fiscal decentralization outcomes. Conversely, in developing countries, fiscal decentralization shows a negative impact and follows a U-shaped relationship, with expenditure and revenue thresholds of 61.33% and 24.12%, respectively. Both green innovation and geopolitical risk enhance sustainable development, and their interaction with fiscal decentralization leads to more sustainable growth.

5.2. POLICY IMPLICATION

5.2.1. Policy implications on fiscal decentralization

5.2.1.1. Maintaining fiscal decentralization within the optimal threshold in developed countries

5.2.1.2. Strengthening fiscal decentralization in developing countries

5.2.2. Policy implications on green innovation

5.2.2.1. Designing fiscal decentralization mechanisms that encourage green investment

5.2.2.2. Enhancing green innovation capacity at the local level

5.2.2.3. Strengthening vertical and horizontal coordination in green financial management

5.2.2.4. Promoting private sector engagement through green financial instruments

5.2.3. Policy implications on geopolitical risk

5.2.3.1. Developed countries

Enhancing policy adaptability and multilevel fiscal coordination in the context of geopolitical risks.

Strengthening local governance capacity and fiscal oversight mechanisms in high-risk environments.

Adjusting public expenditure structures to enhance resilience and promote sustainable development.

Expanding international cooperation and ensuring economic–financial security within decentralized frameworks.

5.2.3.2. Developing countries

Promoting flexible decentralization to adapt to geopolitical uncertainties.

Building local governance and institutional capacities to transform risks into development opportunities.

Strengthening multilevel government coordination to balance autonomy and macroeconomic stability.

Utilizing fiscal decentralization as a tool to foster sustainable development aligned with local autonomy.

Enhancing transparency and accountability in fiscal decentralization processes.

5.2.4. Other policy implications

Promoting economic growth aligned with sustainable development goals through measures such as: enhancing green investment, improving resource efficiency, developing sustainable infrastructure, maintaining macroeconomic stability, investing in education and skill development, fostering innovation and entrepreneurship, supporting SMEs, advancing financial inclusion, and deepening international cooperation.

Strengthening trade liberalization.

Exercising prudence in attracting and managing FDI inflows.

Expanding government revenue sources to support sustainable development initiatives.

5.3. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Despite its theoretical and practical contributions, this dissertation has several limitations. First, due to data constraints, the analysis focuses only on the impact of fiscal decentralization on sustainable development and the moderating roles of green

innovation and geopolitical risk across 31 countries during 2010–2022. Future research could extend the scope to a larger sample with updated datasets to enhance generalizability. Second, this study examines the individual moderating effects of green innovation and geopolitical risk on the fiscal decentralization–sustainable development nexus, but it does not explore their simultaneous interaction. Future studies should develop and test a comprehensive theoretical framework incorporating the joint moderating effect of (Green Innovation*Geopolitical Risk) on the fiscal decentralization–sustainable development relationship, which would significantly enrich the theoretical contribution of this research field.