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2026 Aralık sayısı ve sonraki sayılar için ilginç makalelerinizi merakla bekliyoruz.

Sevgi ve saygılarımla...

Doç. Dr. Abdulmuttalip PİLATİN

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**Editorial
Note**

Journal of Economics, Finance and Sustainability (EFS), which started publishing in 2023, is an international, peer-reviewed scientific journal that will be published twice a year (June - December). It is planned that EFS magazine will continue to be published electronically, regularly and free of charge. The journal aims to publish original and qualified studies in Turkish and English in the fields of business, banking, finance, labor economics, econometrics, public administration, Islamic finance and big data, especially in the fields of economy, finance and sustainability. I would like to express my sincere gratitude to the authors, referees and editorial board members who contributed to the publication of the journal.

We set out on this path with the aim of creating a problem that has international standards, is tracked and indexed. In line with this goal, we will aim to publish publications of higher quality in terms of quality and quantity than the previous issue in each new issue. I would like to state that we will take into consideration the feedback we receive from our authors, referees and readers during this process.

We are happy to have published the fifth issue of our journal as of June 2026. This issue contains a total of 6 original articles. All published articles were first examined by referees who are experts in their fields after passing the preliminary control of the field editor, and the process was completed by the editorial board, taking into account the referee reports, and was sent to the relevant authors for revision.

EFS Journal uses the **Dergiprak** system, which is used by many journals in Turkey. It also uses the Open Journal System (OJS), which is the most advanced publishing system developed in accordance with world academic publishing standards and used by more than 25,000 academics, universities and publishing houses in the world. I would like to state that in the future, we will continue our efforts to ensure that the EFS journal is recognized in the field, accessible and becomes an international scientific journal. I hope that our fifth issue will be beneficial to the scientific world.

We will be eagerly awaiting your articles for the December 2026 issue and subsequent issues.

Love and respect....

Dr. Abdulmuttalip PİLATİN

Editor

A Premium-based Financial Performance Analysis for 7 Turkish Insurance Companies between the Years of 2014 and 2023

Alper Odabaşı^a , Olcay Ölçen^b  

ABSTRACT

Purpose – The Insurance Industry is one of the rising financial sectors of Turkey, with recent developments such as insurtech and digitalism. On the other hand, the efficient and effective management and positioning of the insurance companies are so important. This research mainly aims to develop a comparative framework with 6 premium dependent variables. As five variables indicate how the Turkish companies can manage their activities (equities and assets) according to premiums, the other one (Total Damage/Total Premiums) shows the consumer happiness regarding high premiums. The research includes the 7 biggest insurance companies over the past ten years.

Design/data/methodology – CRITIC, TOPSIS, GRA and ELECTRE were used as a research method.

Findings – According to findings, Aksigorta insurance company is at the first rank for TOPSIS and GRA results. On the other hand, it was confirmed that the industry lived through hard times due to the COVID-19 pandemic. According to ELECTRE results, the competition structure of the Turkish insurance companies is complicated and complex, considering the performance variables for the research sample and period.

Originality/value – At the end of the analysis, it was said that the positioning of the insurance structure carried a similar pattern to other emerging countries. Moreover, similar analyses can be realized for large samples from different countries, and comparisons can be made for the future.

Keywords: Insurance, Active-Based Premium Performance, Multi-Criteria Decision Making

2014-2023 Yılları Arasında 7 Türk Sigorta Şirketi İçin Prim Bazlı Finansal Performans Analizi

ÖZET

Amaç - Sigorta sektörü, insurtech ve dijitalizm gibi son gelişmelerle birlikte Türkiye'nin yükselen finans sektörlerinden biridir. Öte yandan, sigorta şirketlerinin etkin ve etkin yönetimi ve konumlandırılması çok önemlidir. Bu araştırma temel olarak 6 prim bağımlı değişkenle karşılaştırmalı bir çerçevede geliştirmeyi amaçlamaktadır. Beş değişken, Türk şirketlerinin faaliyetlerini (hisse senetleri ve varlıkları) primlere göre nasıl yönetebileceklerini gösterirken, diğeri (Toplam Hasar/Toplam Primler) yüksek primlerle ilgili tüketici mutluluğunu göstermektedir. Araştırma, son on yılın en büyük 7 sigorta şirketini içermektedir.

Tasarım/veri/metodoloji - CRITIC, TOPSIS, GRA ve ELECTRE yöntemleri kullanılmıştır.

Bulgular - Bulgulara göre Aksigorta sigorta şirketi TOPSIS ve GRA sonuçlarında birinci sırada yer almaktadır. Öte yandan COVID-19 salgını nedeniyle sektörün zor zamanlar yaşadığı doğrulanmıştır. ELECTRE sonuçlarına göre, Türk sigorta şirketlerinin rekabet yapısı, araştırma örneği ve döneme ilişkin performans değişkenleri dikkate alınarak karmaşıktır.

Özgünlük / Değer - Analizin sonunda, sigorta yapısının konumlandırılmasının diğer gelişmekte olan ülkelere benzer bir model taşıdığı söylenmiştir. Ayrıca farklı ülkelerden gelen büyük numuneler için de benzer analizler yapılabilir ve gelecek için karşılaştırmalar yapılabilir.

Anahtar Kelimeler: Sigorta, Aktif Bazlı Prim Performansı, Çok Kriterli Karar Verme

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1. Introduction

Insurance companies strive to develop a comprehensive framework for premiums and premium production mechanisms. The premium production and risk diversification processes should be evaluated alongside other corporate structures in the financial world. Although this industry has different rules and regulations, the rules of the trade, which include simple reasoning and logic, remain the same. This paper examines the financial profitability and operational efficiency of the Turkish Insurance Industry for 2014 and 2023, focusing on 6 ratios such as premiums/total equity, premiums/total assets, profits/premiums, damages/premiums, Return on Assets (ROA) and Return on Equity (ROE). By doing this, it aims to complete a performance gap in insurance companies, benefiting from the financial indicators of the literature. Throughout the research, an industrial analysis was conducted by questioning the maximum performance structures of 7 members of the Turkish Insurance Industry.

According to Santhiya and Ramalingam (2017), insurance is a means by which the problem of risk in business or the life of a person is covered. The two main classes of insurance are: (i) general insurance, which covers all forms of insurance other than life and is usually written on an annual basis, and (ii) life insurance, which is generally on a long-term basis against the risk of death. An insurance premium is the fee that the insuree pays (Kaya and Beşer, 2020). It is a vital element not only for companies but also for countries and states. Besides these, the insurance sector, one of the most important components of the financial system, can create resources for the national economy thanks to the funds collected from the policyholders (Işık et al, 2023). Depending on the developing structure of the insurance concept, the industry has taken different utilisation methods throughout history, from China to the Middle East, because of cultural changes. For instance, Jumaa (2020) examines the UAE insurance industry by stating that the UAE insurance market offers two types of insurance: conventional insurance, which allows individuals to shift the burden of riskiness loss to the insurance firm, and the Takaful insurance that collects the premium from the members to ensure that there's no damage or loss against each other.

On the other side, insurance forms a supply and demand relationship between various risks and premiums. Therefore, it is subject to a price. The price of insurance is the monetary value for which two parties agree to exchange risk and "certainty". There are two commonly encountered situations in which the price of insurance is subject to consideration: when an individual agent (for example, a household), bearing an insurable risk, buys insurance from an insurer at an agreed periodic premium; and when insurance portfolios (that is, a collection of insurance contracts) are traded in the financial industry (e.g., being transferred from an insurer to another insurer or from an insurer to the financial market (securitization) (Laeven and Goovaerts, 2011). Insurance markets and

varieties of insurance businesses are open to financial hardships such as systemic risks, moral hazards, adverse selection, data restrictions and credibility, so long-term sustainability needs extra effort (Zhu et al., 2019). On the other hand, the insurance industry needs extra care and caution regarding regulation and governance measures. Mannar (2015) describes a regulatory framework for the Indian insurance industry, considering competition between domestic and international insurance companies, challenges, opportunities and customer satisfaction. Ang and Lai (1987) examine the insurance industry with two financial submarkets that should be described as insurance and financial markets.

Therefore, an insurance company should be activated and should take action against the developments and risks of both markets. Performance analyses gain importance, as in the analyses of Adeel et al. (2022) in Pakistan, where the insurance industry plays an intermediary and catalyst role. Another pressure element is the position of stakeholders and their interests, concerns, potential positions, power and influence (Abihiro and McIntyre, 2012). Another important feature of the insurance industry is that it is the most productive sector of the economy for investment, risk management, and price information to help coordinate decentralized decision-making in various sectors of the economy, among others (Ojo, 2012). Moreover, the insurance sector plays a crucial role in financial and economic development, especially with its impact on financial uncertainty and encouraging new investments, innovation and competition (Feyen et al., 2013). Especially, the industrial structure is open to new developments such as insurtech with the developments in information technology in the forms of machine learning, artificial intelligence and economics (Cosma and Rimo, 2024). Gupta and Venkataraman (2024) state the importance of insurance and insurance-related business in the era of climate change, with their mitigative, adaptive and innovative responses to a resilient global insurance sector. For Elling (2024), the insurance industry significantly impacts the sustainability policies of companies and states strategically with risk assessment models, diversified insurance product offerings, cross-industry collaboration, and investments in resilience and prevention measures.

On the other hand, according to Nguyen (2024), the cooperation between banks and insurance companies is another important detail in the description of the future of the insurance industry. With a clearer emphasis on Gupta et al. (2019), uncertainty is a clear element in premium detection; naturally, in the price of insurance agreements. For this reason, the insurance transforms into a life science as such in the health insurance that points out the importance of age, occupation, family size, smoking habits, drinking habits, diabetes history, and heart disease in risk calculation (Arora and Vij, 2013) and more exact and definitive techniques can be used for the evaluation and calculation of these risks by insurance companies through artificial intelligence, machine learning in nowadays (Ahmad et al., 2023).

In light of these arguments, it can be said that the insurance companies have undergone dramatic changes and challenges with new opportunities and fruits. In this kind of industry, where the risks are problematic, the performance needs extra and comprehensive development and care. And for this reason, the performance analyses and the examination of various performances are important to detect benchmarks internationally, regionally and state as in the design of this analysis. Moreover, these kinds of analysis can contribute to future development and directions regarding the performance of insurance companies comparatively. On the other hand, the multi-criteria decision-making methods present a wide and comprehensive methodology cluster for researchers, also for the insurance industry (Gairahzadeh-Beiragh et al., 2020; Puska et al., 2023; Shammari and Masri, 2015)

2. Literature Review

The insurance industry is generally known as a multilayered and complex sector. On the other hand, to maintain a performance and sustain it requires extra and rigorous efforts in terms of work and business, as well as ethics and principles, in the insurance sector. Moreover, besides the financial management and the ability to read financial markets and manoeuvre in high-risk financial conditions, have a significant impact on achievements in this industry. At the corporate level, marketing policies on premiums can significantly alter the game rules, such as regulatory measures like Solvency II in the European Union.

The insurance premiums include a lot of information regarding financial quality and quantity; at the same time, they should be prepared according to other components, such as transparency and fairness (Patil and Sanika, 2024) and in a context where they should not be negatively impacted by wish, will and expectations of stakeholders, or technology and competition (Santhiya and Ramalingam, 2017). And, the premiums should cover the operating costs of companies and increase their profits (Markonah et al., 2017). In the analysis of Lester (2011) which examines the insurance industry in the Middle East and North Africa, the macro-level indicators such as per capita income and demographic characteristics is associated with the micro-level or industry-specific indicators such as the absence of mandatory insurance in key areas, the predominant presence of the state in some countries, gaps in regulation and supervision, unsupportive tax regimes, fragmented market structures, a chronic lack of suitably skilled people, as well as the absence of products that conform with cultural/religious preferences, especially in the case of life insurance.

Moreover, for Dhar et al. (2013), financial penetration, product innovation, flexible premium, product based on community, solution for health management, retirement scheme and portfolio management services are considered to be some of the key success variables of the sector. Besides these, the nourishment channels are cut in mature economies; for this reason, global insurance companies widen their scope to relatively less

developed or developing countries such as the BRICS countries (Dam, 2016). In a more micro dimension, awareness, tax benefits, financial security and risk coverage can be of interest in selecting insurance (Amutha, 2023) or payment for the insurance for people.

Return on Assets and Return on Equity are used as profitability variables in the analysis of Eling and Jia (2019); on the other hand, labour, equity capital, debt capital, and some variables related to the premium are selected as efficiency indicators. Another analysis (Bodla et al., 2017) focuses on premium-based measures such as net premium, income from investment, and underwriting income near the Return on Assets (ROA). For Alhassan et al. (2014), size, underwriting risk, leverage, GDP Growth rate, and inflation are controlling variables of profitability, so ROA. Premium growth, asset tangibility and liquidity are important variables of profitability in the analysis of Zainudin et al. (2017). Besides these, according to Boadi et al. (2013) and Dhiab (2021), there is no difference between a company and an insurance company regarding profitability; for this reason, the measures such as ROA, leverage, tangibility, liquidity, size, risk and growth should give similar results and deviations from the normal for financial development. The intervention of rule-makers in effective capital allocation decisions to avoid collapse is also important for the sake of insurance companies (Tuffour et al., 2021). According to Rahman et al. (2017), the most profitable insurance companies are the institutions which take a position in the middle of a turmoil forming with firm-specific factors such as financial leverage, size, tangibility and managerial efficiency and with economic growth and inflation rate, like others, which realize a good formulation strategy for the balance of revenue and cost management (Kumar et al, 2022). Ali and Tausif (2019) underline the importance of premiums in operational profitability with financial profitability. Greene and Segal (2004) add to this equation the changes in cost structures and costs. Malik (2011) defines other variables as age and size of the insurance company, in the profitability analysis.

Total Premiums/ Total Assets: This measure shows how the insurance company transforms its assets into premiums. Moreover, it is an indicator of how insurance companies realize the asset allocation and asset management to produce more premiums (Kielholz, 2000). As it is known, exposure to credit and liquidity risks is common in asset management of insurance companies, and also, the expected investment return should be arranged in the asset management (Knox and Sorensen, 2021). For this reason, asset management is a battlefield regarding the risks and proactive management of these risks in insurance companies. Therefore, the qualitative and quantitative management of the assets, considering and concentrating on special risk characteristics such as liquidity and credibility, has great importance for insurance companies (Eladly, 2024; Polyakov and Polyakova, 2024). Besides these, efficient and effective insurance companies should be aware of mechanisms and transformations between premiums and assets. On the other hand, the balance between the different elements of the balance sheets of insurance

companies, such as liabilities and receivables, is indispensable in the financial asset management of these kinds of companies (Kiptoo et al, 2021).

Total Premiums/ Total equity: This performance measure indicates complex and comprehensive relationships after the SOLVENCY II framework, which makes the insurance companies more vulnerable; on the other hand, which transforms the insurance industry more consistent structure with its principle to govern risks responsibly due to equity levels. The management of equity-premiums management gains different insights in the era of SOLVENCY II. Moreover, according to Tsvetkova et al. (2021), effective and efficient capital and equity management contribute to the profitability with other variables such as liquidity, leverage and size of a company. On the other hand, equity management directly relates to the maximization of shareholders' wealth, the content and satisfaction of stakeholders and the essence of financial performance theories that derive from the balance sheet, income statement, and cash flow statements management policies (Morara and Sibindi, 2021). On the other side, the pricing and capital management in insurance companies is complex; the balance is essential between insurers', consumers's and corresponding risks (Mao and Wang, 2023). In an insurance firm, which is thought to be an efficient, effective and profitable one, the maximization of the measure serves a clear wisdom about how the insurance company transforms its equity into its premiums.

Total Profits/Total Premiums Ratio: This indicator measures whether insurance companies effectively convert their premiums into profits. In a sophisticated context, the insurer's profits are produced by premiums and the quality of premiums, which are special elements of consumer markets regarding pricing mechanisms. And the premium structure of the companies is impacted by the micro, macro and international economic and financial changes (Dorofiti and Jakubik, 2015). In both ordinary and crises, the maximisation of this value provides insights into profit production processes of insurers.

Total Damage/Total Premiums (Loss Ratio): This measure indicates the earned premiums per damage. On the other hand, the purpose of putting these variables into the evaluation criteria of this research is marketing. Rational consumers intend to select insurance companies due to the maximum loss ratio; conversely, a higher loss ratio can not be supported by the insurance company analyst and regulators because higher loss ratios have higher risks regarding financial management. The ratio was incorporated into this analysis to examine the companies from the perspective of an ordinary insurance consumer, so the value was evaluated using the maximisation principle.

ROE and ROA are key variables in this analysis, as they describe the financial performance of companies.

3. Methodology Data and Findings

The research dataset was prepared using data collected from the Turkish Insurance Association for the years 2014-2023. The dataset evaluates the performance of Turkish

Insurance companies regarding the maximization of Total Premiums/Total Assets, Total Premiums/Total Equity, Total Profits/Total Premiums, Total Damage/Total Premiums, ROE, and ROA ratios. If the variables are examined one by one;

This paper systematically analyses the performances of seven insurance companies between 2014 and 2023 using Multi-Criteria Decision-Making methods. The methods have complementary impacts on each other, focusing on different dimensions. The CRITIC method, which focuses on relationships and the amount of information within the criteria, is used to detect the weights of the criteria without expert input. Thus, the weight structure of the analysis was formed objectively and consistently based on data. Especially in financial analyses, the use of the objective CRITIC method increases the reliability and validity of the analysis. The findings of the CRITIC analysis are presented in Table 1.

Table 1. Critic Analysis Results

Code	Name Of The Variable	Critic Results
C1	Total Premiums/ Total Assets	0.2013604
C2	Total Premiums/ Total equity	0.1880438
C3	Total Profits/Total Premiums	0.1249656
C4	Total Damage/Total Premiums	0.2246115
C5	Return on Assets	0.1214189
C6	Returns on Equity	0.1395998

For each insurance company, the periodic performance is analysed with the TOPSIS methodology. The main purpose of this analysis is to prove the performance variations of each company over the years. Thus, every company is evaluated according to its previous years' performances, and it is possible to realise a comparison between the yearly performances from weakest to strongest. The findings of TOPSIS analyses can be shown as in the following Figure 1, and numerical explanations are presented in Table 2.

According to the analysis results, the total industry structure was impacted by the negatives in 2020 and 2021 (the COVID-19 period); on the other hand, the findings show that the industrial financial structure generally witnessed a recovery from 2022 onwards. It can be said that all seven industrial participants feel the negativities that were sourced from COVID-19. It is understood that insurance companies and the industry were unprepared or did not anticipate the magnitude of the crisis.

Figure 1. TOPSIS Results

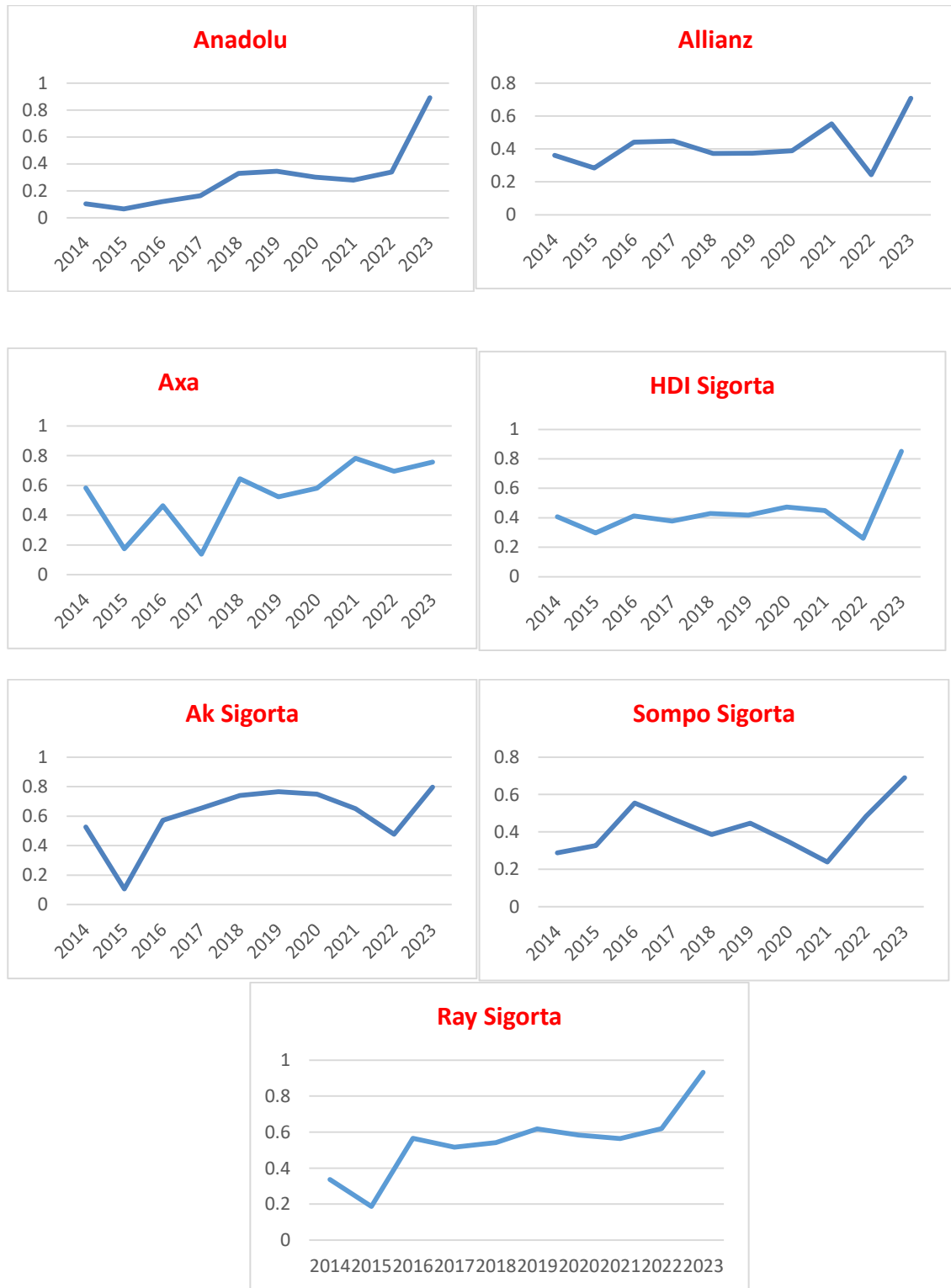


Table 2. Topsis Results

Years	Anadolu	Allianz	Axa	Ak Sigorta	Sompo Sigorta	Ray Sigorta	HDI Sigorta
2014	0.102	0.360	0.583	0.527	0.287	0.336	0.407
2015	0.064	0.283	0.174	0.105	0.326	0.186	0.297
2016	0.119	0.441	0.463	0.571	0.554	0.565	0.413
2017	0.163	0.447	0.138	0.654	0.467	0.515	0.377
2018	0.330	0.372	0.644	0.739	0.385	0.541	0.429
2019	0.345	0.374	0.522	0.766	0.446	0.618	0.417
2020	0.301	0.388	0.581	0.748	0.346	0.583	0.473
2021	0.279	0.551	0.782	0.649	0.238	0.563	0.449
2022	0.339	0.243	0.695	0.476	0.483	0.618	0.260
2023	0.891	0.707	0.756	0.796	0.690	0.932	0.851

The second group of analysis is the GRA (Grey Relational Analysis) by years, which is selected to determine yearly comparative findings of insurance companies. This analysis class includes two graphs. The top one shows the GRA analysis results, and the bottom one shows the ranking of insurance companies over the years. These are shown in Figure 2, and numerical explanations are given in Table 3.

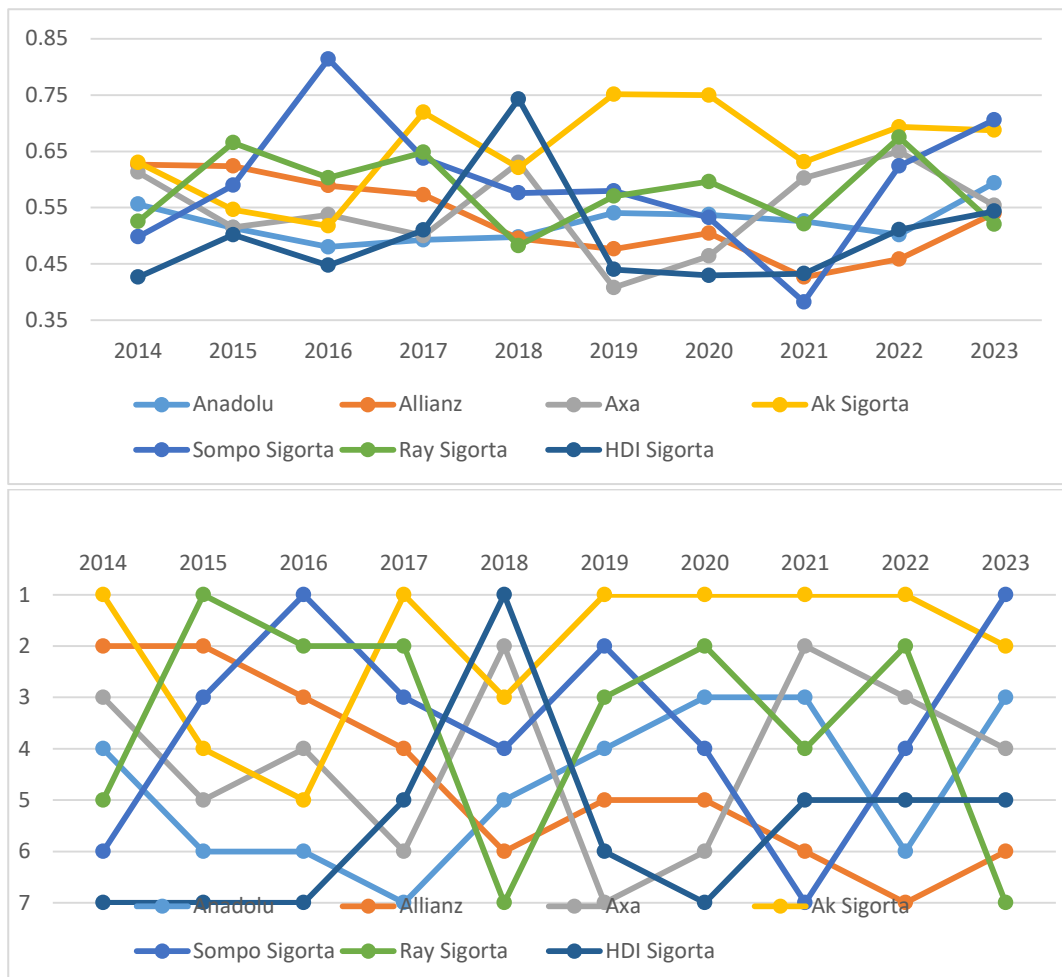
Figure 2. GRA Results

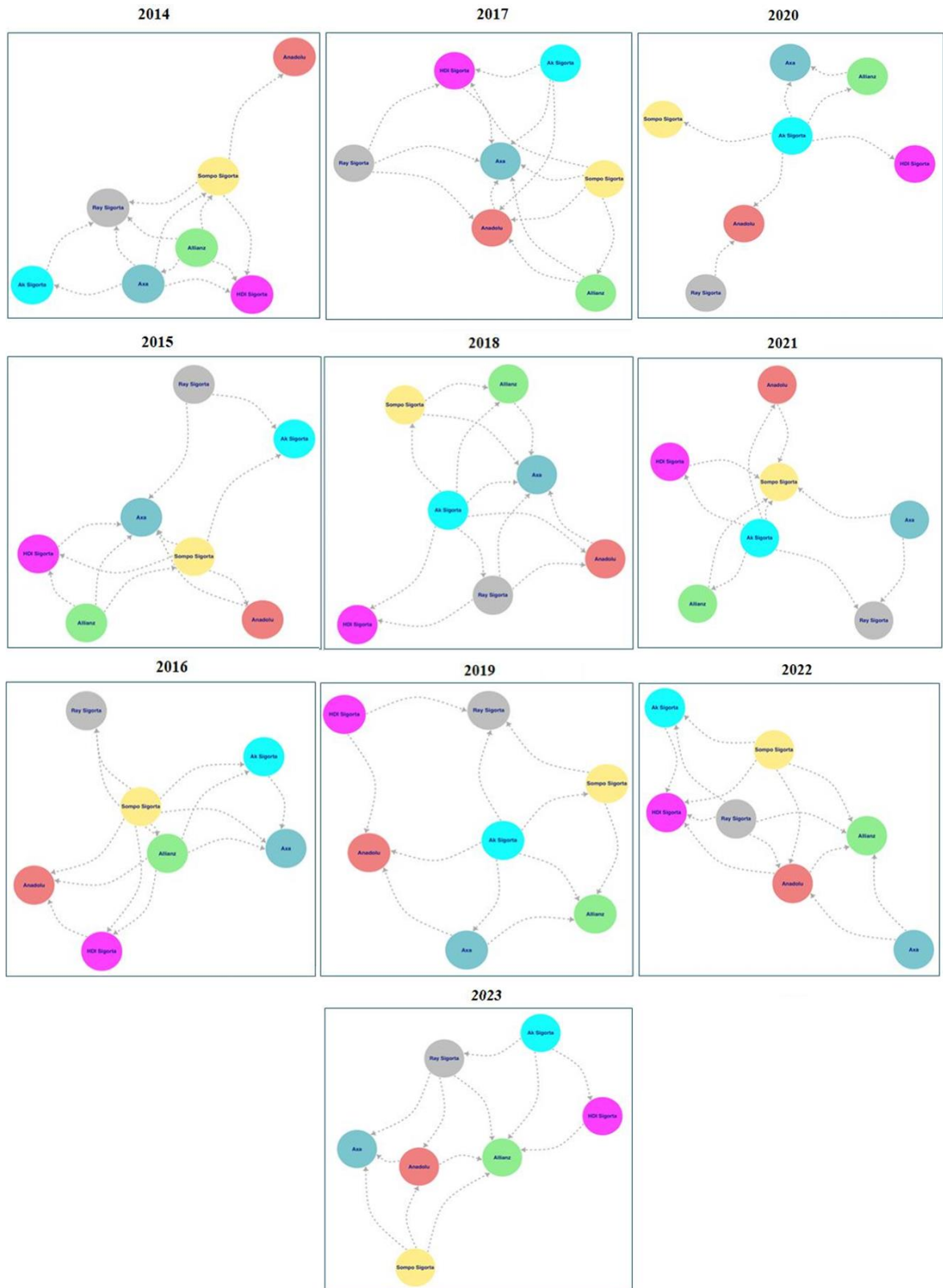
Table 3. Gra Results

	2014	2015	2016	2017	2018
Anadolu	0.5561572	0.5140992	0.4802254	0.4927627	0.4977192
Allianz	0.6263796	0.6237598	0.5890573	0.5728387	0.495344
Axa	0.6129367	0.514895	0.5373518	0.5001529	0.6299301
Ak Sigorta	0.630141	0.5462817	0.5174743	0.7190913	0.6209178
Sompo Sigorta	0.4980965	0.5897268	0.8137484	0.6375664	0.5759025
Ray Sigorta	0.525356	0.6650957	0.6030626	0.6480499	0.482388
HDI Sigorta	0.4264113	0.5018152	0.4475938	0.5099827	0.7426771
	2019	2020	2021	2022	2023
Anadolu	0.5403879	0.5373017	0.5258935	0.5018403	0.5939958
Allianz	0.4765436	0.5047476	0.4264979	0.45866	0.5397361
Axa	0.4079369	0.4640587	0.6024717	0.6495407	0.5538588
Ak Sigorta	0.7514387	0.7496809	0.6310988	0.6932145	0.6873948
Sompo Sigorta	0.5796121	0.5323092	0.3825206	0.6239909	0.7057341
Ray Sigorta	0.5702292	0.5960878	0.5210446	0.6748746	0.5202659
HDI Sigorta	0.4401794	0.4295085	0.4326315	0.510767	0.5435307

The performance ranks of the companies are in continuous change over the years. On the other hand, the leadership of AK Sigorta is an interesting finding for the years 2014, 2017, 2019, 2020, 2021 and 2022. And the last analysis group is the ELECTRE method, which presents strong opportunities to realize dual comparisons and dominance between companies, as it is shown in Figure 3.

Figure 3 demonstrate a dominance relationship between the variables. For instance, the performance of Sompo Sigorta is larger than that of Anadolu Sigorta. The performance of Allianz Sigorta is larger than that of Sompo Sigorta, HDI Sigorta, and Ray Sigorta. In comparison, the performance of Ray Sigorta is smaller than that of Axa Sigorta, Ak Sigorta, and Allianz Sigorta. The performance of Axa Sigorta is larger than that of HDI Sigorta, Ray Sigorta, and Ak Sigorta for 2014. So, the arrowhead implies the smallness. The same principle can be utilised for the other years.

Figure 3. Electre Results



Detailed numerical explanations are presented in Appendix 1.

5. Discussions and Conclusion

The insurance industry encompasses a range of diverse utilisation strategies and products. On the other hand, the main contribution of this paper is to provide a detailed picture of the Turkish insurance industry, regardless of these variations. Moreover, the research ranks the insurance industry for the period between 2014 and 2023. According to the findings, the leadership of Aksigorta was confirmed in terms of performance measures, including Total Premiums/Total Assets, Total Premiums/Total Equity, Total Profits/Total Premiums, Total Damage/Total Premiums, Return on Assets, and Return on Equity.

The insurance industry has a multi-layered and complex structure regarding premiums; the utilization of premiums, on the other hand, and financial premium production methods are important. Nowadays, the world witnesses a development process regarding insurance and insurance understanding in the emerging world, as in the cases of Nigeria (Augustine and Ayoni, 2021), Indonesia (Dartando et al, 2020; Markonah, 2019), Taiwan (Lee, 2014), Czechia (Zmeska et al, 2025) and Serbia (Vojinovic et al, 2022). On the other hand, the spread of insurance industries through micro, macro and international environments with new collaborations and ventures, can require other needs. For instance, there are 50 insurance companies in Turkey. They have specific roles in regulating and governing the Turkish financial markets, supported by a special infrastructure of Turkish law and the legal system. At the same time, the industry tends to develop a more sophisticated structure regarding new and innovative products with the implementation of insurtech applications and digitalisation.

Author Contribution Statements

Both authors contributed equally to the article.

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Appendix 1. The Electre Results

2014	Dominance - Conformity	Dominance-Non-Conformity	Conformity Rank	Non-Conformity Rank	Average Rank
Anadolu	0.951788	3.28354	2	7	5
Allianz	1.1343766	-4.1439566	1	1	1
Axa	0.4820456	-2.3851387	5	2	3
Ak Sigorta	0.8656234	-0.3224504	3	4	3
Sompo Sigorta	0.7254664	-1.6284642	4	3	3
Ray Sigorta	-1.7298704	3.0488567	6	6	6.5
HDI Sigorta	-2.4294296	2.1476132	7	5	6.5
2015					
Anadolu	-0.7788084	-1.0311093	5	3	4
Allianz	-0.140157	-4.3360552	4	1	2.5
Axa	-1.6543618	3.9374597	7	7	7
Ak Sigorta	-0.0126326	3.5823209	3	6	5
Sompo Sigorta	1.3777974	-3.3120348	2	2	1
Ray Sigorta	2.0136796	0.5147094	1	4	2.5
HDI Sigorta	-0.8055172	0.6447093	6	5	6
Anadolu	-0.7788084	-1.0311093	5	3	4
2016					
Anadolu	-2.2229014	2.3647237	7	7	7
Allianz	1.5878042	-2.6323191	2	2	2
Axa	-0.535574	2.0441278	4	5	4.5
Ak Sigorta	-0.971835	0.1073453	6	3	4.5
Sompo Sigorta	3.550456	-5.5441238	1	1	1
Ray Sigorta	-0.4958916	1.5004243	3	4	3
HDI Sigorta	-0.9120582	2.1598218	5	6	6
2017					
Anadolu	-0.7082326	2.732309	5	6	5.5
Allianz	-0.4362694	-1.232976	4	4	4
Axa	-1.8003116	4.149766	7	7	7
Ak Sigorta	1.7607248	-1.86387	1	2	1
Sompo Sigorta	1.0413722	-4.034264	3	1	2
Ray Sigorta	1.2277778	-1.40842	2	3	3
HDI Sigorta	-1.0850612	1.657455	6	5	5.5
2018					
Anadolu	-0.3227456	2.3746581	5	7	6
Allianz	-0.7957886	1.6075124	6	6	6
Axa	0.5425718	-0.26423	3	4	3.5
Ak Sigorta	0.5721022	-3.1958588	2	1	1.5
Sompo Sigorta	-0.1034742	-0.9662705	4	3	3.5
Ray Sigorta	-1.260854	1.5382421	7	5	6
HDI Sigorta	1.3681884	-1.0940534	1	2	1.5
2019					
Anadolu	0.8549	1.6762435	2	6	4.5

Allianz	0.362729	0.8194315	3	4	3
Axa	-2.1791018	4.0264903	7	7	7
Ak Sigorta	2.974823	-4.5167191	1	1	1
Sompo Sigorta	0.0928614	-2.2053385	4	2	2
Ray Sigorta	-0.5691142	-1.0017014	5	3	4.5
HDI Sigorta	-1.5370974	1.2015938	6	5	6
2020					
Anadolu	0.0900248	2.3576219	3	7	5.5
Allianz	0.9351522	-0.3743869	2	3	2
Axa	-0.5691226	2.2090555	4	6	5.5
Ak Sigorta	1.77606	-4.3099572	1	1	1
Sompo Sigorta	-0.6255116	0.1773743	5	4	4
Ray Sigorta	-0.6350888	-1.3406973	6	2	3
HDI Sigorta	-0.971514	1.2809897	7	5	7
2021					
Anadolu	1.1048312	2.2191853	2	6	4
Allianz	0.3159058	-0.1322194	3	4	2.5
Axa	-0.140157	-3.372152	5	2	2.5
Ak Sigorta	1.4875958	-3.6286023	1	1	1
Sompo Sigorta	-1.843747	3.9113236	7	7	7
Ray Sigorta	-1.1741064	-0.5178687	6	3	5.5
HDI Sigorta	0.2496776	1.5203336	4	5	5.5
2022					
Anadolu	-0.482375	0.6781396	5	5	5
Allianz	-2.4194474	2.3648722	7	6	6.5
Axa	0.7117868	-3.5415009	3	1	2
Ak Sigorta	1.2882132	0.4784814	2	4	3
Sompo Sigorta	1.8697064	-2.1244154	1	2	1
Ray Sigorta	0.5692134	-1.557376	4	3	4
HDI Sigorta	-1.5370974	3.7017991	6	7	6.5
2023					
Anadolu	0.8187918	0.5437187	2	5	3
Allianz	-2.4559	3.154302	7	6	6.5
Axa	-1.6304312	3.1597774	6	7	6.5
Ak Sigorta	0.2633572	-2.7799626	3	1	2
Sompo Sigorta	2.971514	-2.2801758	1	2	1
Ray Sigorta	-0.156253	-1.3099049	5	3	4.5
HDI Sigorta	0.1889212	-0.4877548	4	4	4.5

The Substitution Effect of Peer-to-Peer Lending: Evidence from Indonesian Provinces

Zoubir Boulahbel  

ABSTRACT

Purpose – Peer-to-peer (P2P) lending is regarded as a solution to financial exclusion in developing countries, yet robust evidence testing its role as a substitute for traditional banks in these contexts remains scarce. This study provides the first empirical test of this "substitution hypothesis" in Indonesia, examining whether P2P lending per capita is higher in regions with weaker banking infrastructure.

Design/data/methodology – We employ a Two-Way Fixed Effects model on a panel dataset of 31 Indonesian provinces from 2020-2024 (N=1,736). The model identifies the within-province relationship between P2P lending per capita and two banking density measures: bank credit to GRP and bank branches per capita, while controlling for unobserved regional and time-specific factors. Robustness checks replace credit-based banking density with deposit-based density and substitute P2P depth (lending scaled by GRP) for the dependent variable.

Findings – The main results support the substitution hypothesis: P2P lending per capita is significantly higher in provinces with lower bank credit to GRP ($\beta = -0.098$, $p < 0.01$) and fewer bank branches per capita ($\beta = -7.865$, $p < 0.001$). A strong positive time trend confirms sustained sector growth. However, robustness checks reveal that substitution is specific to the credit dimension of banking and to per capita P2P lending. When banking density is measured by deposit mobilization, the relationship becomes positive, suggesting a complementary dynamic. The substitution effect is not robust when P2P activity is scaled by GRP.

Originality/value – This study provides evidence that P2P lending substitutes for bank credit in Indonesia, particularly in underserved regions, while coexisting with broader deposit-based banking infrastructure. It refines the substitution debate by showing context-dependent roles of FinTech, offers guidance for financial inclusion policies, and highlights the need for differentiated regulatory approaches.

Keywords: P2P Lending, Substitution Hypothesis, Financial Inclusion, Banking Density

Kişiden Kişiyne Kredide İkame Etkisi: Endonezya Eyaletlerinden Kanıtlar

ÖZET

Amaç – Peer-to-peer (P2P) kredi sistemleri, gelişmekte olan ülkelerde finansal dışlanmaya bir çözüm olarak görülmekle birlikte, bu bağlamda geleneksel bankaların yerini alma rolünü test eden sağlam kanıtlar halen yetersizdir. Bu çalışma, Endonezya'daki bankacılık altyapısının zayıf olduğu bölgelerde P2P kredi büyümesinin daha hızlı olup olmadığını inceleyerek, söz konusu "ikame hipotezi"nin ülke özelinde ilk ampirik testini sunmaktadır.

Tasarım/veri/metodoloji – 31 Endonezya eyaletine ait 2020-2024 dönemi panel verisi (N=1.736) üzerinde Çift Yönlü Sabit Etkiler modeli uygulanmıştır. Model, kişi başına P2P kredi hacmi ile iki bankacılık yoğunluk göstergesi (banka kredisi/GRP ve kişi başı şube sayısı) arasındaki ilişkiyi, gözlemlenemeyen bölge ve zaman etkilerini kontrol ederek tahmin etmektedir. Sağlamlık testlerinde, kredi temelli yoğunluk mevduat temelli yoğunlukla değiştirilmekte ve bağımlı değişken olarak P2P derinliği (GRP'ye göre ölçeklendirilmiş borç verme) kullanılmaktadır.

Bulgular – Sonuçlar belirgin bir ikame ilişkisi göstermektedir. Kişi başına P2P kredi hacmi, bankacılık yoğunluğunun düşük olduğu eyaletlerde anlamlı biçimde yüksektir; hem banka kredisi/GRP oranı ($\beta = -0.098$, $p < 0.01$) hem de kişi başı şube sayısı ($\beta = -7.865$, $p < 0.001$) ile negatif ilişki mevcuttur. Piyasanın büyüme eğilimini doğrulayan pozitif zaman trendi ($\beta = 0.000881$, $p < 0.001$) kaydedilmiştir. Sağlamlık kontrolleri ise ikamenin yalnızca bankacılığın kredi boyutuna ve kişi başı P2P borç vermeye özgü olduğunu; mevduat temelli yoğunlukta ilişkinin pozitifte dönerek tamamlayıcılığa işaret ettiğini ve P2P faaliyeti GRP ile ölçeklendirildiğinde etkinin kaybolduğunu ortaya koymaktadır.

Özgünlük/değer – Bu çalışma, Endonezya'da P2P borç vermenin özellikle yetersiz hizmet alan bölgelerde banka kredisini ikame ettiğini, ancak mevduat temelli bankacılık altyapısıyla bir arada var olduğunu göstermektedir. Bulgular, FinTek'in bağlama göre değişen rollerini ortaya koyarak ikame tartışmasını rafine etmekte, finansal kapsayıcılık politikalarına yön vermekte ve farklılaştırılmış düzenleyici yaklaşımların gerekliliğini vurgulamaktadır.

Anahtar Kelimeler: P2P Kredi, İkame Hipotezi, Finansal Kapsayıcılık, Banka Yoğunluğu

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1. Introduction

In many developing countries, traditional banking systems fail to reach vast segments of the population, leaving an estimated 1.3 billion adults globally unbanked (World Bank, 2025). Peer-to-peer (P2P) lending has emerged as a potentially transformative solution to this exclusion, promising to connect borrowers and lenders directly through digital platforms. By leveraging alternative data for credit assessment, P2P lending offers a pathway to credit for those marginalized by conventional finance due to a lack of credit history, high transaction costs, or geographical isolation.

The dynamics of P2P lending are increasingly well-documented in developed economies. Seminal research in the United States has established that P2P lending often expands in areas underserved by traditional banks (Eid and Yang, 2018; Jagtiani and Lemieux, 2018), acting as a partial substitute, particularly in markets with fewer small banks. Studies on platforms like Lending Club and Prosper have further explored its role in consumer credit markets (Tang, 2019; Havrylchyk *et al.*, 2020). Similarly, research in the UK and European contexts has examined its fit within the broader credit ecosystem (De Roure *et al.*, 2016; Pierrakis and Collins, 2013).

However, a critical gap remains. The findings from mature, highly banked economies cannot be automatically extrapolated to developing countries, where the fundamental structure of the financial system, levels of digital infrastructure, and the demographic profile of the unbanked are fundamentally different. Moreover, the substitution versus complementarity debate has largely focused on credit provision, with limited attention to other dimensions of banking presence, such as deposit mobilization. Whether P2P lending fills credit gaps in underserved regions or complements broader banking infrastructure remains an open question, particularly in emerging economies.

Despite Indonesia's status as a major emerging economy with a rapidly growing FinTech sector, no study has systematically investigated this question in a way that distinguishes between different facets of banking activity. As documented in recent studies, Indonesia's financial inclusion landscape is marked by deep regional imbalances: only 24.3% of rural adults hold a bank account compared to 43.2% in urban areas (Sahputri *et al.*, 2024). These conditions make Indonesia an ideal setting to test whether P2P lending substitutes for traditional banking in underserved regions.

This paper directly addresses this gap by examining the relationship between P2P lending and traditional banking in Indonesia. Our primary objective is to test the substitution hypothesis—whether P2P lending per capita is higher in regions with weaker banking infrastructure—using two distinct measures of banking density: credit depth (bank credit to GRP) and physical branch presence. Recognizing that

banking presence also includes deposit mobilization, we further examine whether the relationship holds when using deposit-based density as an alternative indicator. Additionally, we assess whether results are sensitive to measuring P2P activity per capita versus relative to regional economic product. By employing a rigorous panel data methodology across Indonesian provinces, this study provides the first empirical evidence from a major developing economy on the nature of the relationship between different dimensions of banking density and P2P market penetration. The findings offer crucial insights for policymakers seeking to foster financial inclusion and for platforms designing market-specific strategies, moving beyond assumptions based on Western models to ground-truth evidence from the Global South.

2. Literature Review and Hypothesis Development

2.1. The Concept and Mechanics of P2P Lending

P2P lending has emerged as a disruptive force in the financial landscape, operating as an online marketplace that directly connects borrowers and lenders, thereby disintermediating traditional banks (Eid and Yang, 2018). Since its inception following the 2008 financial crisis, this model has provided a critical source of credit for individuals and small businesses marginalized by conventional institutions (Tang, 2019). Its innovation lies not in creating new financial products, but in revolutionizing the lending process through digital efficiency, leveraging technology to lower operational costs and offer more accessible alternatives to bank credit (Eid and Yang, 2018).

The core function of a P2P platform is that of an information intermediary, not a credit intermediary (Azganin *et al.*, 2021). The platform facilitates the transaction by providing borrower information, conducting credit evaluations, and managing the exchange, but it does not assume the liability for loan defaults. This model has seen explosive growth globally, from a nominal financing volume of USD 3.5 billion in 2013 to a projected USD 1 trillion by 2025 (Al-Hashfi and Zusryn, 2020; Bella, 2020). However, it is worthy to note that the most relevant features of this model are its reliance on alternative data for credit assessment and its significantly lower operational overhead, which are the fundamental mechanisms enabling it to potentially serve segments traditionally excluded from formal finance.

2.2. The Substitution versus Complementarity Debate in Developed Markets

The potential of P2P lending to promote financial inclusion is rooted in its structural advantages. By disintermediating traditional banks, P2P platforms can theoretically reduce interest spreads, offering borrowers lower rates and lenders higher returns (Yum *et al.*, 2012; Polyzosa *et al.*, 2021). Crucially, their use of proprietary, flexible credit risk models—which can incorporate non-standard information—allows them to assess the creditworthiness of "unbankable" borrowers who lack a formal credit history (Yum *et al.*,

2012; Eid and Yang, 2018). This suggests a clear potential for P2P lending to act as a substitute for traditional banks in underserved areas.

Empirical evidence from developed markets, however, presents a nuanced picture, forming a central debate in the literature. A body of research supports the substitution hypothesis. Studies of U.S. platforms like Lending Club find that FinTech lending expands in areas with fewer bank branches and serves higher-risk borrowers who are neglected by the traditional system (Jagtiani and Lemieux, 2018; De Roure *et al.*, 2016). This stream of literature positions P2P lending as filling a credit gap left by retracting banks.

Conversely, other studies argue for a complementary relationship. Research in European contexts concludes that P2P lending often supplements, rather than competes with, conventional banking activity, serving niche segments without directly substituting for core banking products (Milne and Parboteeah, 2016; Boitan, 2016). Some findings even suggest a hybrid role; for instance, Tang (2019) finds that P2P lending can substitute for bank credit for some borrowers while complementing it for others, particularly for small-sized loans.

This ongoing debate is almost exclusively informed by evidence from mature, highly banked financial systems. The extent to which these findings apply to developing economies—where banking infrastructure is inherently patchier, the unbanked population is larger, and digital financial services are often a first entry point into the formal system—remains a pressing, unanswered empirical question. Moreover, the debate has largely focused on the credit dimension of banking, leaving open the question of whether substitution holds for other aspects of banking presence, such as deposit mobilization.

2.3. The Indonesian Context: Financial Inclusion, FinTech and the Regulatory Landscape

Indonesia presents a critical case for testing the substitution hypothesis. Despite the government's target of 90% financial inclusion by 2024, data from the World Bank reveals a stark reality: only 62% of Indonesians over 15 hold an account at a formal financial institution, and a mere 5% have borrowed from one (World Bank, 2025). This vast gap underscores the limitations of the traditional banking sector and makes the goal of universal inclusion nearly impossible to achieve using only conventionally available services.

Financial inclusion in Indonesia is characterized by significant regional imbalances in both bank account ownership and credit access. As of 2018, no district had surpassed a 60% adult bank account ownership rate, with a notable urban–rural divide (43.2% vs. 24.3%). The highest ownership rates are concentrated in major urban centres such as DKI Jakarta (54.5%), North Kalimantan (50.7%), and East Kalimantan (50.2%), while the lowest

rates are found in South Sumatra, Lampung, and Papua. Credit access is heavily concentrated in Java, Bali, and Sumatra, where rates exceed 1% of the population, whereas Eastern Indonesia—including Kalimantan, Sulawesi, and Papua—shows substantially lower access at less than 0.25% (Sahputri *et al.*, 2024). Indonesia's status as a sprawling archipelago of over 17,000 islands creates significant logistical hurdles for traditional banking, a problem compounded by a stark digital divide: internet penetration reaches 73% in urban centres but only 48% in rural regions (Pradhipta *et al.*, 2025).

Recognizing this, the Indonesian Financial Services Authority (OJK) has explicitly championed FinTech as a vehicle for financial inclusion. The regulatory framework, particularly OJK Regulation No. 77/POJK.01/2016, catalyzed the rapid expansion of the P2P lending sector. The number of borrowers increased sharply from 38 thousand in 2016 to nearly 16 million by October 2019, demonstrating its rapid market penetration (OJK, 2020). As of February 2024, there were over 131 million borrowers who received loans through Indonesian P2P lending platforms, with outstanding loans reaching IDR 66.9 trillion in August 2024. These platforms are designed to fill the financing gap by opening access to individuals and small business units previously excluded from formal banking services (Atahau *et al.*, 2026). From a regional access perspective, P2P lending platforms in Indonesia have achieved a wider market expansion than traditional banks by serving markets that cannot be penetrated by conventional banking infrastructure (Sari, 2021).

Several mechanisms explain why P2P lending expands in regions with weak banking infrastructure. First, lower transaction costs: digital platforms eliminate the overhead of physical branches and intermediaries, making small loans economically viable (Sari, 2021). Second, mobile penetration: widespread smartphone use and growing internet access allow remote populations to bypass physical bank branches (Pradhipta *et al.*, 2025). Third, lack of branches: the archipelago's geography leaves many areas with no bank presence, creating a natural demand for digital alternatives (Sahputri *et al.*, 2024). Fourth, flexibility in credit scoring: P2P platforms use alternative data (e.g., digital transaction histories, business cash flows) rather than requiring formal collateral, enabling them to serve borrowers rejected by traditional banks (Pradana *et al.*, 2025; Atahau *et al.*, 2026). Shifting digital behaviour is also influenced by a "distrust mindset": consumers who harbour distrust toward traditional banking services are significantly more likely to participate in P2P lending (Atahau *et al.*, 2026).

The industry has seen considerable expansion, with a large portion of loans being disbursed to individuals, but it is important to note that some issues of concern have emerged. Examples are the proliferation of unlicensed lenders, lack of financial literacy among borrowers, and questionable debt-collection methods (Yulisman, 2024). Despite being highly monitored, P2P regulation is noted to be lagging behind the established banking sector; current priorities include user education, consumer protection, data privacy, and monitoring of illegal P2P activities (Atahau *et al.*, 2026).

While P2P platforms in Indonesia have thrived in recent years with rapid developments in mobile technology and the widespread use of smartphones, this rapid growth, set against a backdrop of significant regional variation in banking density, provides a valuable empirical setting to investigate whether P2P lending is primarily growing in the provinces where traditional banks are absent. Supporting the relevance of this inquiry, Sari (2021) finds that P2P lending growth has a significant negative effect on the profitability of 109 OJK-registered banks between 2015 and 2019—particularly for state-owned banks slower to innovate—suggesting a substitutive rather than purely complementary relationship. Thus, the deep regional disparities, low financial literacy, evolving digital behaviour, and still-developing regulatory framework together to create a rich laboratory for testing the substitution hypothesis and exploring the conditions under which P2P lending complements rather than replaces traditional banking.

2.4. Hypothesis Development

The theoretical promise of P2P lending, combined with the specific structural gaps in the Indonesian financial system, leads to a clear and testable prediction. If P2P platforms are fulfilling their promise of serving the financially excluded, their penetration should be highest in regions where traditional banking infrastructure is weakest. Therefore, this study tests the following hypothesis:

H1: *P2P lending acts as a substitute for traditional banking infrastructure in Indonesia. Specifically, P2P lending volume per capita will be significantly higher in provinces with lower banking density, measured by bank credit relative to gross regional product and bank branches per capita.*

We focus on these two dimensions because they directly capture credit availability and physical access, which are the primary channels through which financial exclusion operates. The relationship with other dimensions of banking presence, such as deposit mobilization, is explored separately as a robustness check.

3. Data and Methodology

3.1. Data Sources and Variable Construction

This study utilizes a balanced panel dataset of 31 Indonesian provinces over the period January 2020 to August 2024, yielding 1,736 province-month observations. Seven provinces were excluded due to incomplete data for the study period or because they were newly formed during this time, ensuring a balanced panel. The data is compiled from three primary official sources to ensure reliability and consistency:

- a. **Financial Data:** Provincial-level data on commercial bank credit, branch counts, and third-party funds (deposits) are sourced from the publicly available Indonesia Banking Statistics reports published by the Financial

Services Authority (OJK).

- b. **FinTech Data:** Data on P2P lending disbursements are obtained from the monthly Information Technology-Based Joint Funding Services (LPBBTI) Statistics, also published by OJK.
- c. **Macroeconomic and Demographic Data:** Data on provincial Gross Regional Product (GRP) and mid-year population projections are collected from Statistics Indonesia (BPS, 2025). GRP is reported annually by BPS; to match the monthly frequency of other variables, we linearly interpolated GRP to monthly estimates.

Our empirical analysis centers on the relationship between traditional banking density and P2P lending penetration. The variables are constructed as follows:

- **Dependent Variable:**
 - **P2P_pc:** P2P lending per capita. Calculated as the total monthly P2P loan disbursement (in Rupiah) in a province divided by the province's population. This normalization is critical to control for provincial size and to accurately measure per capita credit access, following the approach used in prior research on FinTech lending (e.g., Jagtiani and Lemieux, 2018).

As an alternative measure of P2P lending depth, we also construct P2P_GRP.

- **P2P_GRP:** total monthly P2P loan disbursement divided by Gross Regional Product. This variable captures the scale of P2P lending relative to the regional economy, allowing a direct comparison with the banking depth measure described below.
- **Independent Variables (Banking Density Measures):**
 - **BankCredit_GRP:** The ratio of total commercial bank credit to Gross Regional Product (GRP). This measure captures the financial depth and lending capacity of the traditional banking sector within a regional economy, a common metric in the finance-growth literature.
 - **BankBranches_pc:** The number of commercial bank branches per capita. This measure captures the physical accessibility and proximity of traditional banking infrastructure for the local population, a key variable in studies of financial inclusion (e.g., Martinez Peria *et al.*, 2005).

To capture the overall scale of banking activity beyond lending, we also construct a deposit-based measure:

- **TPF_GRP:** The ratio of total third-party funds (demand deposits,

savings deposits, and time deposits) of commercial banks to Gross Regional Product. This variable reflects the size and depth of the deposit base in a region, serving as an alternative indicator of banking presence and financial inclusion.

In robustness checks, we replace BankCredit_GRP with TPF_GRP to test whether the substitution effect holds when banking density is measured by deposit mobilization rather than credit provision. Similarly, we examine the sensitivity of our results by using P2P_GRP as an alternative dependent variable.

3.2. Empirical Strategy

To isolate the relationship between banking density and P2P lending, we employ a Two-Way Fixed Effects (TWFE) panel regression model. This approach is standard in regional economic studies as it controls for unobserved, time-invariant provincial heterogeneity (e.g., cultural norms, geographic constraints) through province fixed effects, and common temporal shocks affecting all provinces (e.g., national policy changes, macroeconomic trends) through time (month-year) fixed effects (Wooldridge, 2010).

The multivariate empirical model is specified as follows:

$$P2P_pc_it = \beta_0 + \beta_1 BankCredit_GRP_it + \beta_2 BankBranches_pc_it + \beta_3 Time_t + \mu_i + \lambda_t + \varepsilon_{it}$$

Where:

- P2P_pc_it is the P2P lending per capita in province i and month t.
- BankCredit_GRP_it is the ratio of bank credit to GRP in province i and month t.
- BankBranches_pc_it is the number of bank branches per capita in province i and month t.
- Time_t is a linear time trend to capture the sustained increase of the P2P sector.
- μ_i represents province fixed effects.
- λ_t represents time (month-year) fixed effects.
- ε_{it} is the idiosyncratic error term.

This multivariate approach allows us to assess the unique contribution of each dimension of banking infrastructure while controlling for the other. The coefficients of interest are β_1 and β_2 . A statistically significant negative coefficients ($\beta_1 < 0$; $\beta_2 < 0$) would provide support for the substitution hypothesis, indicating that P2P lending per capita is higher in provinces and during periods where traditional banking density is lower, consistent with findings in developed market contexts (Jagtiani and Lemieux, 2018; Tang, 2019).

While the TWFE model mitigates many sources of omitted variable bias, we acknowledge that a strictly causal interpretation may be limited by potential endogeneity, such as reverse causality. Therefore, we interpret our findings as conditional correlations that are consistent with a substitution effect, rather than as definitive causal evidence. We further assess the robustness of our findings through a series of alternative specifications described in Section 3.3.

3.3. Robustness and Alternative Specifications

To address concerns regarding the measurement of banking density and the depth of P2P lending, we implement two additional specifications. These checks help assess whether the main findings are sensitive to alternative definitions of banking presence and P2P activity.

First, we replace the credit-based banking density measure (BankCredit_GRP) with a deposit-based measure (TPF_GRP), defined as the ratio of total third-party funds to GRP. This specification captures banking presence through deposit mobilization rather than credit provision, reflecting the broader concept of financial inclusion and addressing the point that banks may be active in non-lending services.

Second, we substitute the dependent variable with an alternative measure of P2P lending depth: P2P_GRP, defined as total P2P loan disbursement divided by GRP. This allows us to examine whether the substitution effect holds when P2P activity is scaled to the size of the regional economy, rather than measured on a per capita basis.

All other elements of the model (province fixed effects, time fixed effects, and the branch density variable) remain unchanged. Results of these robustness checks are presented alongside the main findings.

4. Analysis and Results

4.1. Descriptive Statistics and Preliminary Analysis

The empirical analysis, conducted using IBM SPSS Statistics (v.26), employs a balanced panel dataset, free of missing values, comprising 1,736 province-month observations across 31 Indonesian provinces from January 2020 to August 2024. Prior to estimating the main model, the data underwent standard diagnostic checks to ensure the robustness of the results.

An examination of descriptive statistics across all provinces revealed no influential outliers that would unduly affect the estimates. The total sample means and standard deviations, presented in Table 1, indicate substantial variation in the key variables, a necessary condition for testing the hypothesized relationships. The total sample mean for P2P lending per capita was 0.045 (SD = 0.065), indicating significant variation in P2P lending penetration across the country. The key independent variables also showed considerable variation, with the bank credit to GRP ratio averaging 0.241 (SD = 0.147) and

bank branches per capita averaging 0.016 (SD = 0.007). For the robustness checks, we also examined the alternative measures: P2P lending depth (P2P_GRP) had a mean of 0.0006 (SD = 0.0051), and the deposit-based banking scale (TPF_GRP) had a mean of 0.2394 (SD = 0.14611), confirming substantial cross-provincial variation.

Table 1. Descriptive Statistics

	Count	Mean	Standard Deviation
P2P_pc	1736	,04483524	,064537437
P2P_GRP	1736	,0006	,0051
BankCredit_GRP	1736	,24130049	,146823656
BankBranches_pc	1736	,01620288	,007189891
TPF_GRP	1736	,2394	,14611

To test for multicollinearity, Variance Inflation Factors (VIFs) were calculated via an auxiliary ordinary least squares (OLS) regression. The results presented in the Table 2 showed VIFs of 1.434 for bank credit to GRP, 1.438 for bank branches per capita, and 1.004 for the time trend. All values are well below the conservative threshold of 5, indicating that multicollinearity does not pose a concern for the estimation of the fixed effects (O'Brien, 2007).

Table 2. Multicollinearity Test

Coefficients ^a							
Model	Unstandardized Coefficients		Standardized Coefficients		Sig.	Collinearity Statistics	
	B	Std. Error	Beta	t		Tolerance	VIF
1 (Constant)	-31.213	1.342		-23.256	0.000		
BankCredit_GRP	0.268	0.007	0.609	36.756	0.000	0.697	1.434
BankBranches_pc	2.160	0.149	0.241	14.513	0.000	0.695	1.438
Time_t	0.001	0.000	0.322	23.218	0.000	0.996	1.004

a. Dependent Variable: P2P_pc

4.2. Main Results: Two-Way Fixed Effects Estimation

To test the substitution hypothesis, a Two-Way Fixed Effects (TWFE) model was estimated, with P2P lending per capita as the dependent variable. The model included province fixed effects to control for time-invariant regional heterogeneity and time (month-year) fixed effects to account for common temporal shocks. The results, presented in Table 3, are consistent with our central hypothesis.

The estimates for the key explanatory variables are both statistically significant and negative, as hypothesized. First, the coefficient for Bank Credit to GRP Ratio is -0.098 (p = 0.004). This indicates that for a one-unit increase in the ratio of bank credit to GRP, P2P lending per capita decreases by 0.098 units, holding all else constant. This finding

suggests that P2P lending per capita is higher in provinces where the traditional banking sector's financial depth is lower.

Second, the coefficient for Bank Branches Per Capita is -7.865 ($p < 0.001$). This highly significant result implies that a one-unit increase in bank branches per capita is associated with a substantial decrease of nearly 7.87 units in P2P lending per capita. This is consistent with the view that P2P lending penetration is strongest in regions with poorer physical access to traditional bank branches.

Furthermore, the model reveals a strong, independent positive time trend ($\beta = 0.000881$, $p < 0.001$), which translates to an average increase of approximately 23% per year. This confirms the sustained and rapid expansion of the P2P lending sector in Indonesia over the study period, even after controlling for the level of banking infrastructure.

Table 3. Two-Way Fixed Effects Regression

Estimates of Fixed Effects ^a							
Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	-21.186	1.175	1003.058	-18.021	0.000	-23.493	-18.879
BankCredit_GRP	-0.098	0.034	1610.454	-2.850	0.004	-0.166	-0.030
BankBranches_pc	-7.865	1.255	572.184	-6.263	0.000	-10.331	-5.398
Time_t	0.001	4.778	1026.342	18.439	0.000	0.001	0.001

a. Dependent Variable: P2P_pc.

The model's overall fit is indicated by the highly significant Type III F-tests for the fixed effects (Table 4). The F-statistic for the time trend ($F = 340.006$, $p < .001$) confirms the powerful and sustained increase of the P2P sector throughout the study period. More critically for the research hypothesis, the F-tests for both banking density measures were highly significant, with the F-statistic for physical access (bank branches per capita, $F = 39.231$, $p < .001$) being particularly strong, underscoring its pronounced role in the pattern of P2P lending expansion.

Table 4. Fixed Effects

Type III Tests of Fixed Effects ^a					
Intercept	1	1003.058	324.763	0.000	
BankCredit_GRP	1	1610.454	8.122	0.004	
BankBranches_pc	1	572.184	39.231	0.000	
Time_t	1	1026.342	340.006	0.000	

a. Dependent Variable: P2P_pc.

The variance components reported in Table 5 confirm the appropriateness of the panel data specification. The significant variance of the province-level random intercepts

($\sigma^2 = 0.0138$, $p = 0.001$) justifies the inclusion of province fixed effects, confirming that unobserved, time-invariant provincial characteristics significantly influence baseline P2P lending levels.

Table 5. Variance Components

Estimates of Covariance Parameters ^a						
Parameter	Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual	0.000452	1.554004E-05	29.054	0.000	0.000422	0.000483
Intercept [subject = location_id]	Variance 0.013774	0.004333	3.179	0.001	0.007435	0.025518

a. Dependent Variable: P2P_pc.

4.3. Robustness Checks

To assess the sensitivity of our findings to alternative measures of banking density and P2P lending depth, we conducted two additional specifications as outlined in Section 3.3. The same mixed model structure was used: province random intercept, month-year fixed effects, and a linear time trend.

Specification 1: Deposit-Based Banking Density:

We replaced BankCredit_GRP with TPF_GRP (total third-party funds to GRP). The results (Tables 6 and 7) show that the coefficient for TPF_GRP is positive and highly significant ($\beta = 0.473$, $p < 0.001$; $F = 367.239$, $p < 0.001$), indicating that provinces with a larger deposit base have significantly higher P2P lending per capita. This contrasts with the main model, where credit-based banking density exhibited a negative relationship. BankBranches_pc remains negative and significant ($\beta = -5.053$, $p < 0.001$; $F = 28.800$, $p < 0.001$), consistent with the main finding that physical branch scarcity drives P2P substitution. The positive association for deposit-based density suggests a complementary dynamic: regions with stronger deposit mobilization may possess more developed financial ecosystems that also support P2P lending.

Table 6. Fixed Effects Estimates: Deposit-Based Banking Density

Estimates of Fixed Effects ^a						
Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound Upper Bound
Intercept	-28.349	0.983	301.598	-28.829	0.000	-30.284 -26.414
TPF_GRP	0.473	0.025	895.243	19.163	0.000	0.425 0.522
BankBranches_pc	-5.053	0.942	89.626	-5.367	0.000	-6.924 -3.182
Time_t	0.001169	0.000040	315.331	29.171	0.000	0.001090 0.001248

a. Dependent Variable: P2P_pc.

Table 7. Fixed Effects – Deposit-Based Banking Density

Type III Tests of Fixed Effects ^a				
Intercept	1	301.598	831.117	0.000
TPF_GRP	1	895.243	367.239	0.000
BankBranches_pc	1	89.626	28.800	0.000
Time_t	1	315.331	850.943	0.000

a. Dependent Variable: P2P_pc.

Specification 2: P2P Depth as Dependent Variable:

We substituted the dependent variable with P2P_GRP (P2P lending scaled by GRP). Tables 8 and 9 report the results. BankCredit_GRP is not statistically significant ($\beta = -0.000121$, $p = 0.677$), while BankBranches_pc shows a positive and significant coefficient ($\beta = 0.0236$, $p = 0.006$). However, a convergence warning was issued during estimation, likely due to the very small magnitude of P2P_GRP (mean = 0.0006). This makes the model unstable, and the results should be interpreted with caution. The non-significance of BankCredit_GRP is not robust to this alternative scaling, though the convergence issues preclude strong conclusions. This specification may not be well suited to the data structure given the very small scale of the dependent variable.

Table 8. Robustness Check: P2P Depth as Dependent Variable

Estimates of Fixed Effects ^a						95% Confidence Interval	
Parameter	Estimate	Std. Error	df	t	Sig.	Lower Bound	Upper Bound
Intercept	-0.3606	0.0092	652.855	-39.119	0.000	-0.3787	-0.3425
BankCredit_GRP	-0.000121	0.000290	653.552	-0.416	0.677	-0.000691	0.000449
BankBranches_pc	0.0236	0.0084	124.417	2.813	0.006	0.0070	0.0402
Time_t	1.4868e-5	3.7642e-7	693.255	39.499	0.000	1.4129e-5	1.5607e-5

a. Dependent Variable: P2P_GRP.

Collectively, the robustness checks are consistent with the view that the substitution effect observed in the main model is specific to the credit dimension of banking presence and to per capita P2P lending. The positive association with deposit-based banking density points to a potential complementary role, though this interpretation requires further investigation.

Table 9. Fixed Effects – P2P Depth as Dependent Variable

Type III Tests of Fixed Effects ^a				
Intercept	1	652.855	1530.301	0.000
BankCredit_GRP	1	653.552	0.173	0.677
BankBranches_pc	1	124.417	7.913	0.006
Time_t	*	*	*	*

a. Dependent Variable: P2P_GRP.

Note: The Type III test for Time_t was not computed due to convergence issues; the model failed to converge, likely because of the very small scale of the dependent variable.

Multicollinearity diagnostics for these robustness models are shown in Table 10. For all estimators, it shows VIF values below (5), confirming that multicollinearity does not affect the estimates.

Table 10. Collinearity Diagnostics for Robustness Models

Variable	Tolerance	VIF
Model 1 (TPF_GRP as IV)	TPF_GRP	0.717
	BankBranches_pc	0.715
	Time_t	0.996
Model 2 (P2P_GRP as DV)	BankCredit_GRP	0.697
	BankBranches_pc	0.695
	Time_t	0.996

Note: All VIFs are well below 5, indicating no multicollinearity issues.

4.4. Interpretation and Synthesis of Findings

The main model yields findings consistent with the substitution hypothesis (H1) when banking density is measured by credit depth (BankCredit_GRP) and physical branch presence (BankBranches_pc). The significant negative coefficients indicate that in provinces where traditional banks lend less relative to regional output and where branch infrastructure is sparser, P2P lending per capita is higher. This pattern aligns with findings from developed markets like the United States (Jagtiani and Lemieux, 2018) and is demonstrated here for the first time in a major developing economy with a large unbanked population. The coexistence of a strong negative substitution effect with a powerful positive time trend reflects a financial system in transition, where FinTech is concurrently expanding the overall credit pie and redistributing its geographical allocation.

However, robustness checks reveal a more nuanced picture. When banking density is measured by deposit mobilization (TPF_GRP) rather than credit provision, the relationship becomes positive and significant, which is consistent with the possibility that regions with a larger deposit base also host more active P2P lending. This could reflect a

complementary role: banks that are strong in deposit collection may contribute to broader financial infrastructure (e.g., payment systems, financial literacy) that also benefits FinTech lenders. Additionally, when P2P activity is scaled by regional economic output (P2P_GRP) rather than per capita, the coefficient for BankCredit_GRP loses statistical significance. This model exhibited convergence issues, likely due to the very small scale of P2P_GRP, indicating that this specification may be less suitable for capturing the substitution effect.

Taken together, the findings are consistent with substitution is most evident in the credit dimension of banking and in per capita P2P lending. The evidence does not support a general substitution effect across all measures of banking presence or P2P activity. Instead, it highlights a context-dependent relationship where P2P lending fills gaps left by bank credit supply, while coexisting with broader banking infrastructure. This complexity underscores the need for future research to disentangle the mechanisms behind these contrasting patterns.

5. Discussion

The primary objective of this study was to provide the first empirical test of the substitution hypothesis between P2P lending and traditional banking within a major developing economy. The main results are consistent with the substitution hypothesis when banking density is measured through credit depth (bank credit to GRP) and physical accessibility (bank branches per capita). In provinces where banks lend less relative to regional output and where branch infrastructure is sparser, P2P lending per capita is significantly higher. This finding allows us to refine and contextualize the existing literature in several important ways.

Most directly, our results confirm and amplify the nascent stream of substitution literature originating in developed markets, but within a context where the effect appears more pronounced. For instance, while Jagtiani and Lemieux (2018) found that U.S. FinTech lenders penetrated areas where banks had retracted, their study described a phenomenon occurring at the margins of a deep and mature financial system. Our findings are consistent with the view that in Indonesia, this is not a marginal adjustment but a large-scale, structural market response. The magnitude and significance of our coefficients, particularly for physical branch density, indicate that P2P lending is not merely filling gaps but is establishing itself as a primary credit channel in regions the formal sector has largely failed to reach. This is in line with the theoretical promise of P2P lending as a tool for financial inclusion (Yum et al., 2012; Polyzosa et al., 2021), moving it from theory to observable, macro-level reality in the Global South.

However, robustness checks reveal that the substitution effect is not uniform across all dimensions of banking presence. When banking density is measured by deposit mobilization (TPF_GRP) rather than credit provision, the relationship becomes positive

and significant. This is consistent with the possibility that regions with a larger deposit base—often indicative of more developed banking infrastructure—also host more active P2P lending. Such a pattern points to a possible complementary role: banks that are strong in deposit collection may contribute to broader financial infrastructure (e.g., payment systems, financial literacy) that also benefits FinTech lenders. Similarly, when P2P activity is scaled by regional economic output (P2P_GRP) rather than per capita, the coefficient for bank credit to GRP loses statistical significance. This specification exhibited convergence issues, likely due to the very small scale of P2P_GRP, indicating that it may be less suitable for capturing substitution. Taken together, the evidence suggests that substitution is most evident in the credit dimension of banking and in per capita P2P lending, while deposit-based banking activity coexists with P2P expansion.

These findings help reconcile the apparent contradiction in the literature between “substitution” and “complementarity.” Studies in European contexts often concluded that P2P lending complemented traditional banking (Milne and Parboteeah, 2016; Boitan, 2016), while others in the U.S. noted substitution (Tang, 2019). Our analysis, situated in a developing economy with a large unbanked population, is consistent with the idea that the pre-existing structure of the financial ecosystem is a key determinant. Where banking systems are weak in credit provision, P2P lending steps in as a substitute. However, where banking systems are strong in deposit mobilization, a complementary dynamic may emerge. This context-dependent understanding moves the field beyond a binary debate towards a more nuanced framework.

The powerful, independent positive time trend we documented underscores the explosive increase of the sector. This trend, even after controlling for banking density, is consistent with P2P lending’s expansion is driven not only by static gaps in banking infrastructure but also by a dynamic process of market discovery, technological adoption, and potentially, a growing reliance on digital credit. This rapid expansion, however, brings the discussion to a critical juncture, mirroring concerns raised in earlier literature but with greater urgency. The very mechanisms that enable this substitution—disintermediation, use of alternative data, and digital onboarding (Eid and Yang, 2018)—are the same ones that can elevate consumer risk in a less regulated environment (Claessens et al., 2018). The substitution we observe, therefore, is not merely a market transaction; it represents a transfer of both opportunity and risk. The opportunity is greater financial inclusion for the unbanked; the risk is that this new digital frontier, expanding in underserved areas, may outpace the development of corresponding consumer protections and financial literacy, potentially leading to new vulnerabilities like over-indebtedness and data exploitation.

Our finding of a negative relationship between bank credit depth and P2P lending per capita aligns with Sari (2021), who documented that P2P lending growth reduces bank profitability in Indonesia, indicating a substitution effect. However, our robustness check

showing a positive association with deposit-based banking density echoes Pradhipta *et al.* (2025), who noted complementary dynamics in service delivery (e.g., mobile banking leveraging agent networks).

5. Conclusion

This study set out to resolve a critical gap in the financial technology literature by empirically testing whether P2P lending acts as a substitute for traditional banking within a developing economy. The main findings from a comprehensive provincial-level dataset from Indonesia are consistent with the view that P2P lending per capita is higher in provinces where the traditional banking system's credit provision and physical branch presence are weakest. The robust negative relationship with bank credit depth and bank branches per capita offers support for the substitution hypothesis, moving it from a theoretical proposition in developed markets (Jagtiani and Lemieux, 2018) to an empirically verified reality in a context of widespread financial exclusion. The substitution we observe occurs in a context where FinTech literacy remains very low, raising concerns about consumer vulnerability.

However, robustness checks reveal that substitution is specific to the credit dimension of banking. When banking density is measured by deposit mobilization, the relationship becomes positive, which is consistent with a complementary dynamic. Moreover, the substitution effect does not hold when P2P activity is scaled by regional economic output (P2P_GRP), though this model exhibited convergence issues due to the small magnitude of the variable. These nuances indicate that the role of P2P lending is context-dependent, varying with how banking presence and P2P activity are measured.

The contribution of this research is threefold. First, it contextualizes the global FinTech debate, demonstrating that the dynamics of digital finance are not universal. While studies in bank-saturated economies often find a complementary or hybrid role for P2P lending (Milne and Parboteeah, 2016; Tang, 2019), our findings are consistent with its function as a primarily credit-driven substitute in Indonesia. This is consistent with the idea that the economic role of FinTech is intrinsically linked to the development and inclusivity of the pre-existing financial infrastructure, particularly on the credit side. Second, by leveraging a rigorous Two-Way Fixed Effects panel model with robustness checks, we provide strong correlational evidence of this geographic substitution, addressing a significant methodological shortcoming in the literature on developing economies. Third, our findings bridge the gap between academic research and practical policy, offering clear, data-driven insights for key stakeholders.

6. Implication

The implications of these findings are relevant for policy and practice. For Indonesian policymakers and the OJK, our results argue for a differentiated regulatory approach. Provinces identified as high-substitution zones (e.g., Jawa Barat, Jawa Timur) require

intensified consumer protection, financial literacy programs, and vigilant oversight to ensure that the bridge to financial inclusion does not become a trap of over-indebtedness. Conversely, in regions where deposit-based banking is strong and P2P appears complementary, policies might focus on encouraging collaboration between banks and FinTech platforms to enhance overall financial access. Given that low digital literacy and a lagging regulatory framework characterize many underserved provinces, policies should prioritize consumer education alongside financial access. For P2P platforms, the results provide a strategic blueprint, identifying underserved provinces not as marginal territories, but as core markets with validated demand for credit substitution. For traditional banks, this study serves as an indication of market displacement in the credit domain, urging a strategic rethink of service models for excluded segments, potentially through partnerships or digital innovations of their own.

7. Future Research Direction

This study opens several avenues for future research. The logical next step is a deep dive into the demand side of this equation: who are the borrowers in these high-substitution provinces, and what are their lived experiences? Furthermore, while we find evidence of substitution for credit, the positive association with deposit-based banking density deserves further investigation to understand whether it reflects a complementary mechanism (e.g., banks providing payment infrastructure) or a spurious correlation. Research is also needed to quantify the socio-economic impacts of P2P lending on poverty reduction, business formation, and household resilience, and to explore why the substitution effect does not hold when P2P is scaled by GRP. We have provided evidence consistent with P2P lending is filling a credit void; future work must now determine how effectively and equitably it is doing so. In closing, the rise of P2P lending in Indonesia represents a powerful, market-driven experiment in financial inclusion. Its ultimate success will be measured not only by its expansion metrics, but by its ability to empower the unbanked without introducing new forms of vulnerability, a balance that demands continued scholarly and regulatory attention.

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Conflict of interest

The author declares that there are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

This study did not require ethical approval from an institutional review board because it did not involve human or animal subjects. The research was conducted solely on publicly available data.

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Sürdürülebilir Bölgesel Kalkınma Perspektifinden Rize'nin Yeni Lojistik Kapısı: İyidere Liman Projesi

Gökçen Aydınbaş^a  

ÖZET

Amaç – Bu çalışmanın amacı, Rize'nin lojistik dönüşüm süreci bağlamında İyidere Lojistik Limanı'nın bölgesel kalkınma üzerindeki etkilerini bütüncül bir perspektifle değerlendirmektir. Araştırma, literatürde ağırlık kazanan teknik ve altyapı odaklı yaklaşımların ötesine geçerek, limanın ekonomik, çevresel ve yönetim boyutlarını birlikte ele almaktadır. Çalışma, limanın istihdam, üretim çeşitliliği ve bölgenin uluslararası ticaret ağlarına entegrasyonu üzerindeki potansiyel etkilerini ortaya koymayı amaçlamaktadır.

Tasarım/veri/metodoloji – Araştırmada SWOT yöntemi uygulanmış; limanın güçlü ve zayıf yönleri ile karşı karşıya olduğu fırsat ve tehditler sistematik biçimde değerlendirilmiştir.

Bulgular – Bulgular, limanın stratejik konumu sayesinde uluslararası ticaret koridorlarına entegrasyon potansiyeline sahip olduğunu göstermektedir. İstihdam artışı ve ekonomik çeşitlenme önemli fırsatlar sunarken, demir yolu bağlantısının bulunmaması, yük talebine ilişkin belirsizlikler ve çevresel baskılar temel kısıtlar olarak öne çıkmaktadır.

Özgünlük/değer – Bu araştırma, İyidere Lojistik Limanı'nı yalnızca teknik yönleriyle değil, ekonomik, çevresel ve yönetim boyutlarıyla birlikte ele alması bakımından özgün bir katkı sunmaktadır. Çalışma, literatürde sınırlı ele alınan bölgesel kalkınma perspektifini ön plana çıkararak disiplinler arası bir yaklaşım benimsemektedir. SWOT analizi yoluyla elde edilen bulgular, karar vericilere stratejik bir değerlendirme zemini sunmaktadır.

Anahtar Kelimeler: İyidere Lojistik Limanı, Bölgesel Kalkınma, Lojistik Dönüşüm

Rize's New Logistics Gateway from A Sustainable Regional Development Perspective: The İyidere Port Project

ABSTRACT

Purpose – The purpose of this study is to evaluate the impacts of İyidere Logistics Port on regional development within the context of Rize's ongoing logistics transformation process from a holistic perspective. Moving beyond the predominantly technical and infrastructure-oriented approaches in the literature, the research addresses the economic, environmental, and governance dimensions of the port in an integrated manner. The study aims to reveal the port's potential effects on employment, production diversification, and the region's integration into international trade networks.

Design/data/methodology – The SWOT method is employed in this research, and the port's strengths and weaknesses, as well as the opportunities and threats it faces, are systematically analyzed.

Findings – The findings indicate that, due to its strategic location, the port has significant potential for integration into international trade corridors. While increases in employment and economic diversification represent important opportunities, the absence of a railway connection, uncertainties regarding future cargo demand, and environmental pressures emerge as major constraints.

Originality/value – This study makes an original contribution by examining İyidere Logistics Port not only from a technical perspective but also through economic, environmental, and governance dimensions. By emphasizing the regional development perspective, which remains limited in the existing literature, the research adopts an interdisciplinary approach. The findings derived from the SWOT analysis provide a strategic evaluation framework for policymakers.

Keywords: İyidere Logistics Port, Regional Development, Logistics Transformation

1. Giriş

Rize ekonomisi tarihsel süreç boyunca tarım, kıyı ticareti ve zanaat faaliyetleri etrafında şekillenmiş; özellikle 20. yüzyılın ikinci yarısından itibaren çay sektörünün hızlı büyümesiyle tek ürün eksanlı bir ekonomik yapı ortaya çıkmıştır (Bostan, 2002). Çay tarımının bu baskın konumu, bölgesel ekonomi açısından belirli avantajlar sağlamasına rağmen, uzun vadede ekonomik kırılganlığı artırmış ve sektör çeşitliliğinin sınırlı kalmasına neden olmuştur. Buna bağlı olarak, özellikle genç nüfusun büyükşehirlerle göç etmesi ve sermaye birikiminin zayıflığı, Rize'nin yapısal ekonomik dönüşüm ihtiyacını daha görünür hâle getirmiştir (Rize İli Yatırım Destek Ofisi, 2022).

Lojistik sektörünün bölgesel kalkınmadaki rolü günümüz üretim ve ticaret sistemlerinde stratejik bir konum kazanmıştır. Ulaştırma altyapısının niteliği, mal ve hizmetlerin dolaşım hızını belirlediği gibi bölgesel sermaye birikimi, iş gücü hareketliliği ve firmalar arası etkileşim açısından da belirleyicidir. Lojistik merkezler; taşımacılık, depolama, dağıtım ve gümrükleme gibi faaliyetlerin bütünleşik bir yapıda yürütülmesine imkân sağlayarak maliyetleri azaltmakta ve tedarik zinciri verimliliğini artırmaktadır.

Doğu Karadeniz'in dış ticaret potansiyelini artırmaya yönelik lojistik yatırımlar, Türkiye'nin uluslararası tedarik zincirlerindeki etkinliğini güçlendirmesi açısından kritik önem taşımaktadır. Son yıllarda küresel ticaret rotalarında yaşanan değişimler, Karadeniz Havzası'nı hem bölgesel hem de kıtalar arası mal hareketlerinin yeniden şekillendiği stratejik bir geçiş alanına dönüştürmüştür. Bu bağlamda, bölgenin yük kapasitesini artıracak, multimodal taşımacılığı destekleyecek ve hinterlandını genişletecek liman projeleri, ekonomik kalkınmanın temel araçları arasında değerlendirilmektedir. Söz konusu dönüşüm, Karadeniz'e kıyıdaş ülkelerle olan ekonomik etkileşimi kuvvetlendirmekle kalmamakta; Orta Doğu, Kafkasya ve Avrupa arasında giderek önem kazanan kuzey-güney ticaret ekseninde Türkiye'ye yeni lojistik avantajlar kazandırmaktadır (Ulaştırma ve Altyapı Bakanlığı "UAB", 2025).

İyidere Lojistik Limanı, Türkiye'nin dördüncü büyük lojistik limanı olarak, Rize ve Doğu Karadeniz'in bölgesel kalkınmasında önemli bir rol üstlenmesi beklenen stratejik bir projedir. Limanın bölgesel önemi, sahip olduğu gelişmiş altyapı kapasitesi, mevcut ve planlanan ulaşım ağlarıyla entegrasyonu ile uluslararası ticaret sistemindeki konumu birlikte ele alındığında daha belirgin bir şekilde ortaya çıkmaktadır. Liman, Karadeniz'in büyük tonajlı gemilere hizmet verebilecek az sayıdaki kıyı tesisinden biri olma niteliğiyle bölgenin lojistik kapasitesinde niteliksel bir sıçrama yaratma iddiasındadır. Ancak projeyi kalkınma bağlamında asıl önemli kılan unsur, limanın sadece bir yükleme-boşaltma alanı olarak değil, çok modlu taşımacılığın odak noktası olarak kurgulanmasıdır. Doğu Karadeniz'i Erzurum üzerinden Doğu Anadolu'ya, oradan Orta Doğu'ya ve Kafkasya'ya bağlayacak karayolu ve demir yolu hatlarıyla entegrasyon hedefi, limanı geniş bir hinterlandın giriş kapısı hâline getirmektedir. Bu bağlamda proje, hem bölgesel hem de ulusal düzeyde uluslararası ticaret ağlarıyla kurulan ilişkilerin kapsamını yeniden

şekillendirmektedir. Ulaştırma planlamasında öngörülen bu bütünleşme, limanın yalnızca bölgesel değil, kıtalar arası ticaret akışları açısından da bir aktarma merkezi işlevi üstlenmesine imkân tanımaktadır. Bununla birlikte, limanın ekonomik ve bölgesel etkisinin ortaya çıkması, arka sahada kurulması planlanan lojistik merkezin zamanında hayata geçirilmesine ve ilgili ulaştırma koridorlarının tamamlanmasına bağlıdır. Her ne kadar liman önemli bir altyapı yatırımı olsa da, bu bileşenler gerçekleştirilmediği takdirde beklenen bölgesel dönüşüm potansiyelini tam olarak karşılayamayabilir. Ayrıca projenin çevresel hassasiyetleri gözeterek yürütülmesi, toplumsal kabulün ve sürdürülebilirliğin güçlendirilmesi açısından elzemdir. Bütüncül bir ulaştırma ve lojistik ekosistemi ile desteklendiğinde İyidere Limanı, Doğu Karadeniz'in dış ticaret kapasitesini artırma ve bölgesel kalkınmayı hızlandırma potansiyeline sahiptir; ancak bu potansiyelin gerçekleşmesi, tamamlayıcı unsurların eşgüdümlü biçimde uygulanmasına ve kurumsal koordinasyonun sürekliliğine bağlıdır.

Bu çalışma, SWOT Analiz yöntemi kullanılarak İyidere Lojistik Limanı'nın Rize ve Doğu Karadeniz Bölgesi ekonomik yapısında yaratacağı olası dönüşümü çok boyutlu bir çerçevede değerlendirmeyi amaçlamaktadır. Bu bağlamda proje, yalnızca bir liman yatırımı olarak değil, bölgenin lojistik üstünlüklerini yeniden ölçeklendirebilecek, tedarik zinciri yapısını dönüştürebilecek ve bölgesel kalkınmada yeni bir büyüme eksenini oluşturabilecek stratejik bir altyapı hamlesi olarak ele alınmaktadır. Çalışmada, limanın beklenen etkileri değerlendirilirken altyapı kapasitesi, hinterland genişlemesi, sektörler arası bağlantılar, dış ticaret potansiyeli, ulaşım ağlarına entegrasyon düzeyi ve bölgesel gelişim dinamikleri bütüncül bir yaklaşımla incelenmiştir. Ayrıca projenin bölgesel kalkınmaya katkı sunma potansiyeli, kurumsal koordinasyonun etkinliği, tamamlayıcı yatırımların zamanlaması ve çevresel-sosyal sürdürülebilirlik kriterleri dikkate alınarak analiz edilmiştir. Bu doğrultuda çalışma, İyidere Limanı'nın bölgenin lojistik dönüşümünde gerçek bir "kalkınma motoru" işlevi görüp göremeyeceğine ilişkin kapsamlı bir değerlendirme sunmakta; izleyen bölümlerde limanın teknik özellikleri, ekonomik ve bölgesel etkileri, potansiyel fırsatlar ve sınırlılıklar sistematik bir şekilde ele alınmaktadır.

2. Kavramsal ve Kuramsal Çerçeve

Lojistik, üretim ve tüketim süreçleri arasındaki mal ve hizmet akışının taşımacılık, depolama, elleçleme ve dağıtım faaliyetleri aracılığıyla bütüncül biçimde yönetilmesini sağlayan stratejik bir yapıyı ifade etmektedir. Bu süreç, tedarik zinciri yönetimiyle doğrudan ilişkili olup ürünlerin doğru zamanda, doğru yerde ve mümkün olan en düşük maliyetle teslim edilmesini hedefleyen bir organizasyon mantığına dayanmaktadır. Lojistiğin ekonomik sistemlerde üstlendiği işlev, yalnızca fiziksel taşımayı değil, aynı zamanda değer yaratma süreçlerinin optimizasyonunu da içerdiğinden, bölgesel rekabet gücü ve ekonomik faaliyetlerin coğrafi dağılımı üzerinde belirleyici bir rol oynamaktadır.

Lojistik altyapısının güçlenmesi, özellikle liman ve ulaştırma koridorları çevresinde büyüyen ekonomik kümelenmelerin ortaya çıkmasına yol açmaktadır; bu ise bölgelerin üretim ve yatırım çekme kapasitesini artırmaktadır. Büyüyen çevresel kaygılar ve uluslararası sürdürülebilirlik hedefleri, lojistik sektöründe geleneksel operasyonel yaklaşımların yeniden değerlendirilmesini zorunlu kılmış ve yeşil lojistik, sektörün dönüşümünü şekillendiren stratejik bir çerçeveye dönüşmüştür. Yeşil lojistik, lojistik faaliyetlerin çevre üzerindeki olumsuz etkilerini azaltmayı hedefleyen bütüncül ve önleyici bir yaklaşımı ifade etmektedir. Enerji verimliliğinin artırılması, karbon emisyonlarının düşürülmesi, temiz yakıtların teşvik edilmesi ve çevre dostu taşımacılık modlarının geliştirilmesi bu yaklaşımın temel yapı taşlarını oluşturmaktadır. Küresel ticaret hacminin yoğunlaştığı liman bölgelerinde yeşil lojistik uygulamaları daha kritik bir önem kazanmakta; liman faaliyetlerinin yarattığı çevresel baskı bölgesel sürdürülebilirlik ve kalkınma açısından riskler doğurmaktadır. Bu nedenle liman merkezli lojistik sistemlerin çevresel sürdürülebilirlik ilkeleri gözetilerek yeniden yapılandırılması hem rekabet gücünün korunması hem de uzun vadeli ekonomik dayanıklılığın sağlanması açısından zorunlu bir dönüşüm alanıdır. Literatürde de vurgulandığı üzere, sürdürülebilir politikalarla desteklenmeyen lojistik merkezlerin rekabet avantajını kaybetme riski arttığından, yeşil lojistik artık tercihe bağlı bir uygulama değil, stratejik bir zorunluluk hâline gelmiştir (Ersoy & Aydınbaş, 2025).

Lojistik yapılanmanın önemli bileşenlerinden biri olan lojistik köyler, çok modlu taşımacılık altyapısına sahip, lojistik işletmelerin yer aldığı, depolama, dağıtım, gümrükleme ve katma değerli hizmetlerin bütünleşik biçimde sunulduğu organize lojistik alanlardır. Avrupa’da kurumsallaşmış bu model, taşımacılık modları arasında entegrasyonu güçlendirerek tedarik zinciri maliyetlerini azaltmaktadır ve bölgesel ticaret akımlarını optimize etmektedir. Lojistik entegrasyonunu güçlendirerek tedarik zinciri maliyetlerini azaltmakta ve bölgesel ticaret akımlarını optimize etmektedir (Ballis & Mavrotas, 2007). Lojistik köylerin liman hinterlandlarında konumlanması, bölgesel ölçekte ekonomik faaliyetlerin yeniden örgütlenmesinde kritik bir rol oynamakta; özellikle liman ile kara ulaşımı arasındaki bağlantıların güçlendirilmesine ve ekonomik faaliyetlerin belirli alanlarda yoğunlaşmasına olanak sağlamaktadır.

Dijital teknolojilerin hızla gelişmesi, lojistik faaliyetlerin örgütlenme biçimini köklü biçimde dönüştürmüş ve literatürde “dijital lojistik” olarak nitelenen yeni bir operasyonel paradigma yaratmıştır. Dijital (akıllı) lojistik; bilgi ve iletişim teknolojilerinin, nesnelerin interneti tabanlı izleme sistemlerinin, yapay zekâ algoritmalarının, büyük veri analitiğinin ve blokzincir temelli güvenlik altyapılarının lojistik süreçlere entegre edilmesini ifade etmektedir (Wang & Pettit, 2021). Bu teknolojik dönüşüm, tedarik zincirlerinde görünürlüğün artmasına, operasyonel risklerin azalmasına ve süreç hızının belirgin biçimde yükselmesine yol açarak küresel lojistik ağlarının işleyişini yeniden şekillendirmektedir. Dijitalleşmenin etkisi, özellikle liman-lojistik ilişkilerinde daha

belirgin olup, veri temelli operasyon yönetimi ve otomasyon sayesinde limanlar, yalnızca yük aktarım noktaları olmaktan çıkarak bölgesel kalkınma açısından elzem dijital ve lojistik merkezlere dönüşmektedir (Ersoy & Aydınbaş, 2025). Bu çerçevede dijital (akıllı) limanlar; otomasyon, gerçek zamanlı veri akışı, yapay zekâ tabanlı planlama sistemleri ve IoT sensörleriyle desteklenen bütünleşik bilgi altyapısı üzerine kurulu yeni nesil liman yapıları olarak tanımlanmaktadır. Birleşmiş Milletler Ticaret ve Kalkınma Konferansı (United Nations Conference on Trade and Development) “UNCTAD” (2021), dijital limanları verimlilik, güvenlik ve sürdürülebilirlik hedeflerinin bir arada gerçekleştirilebilmesi için bilgi teknolojilerinin bütüncül kullanıldığı liman yapıları olarak ifade etmektedir. Dijital liman altyapıları operasyonel hız ve doğruluğu artırmakla sınırlı kalmayıp, küresel tedarik zincirlerinin dayanıklılığını ve şeffaflığını güçlendiren yapısal bir dönüşüm yaratmakta; böylece bölgesel ekonomilerin bilgi temelli bir dönüşüm sürecine girmesine zemin hazırlamaktadır (Ersoy & Aydınbaş, 2025).

Lojistiğe ilişkin kavramlarla birlikte sürdürülebilir bölgesel kalkınma kavramları da ele alınmalıdır. Bölge kavramı, tanımlama, analiz, yönetim ve planlama perspektifleriyle ele alındığında öncelikle coğrafi bir alanı ifade etmektedir. Literatürde bölge; homojenlik ya da işlevsellik gibi ölçütlere dayalı olarak sınıflandırılmakta, ayrıca doğal, ekonomik, yönetsel ve politik özelliklerine göre farklı biçimlerde tanımlanmaktadır (Nijkamp & Bergh, 1990). Bu bağlamda bölge, yalnızca mekânsal bir birim değil, aynı zamanda kalkınma süreçlerinin şekillendiği çok boyutlu bir yapı olarak değerlendirilmektedir. Kalkınma, insan yaşamının sürdürülebilirliğini sağlamayı, bireyin kendine saygı duymasını mümkün kılan toplumsal ve ekonomik koşulların sürekliliğini ve bireylerin yaşamları üzerinde tercih yapabilme özgürlüğüne sahip olmalarını içeren çok boyutlu bir süreç olarak ele alınmaktadır (Todaro, 1994). Bölgesel kalkınma ise, bir ülke içinde yer alan bölgeler arasındaki ekonomik ve sosyal gelişmişlik farklılıklarını azaltmaya ya da ortadan kaldırmaya yönelik olarak yürütülen, kamu öncülüğünde veya kamu-özel sektör iş birliğiyle gerçekleştirilen planlı ekonomik ve sosyal faaliyetlerin bütünüdür (Özçiftçi, 2023). Sürdürülebilirlik anlayışı ise ekonomik büyüme ile insan refahının, tüm sistemlerin temelini oluşturan doğal kaynaklara bağımlı olduğunu kabul etmektedir. Bu nedenle ekonomik politikaların uzun vadede sürdürülebilir olabilmesi için çevresel unsurlara yüksek düzeyde öncelik verilmesi gerektiği vurgulanmaktadır (Pearce & Warford, 1993). Dünya Çevre ve Kalkınma Komisyonu (World Commission on Environment and Development “WCED”) tarafından sürdürülebilir kalkınma, bugünün gereksinimlerini karşılarken gelecek kuşakların kendi ihtiyaçlarını karşılama olanaklarını ortadan kaldırmayan bir kalkınma biçimi olarak tanımlanmaktadır (WCED, 1987). Aynı zamanda sürdürülebilir kalkınma, ekonomik kalkınmanın planlanmasına yön veren ve kalkınma politikalarına rehberlik eden ekolojik temelli bir kavram olarak değerlendirilmektedir (Sinemillioğlu, 2009).

2.1. Lojistik ve Bölgesel Kalkınma İlişkisi

Lojistik altyapı; üretim, ticaret ve istihdam üzerinde çok boyutlu etkiler üreten temel bir bölgesel kalkınma bileşenidir. Lojistik merkezlerin faaliyetleri tek bir mekânda toplaması, işletmelerin süreç maliyetlerini azaltarak tedarik zincirlerinin sürekliliğini sağlamakta ve verimliliği artırmaktadır. Literatürde lojistik merkezlerin ekonomik, sektörel ve çevresel kazanımlar sunduğu; üretim süreçlerinde süreklilik sağladığı, ticaret hacmini artırdığı ve istihdam olanaklarını genişlettiği belirtilmektedir (Altunay Nuray & Duman Alptekin, 2023).

Üretim Üzerindeki Etkiler: Lojistik merkezler, hammadde ve ara malzeme tedarikine erişimi kolaylaştırarak üretim süreçlerinin hızlanmasını desteklemektedir. Ayrıca, gelişmiş depolama ve dağıtım altyapısı, özellikle KOBİ'ler için maliyet etkinliğini artırarak rekabet avantajı sağlamaktadır. *Ticaret Üzerindeki Etkiler:* Intermodal taşımacılık kapasitesindeki artış, hem bölgesel hem de uluslararası ticarete işlem sürelerini kısaltmakta ve ihracat ile ithalat maliyetlerini düşürmektedir. Avrupa'daki lojistik köy yapılanma örnekleri, bu etkilerin kurumsallaşmış ve sistematik biçimde gözlemlenebilmesini mümkün kılan somut kanıtlar sunmaktadır (Çelik, 2021).

İstihdam ve Ekonomik Yapı Üzerindeki Etkiler: Lojistik merkezlerin kuruluşu, yeni yatırımların çekilmesine, işletme sayısının artmasına ve lojistik odaklı istihdam fırsatlarının çoğalmasına yol açarak, bölgesel ekonomik canlılığı artırmaktadır (Gümüş, 2009; Sarrazin vd., 2018; Altunay Nuray & Duman Alptekin, 2023). *Ulaştırma-Ekonomi-Kalkınma İlişkisi:* Ulaştırma altyapısı, ekonomik canlılığın temel belirleyicilerinden biridir. "Ekonomik hayatın faaliyet ve canlılığı, ulaştırma vasıtalarının durumuyla orantılıdır" ifadesi, ulaştırmanın bölgesel ve ulusal kalkınmadaki kritik rolünü açık biçimde ortaya koymaktadır (UAB, 2023; Altunay Nuray & Duman Alptekin, 2023).

2.2. Ulusal ve Uluslararası Örnekler

Lojistik merkezler, ekonomik faaliyetlerin işleyişi ve bölgesel kalkınmada kritik rol oynamaktadır. Avrupa'da Rotterdam, Hamburg ve Bremen gibi merkezler intermodal taşımacılık ile şehir merkezlerinin dışında konumlanırken küçük ve fonksiyonel bir yapı benimsemiştir. Türkiye'de ise Samsun, Mersin ve Filyos lojistik köyleri çok modlu taşımacılığı destekleyerek bölgesel ekonomik gelişime katkı sağlamaktadır. Aşağıda söz konusu ulusal ve uluslararası örnekler detaylıca incelenmiştir:

Avrupa'daki Lojistik Merkez Örnekleri (Rotterdam, Hamburg vb.): Avrupa'da lojistik merkez yapılanması 1960'lı yıllarda gelişmeye başlamış ve 1990'lardan itibaren kurumsal bir ağ yapısına kavuşmuştur. Rotterdam, Hamburg ve Bremen gibi liman kentleri, intermodal taşımacılığın gelişmiş olduğu, geniş hinterlanda sahip ve kıta ticaretinde stratejik konumları ile öne çıkan önemli lojistik merkezlerdir. Avrupa'daki lojistik merkezlerin ortak özellikleri; şehir merkezi dışında konumlanmaları, küçük fakat fonksiyonel bir yerleşim modeli izlemeleri ve demir yolu ile karayolu ağlarına yüksek

entegrasyon sağlamalarıdır (Ballis & Mavrotas, 2007; Çelik, 2021).

Türkiye’de Benzer Projeler (Mersin, Filyos, Samsun): Türkiye’de lojistik merkez politikalarının özellikle 2006 sonrası hız kazandığı görülmektedir. Türkiye Cumhuriyeti Devlet Demiryolları (TCDD) tarafından işletmeye alınan lojistik merkezler, ülkenin jeostratejik konumuna uygun olarak çok modlu taşımacılığı desteklemeyi hedeflemektedir (Altunay Nuray & Duman Alptekin, 2023; TCDD, 2024).

Samsun (Gelemen) Lojistik Köyü: Türkiye’deki ilk lojistik köy olup Karadeniz Bölgesi’nin uluslararası ticaret akışında önemli bir rol üstlenmektedir. Demir yolu-karayolu-deniz yolu bütünleşmesi sayesinde bölgesel taşıma maliyetlerinin azalmasına katkı sunmaktadır (Bayraktutan & Özbilgin, 2014; Altunay Nuray & Duman Alptekin, 2023).

Mersin (Yenice) Lojistik Köyü: Akdeniz ticaretinin merkezinde konumlanan bu lojistik merkez, Orta Doğu pazarlarına erişimi kolaylaştırarak uluslararası taşımacılıkta stratejik bir işlev üstlenmektedir (Uluslararası Taşımacılık ve Lojistik Hizmet Üretenleri Derneği “UTİKAD”, 2017; Altunay Nuray & Duman Alptekin, 2023).

Zonguldak (Filyos) Lojistik Köyü: Batı Karadeniz’in sanayi hinterlandı ile liman altyapısı arasında bütünleşik bir lojistik yapı kurmayı hedefleyen bu merkez, bölgesel sanayileşme stratejilerinin önemli bir bileşeni olarak planlanmaktadır (Altunay Nuray & Duman Alptekin, 2023).

3. Doğu Karadeniz Bölge Ekonomisinin Genel Görünümü

Doğu Karadeniz Bölgesi’nin ekonomik yapısı, tarihsel, kültürel ve coğrafi özelliklerin etkisiyle şekillenmiş; bölgenin ekonomik gelişim desenleri büyük ölçüde tarımsal üretim, kıyı ticareti ve hizmet faaliyetleri etrafında yoğunlaşmıştır. Rize, bu genel bölgesel özelliklerin en belirgin şekilde gözlemlendiği illerden biridir. Kentin ekonomik dokusunu biçimlendiren ana unsurlar arasında doğal kaynakların niteliği, nüfus hareketleri, ulaşım ve altyapı kısıtları, tarımsal üretim gelenekleri ve bölgesel yerleşim yapısı yer almaktadır.

Doğu Karadeniz, dağlık topoğrafyası nedeniyle ekonomik faaliyetlerin çeşitlenmesinin sınırlı olduğu bir bölge yapısına sahiptir. Yerleşim alanlarının çoğu kıyıya sıkışmış durumdadır; iç kesimler ise yüksek eğimli dağlık alanlardan oluşmakta ve bu durum ekonomik faaliyetlerin bölgesel dağılımını belirgin biçimde etkilemektedir. Bölgede gelir üretimi büyük ölçüde tarım ve hizmetler sektörüne dayanmakta; sanayi faaliyetleri ise sınırlı ölçekte kalmaktadır. Bu bağlamda Rize, bölgenin hem potansiyellerini hem de yapısal kırılganlıklarını bünyesinde barındıran karmaşık bir ekonomik örüntü sunmaktadır. Rize ilinde istihdam olanakları ağırlıklı olarak tarım, arıcılık, sanayi, turizm ve balıkçılık sektörlerinde yoğunlaşmaktadır. Bölgenin sanayi yapısı büyük ölçüde çay üretimi ve işlenmesine dayanmaktadır. Bu kapsamda il genelinde yaklaşık yirmi çay fabrikası ile on beş civarında çay işleme atölyesi faaliyet göstermektedir. Çay paketleme, ambalajlama ve ana bakım-onarım tesisleri de sanayi

altyapısının önemli bir parçasını oluşturarak istihdama katkı sağlamaktadır. Bunun yanı sıra balık yağı üretimi, un ve şekerli gıda imalatı gibi gıda sanayisi dalları ile kereste, alüminyum, döküm, çivi ve tel üretimi yapan tesisler de Rize'deki sanayi çeşitliliğini artıran unsurlar arasında yer almaktadır (Aydınbaş, 2023).

3.1. Rize'nin Ekonomik Yapısı

Rize ekonomisinin temel belirleyicisi çay tarımıdır. Bölgenin iklim koşulları, yüksek yağış miktarı, eğimli arazi yapısı ve nem oranı, çay bitkisinin yetişmesine son derece elverişli bir ortam oluşturmuştur. Bu çevresel avantaj, 20. yüzyıl ortalarından itibaren devlet destekli çay politikalarıyla birleşerek çay tarımının hızla yaygınlaşmasına yol açmıştır. Günümüzde Rize'de tarımsal faaliyetlerin büyük bölümü çay yetiştiriciliğine dayandığından, üretim yapısı belirgin bir şekilde bu ürün etrafında yoğunlaşmış durumdadır. Çay sektörünün bölge ekonomisine katkısı yalnızca tarımsal üretimle sınırlı değildir. Çay işleme fabrikalarının kurulması, Rize'de modern sanayinin ilk kurumsal adımlarını oluşturmuş; istihdam yaratmış ve ekonomik hareketliliği artırmıştır (Kuzucu, 2012). Ancak bu sanayileşme süreci, bölgenin sermaye birikimi kapasitesinin sınırlılığı, yerleşim alanlarının darlığı ve ulaşım kısıtları nedeniyle geniş çaplı bir sanayi dönüşümüne evrilememiştir. Bunun yanında, son yıllarda kivi, likapa ve fındık gibi ürünlerin yetiştiriciliği yaygınlaşmış; özellikle nemli iklimin uygun olduğu mikro bölgelerde bu ürünlere yönelik yeni pazar açılımları gerçekleşmiştir. Tarımsal ürün deseninin çeşitlendirilmesi bölgenin ekonomik kırılma noktasını azaltmakta ve çiftçi gelirlerini daha sürdürülebilir hale getirmektedir (Aydınbaş, 2023). Tarım dışındaki ekonomik faaliyetler içinde turizm giderek daha belirgin bir yer tutmaktadır.

Yayla turizmi, bölgenin en karakteristik turizm biçimi olup, doğal peyzaj, yüksek rakımlı yaylalar, endemik flora ve fauna unsurları sayesinde ulusal ve uluslararası bir çekim alanı yaratmaktadır. Buna ek olarak, Fırtına Vadisi, rafting ve trekking parkurları, kıyı şeridi, gastronomik zenginlikler ve yöresel el sanatları turizmin çeşitlenmesine katkı sunmaktadır (Erdoğan ve Coşkun, 2021). Ancak turizm sektörünün potansiyeline rağmen altyapı, su kaynakları yönetimi, konaklama kapasitesi, ulaşım erişilebilirliği ve planlama eksiklikleri sektörün büyümesini sınırlandırmaktadır. Turizmin katma değer üretme kapasitesinin artırılabilmesi için planlı ve bütüncül gelişim stratejilerinin hayata geçirilmesi gerekliliği vurgulanmakta; mevcut uygulamaların doğal kaynaklar üzerinde artan bir baskı oluşturduğu ve bu durumun uzun vadede sürdürülebilirlik açısından önemli riskler barındırdığı ifade edilmektedir (Aydınbaş, 2023).

3.2. Altyapı ve Ulaşım Sorunları

Rize ekonomisinin dönüşümünü etkileyen en temel yapısal unsurlardan biri ulaşım altyapısının yetersizliğidir. Bölgenin dik ve parçalı topoğrafyası karayolu inşaatlarını maliyetli ve teknik açıdan zor hale getirmekte; bu nedenle yollar çoğunlukla kıyı şeridi

boyunca yoğunlaşmaktadır. Kıyı şeridindeki sınırlı alan aynı zamanda yerleşim birimlerinin sıkışmasına yol açmakta; geniş ölçekli ticaret alanlarının, depo tesislerinin ve lojistik merkezlerin kurulmasını zorlaştırmaktadır.

Deniz yolu altyapısı ise ekonomik potansiyel taşımaya rağmen teknik kapasite sınırlıdır. Rize Limanı uzun yıllardır bölgenin dış ticaret kapısı olarak kullanılmakta olsa da modern lojistik ihtiyaçlarını karşılayacak ölçekte değildir. 2021 itibarıyla ilin ihracatının %60'ının deniz yolu ile yapılması, deniz yolu taşımacılığının önemini ortaya koymakla birlikte, liman altyapısının geliştirilmesi gerekliliğini de açıkça göstermektedir. Bunun yanı sıra Rize'nin demir yolu bağlantısından yoksun olması, bölgeyi uluslararası ticaret koridorlarının dışında bırakmakta ve sanayi ürünleri ile tarımsal ürünlerin pazarlara erişim sürecini zorlaştırmaktadır. Bu durum hem lojistik maliyetleri artırmakta hem de bölgenin rekabet gücünü düşürmektedir. Özellikle turizm sektörünün ve tarımsal ürün ticaretinin etkin bir şekilde gelişebilmesi için güçlü ulaşım ağlarına duyulan ihtiyacı vurgulayan yaklaşım, ulaşım altyapısının iyileştirilmesini bölgesel kalkınmanın temel unsurlarından biri olarak değerlendirmektedir (Aydınbaş, 2023).

3.3. Bölgede Kalkınma Potansiyeli ve Engeller

Rize ekonomisi, güçlü bir tarımsal üretim geleneğine, zengin doğal kaynaklara ve turizm açısından önemli çekiciliklere sahip olsa da önemli yapısal sorunlarla karşı karşıyadır. Çay sektörünün hâkimiyeti bölgenin ekonomik omurgasını oluşturmakla birlikte, aşırı bağımlılık ekonomik çeşitlenmeyi sınırlandırmakta; sermaye birikiminin düşük olması, ulaşım altyapısındaki yetersizlikler ve beşerî sermaye kaybı bölgesel kalkınma kapasitesini olumsuz etkilemektedir. Dolayısıyla Rize'nin kalkınma sürecinde aşağıdaki adımlar kritik öneme sahiptir:

- Ulaşım ve lojistik altyapısının güçlendirilmesi,
- Turizmin sürdürülebilir ve planlı biçimde geliştirilmesi,
- Tarımsal ürün çeşitliliğinin artırılması,
- Beşerî sermayeyi güçlendiren eğitim ve istihdam politikalarının uygulanması,
- Sermaye birikimini destekleyecek yatırım ortamının iyileştirilmesi.

Tüm bu unsurların bütüncül bir yaklaşımla ele alınması, Rize'nin ekonomik açıdan daha dirençli, çeşitli ve rekabetçi bir yapıya kavuşmasını sağlayacaktır.

Coğrafi Koşulların Etkisi: Doğu Karadeniz'in dağlık topoğrafyası ekonomik kalkınmada hem sınırlayıcı hem de teşvik edici bir rol oynamaktadır. Bir yandan tarımsal üretimin küçük ve parçalı alanlarda yapılmasını gerektirmekte; makineleşmeyi, ölçek ekonomilerini ve verim artışını sınırlandırmaktadır (Taşpınar, 2004). Bu durum tarım sektörünün modernleşme kapasitesini sınırlamaktadır. Diğer yandan bölgenin doğal güzellikleri, yüksek yaylaları, akarsu varlığı ve biyolojik çeşitliliği turizm ve ekoturizm açısından büyük bir potansiyel sunmaktadır. Bölgenin doğal ve kültürel değerleri, turizm

sektöründe stratejik rekabet üstünlüğü yaratabilecektir, ancak bunun sürdürülebilir planlama ve kaynak yönetimiyle desteklenmesi gerekmektedir (Aydınbaş, 2023).

Sermaye Birikimi Sorunu: Rize'nin ekonomik gelişimini sınırlayan en önemli faktörlerden biri sermaye birikiminin düşük olmasıdır. Ekonominin büyük ölçüde çay gibi düşük katma değerli bir ürüne dayanması, yüksek sermaye gerektiren yatırımların yapılmasını zorlaştırmaktadır (Özyurt, 1997). Sermaye birikiminin sınırlılığı sanayi gelişimini yavaşlatmakta, turizm ve ticaret alanlarında büyük ölçekli yatırımların hayata geçirilmesini güçleştirmektedir. Doğu Karadeniz'in genelinde sermaye yetersizliği, uzun vadeli bölgesel kalkınma hedefleri için kritik bir engel teşkil etmektedir (Aydınbaş, 2023).

Beşerî Sermaye ve Nüfus Dinamikleri: Beşerî sermayeye ilişkin göstergeler bölgenin ekonomik dönüşüm potansiyelini doğrudan etkilemektedir. Rize'de nüfusun yaşlanma eğiliminde olması, genç nüfusun daha büyük ekonomik merkezlere göç etmesi ve tarım dışı sektörlerde nitelikli istihdam olanaklarının yetersiz kalması, bölgenin iş gücü niteliğini zayıflatmaktadır. Hizmet sektörünün gelişimi, turizmin niteliği ve tarımda verimliliğin artırılması, nitelikli beşerî sermaye ihtiyacını daha da belirgin hale getirmektedir. Beşerî sermayedeki bu erozyonun, ekonomik faaliyetlerin verimliliğini düşürdüğü ve bölgesel kalkınma sürecini yavaşlattığı ifade edilmektedir (Aydınbaş, 2023).

Table 1. Bölgesel Kalkınmaya İlişkin Temel İstatistikler: Rize İli

Gösterge	Değer
Nüfus (2024)	346.977
Kişi Başına Gayrisafi Yurt İçi Hasıla (GSYH) "Bin TL"	8.027
İşsizlik Oranı (2023)	%8,7
İhracat (2023) "Milyon Dolar"	234,7
İthalat (2023) "Milyon Dolar"	8,3
Şehirleşme Oranı	%66,26
Tarımsal Alan "ha"	55.712,4
Tarımsal Alanın Çay Oranı	%95,3
Bitkisel Üretim Değeri (2021) "Milyar TL"	4.08
Kamu Yatırımı (2022) "Milyar TL"	6.19

Kaynak: Türkiye İstatistik Kurumu "TÜİK", 2023; Doğu Karadeniz Kalkınma Ajansı (DOKA), 2025

Tablo 1, Rize'nin demografik yapısı, ekonomik faaliyetleri ve tarımsal üretim kapasitesi açısından bölgesel kalkınmayı destekleyebilecek güçlü bir potansiyele sahip olduğunu göstermektedir. İlin ihracat düzeyi ve kamu yatırımları, ekonomik canlılığın sürdüğünü ortaya koyarken; tarım alanlarının büyük bölümünün çay üretimine dayanması, ekonomik yapının sektörel çeşitlenme açısından sınırlı olduğunu işaret etmektedir. Buna karşın kentleşme oranı ve bölgenin genel istihdam göstergeleri, insan kaynağı ve altyapı açısından lojistik merkez olma hedefini destekleyen koşulların bulunduğunu göstermektedir. Bu nedenle tablo genel olarak Rize'nin stratejik yatırımlar

için uygun bir sosyoekonomik profile sahip olduğunu ortaya koymaktadır.

Table 2. İktisadi Faaliyet Kollarına Göre GSYH (Bin TL), Rize İli- 2023 Yılı

Faaliyet Kolu	Değer (Bin TL)
Tarım, Ormancılık ve Balıkçılık	7.534.177
Sanayi	10.802.802
İmalat Sanayi	7.908.335
İnşaat	5.368.147
Hizmetler	14.262.319
Bilgi ve İletişim	237.868
Finans ve Sigorta Faaliyetleri	1.395.329
Gayrimenkul Faaliyetleri	3.954.323
Mesleki, İdari ve Destek Hizmet Faaliyetleri	1.703.376
Kamu Yönetimi, Eğitim, İnsan Sağlığı ve Sosyal Hizmet Faaliyetleri	10.787.718
Diğer Hizmet Faaliyetleri	2.017.120
Sektörler Toplamı	58.063.179
Vergi – Sübvansiyon	7.421.518
GSYH (Toplam)	65.484.697

Kaynak: TÜİK, 2023

Tablo 2, Rize ekonomisinin yapısal bileşenlerini bir bütün olarak ele aldığı, ilin ekonomik faaliyetlerinin ağırlıklı olarak tarıma ve hizmetlere dayalı olduğunu; sanayi, bilgi-iletişim ve finans gibi sektörlerin ise daha sınırlı bir gelişmişlik düzeyine sahip olduğunu göstermektedir. Tarım özellikle çay üretimi nedeniyle bölgesel kimliğin temel unsurlarından biri olmayı sürdürürken, hizmetler sektörü ticaret, turizm ve yerel hizmetler aracılığıyla ekonomik canlılığın başlıca kaynağını oluşturmaktadır. Buna karşın, coğrafi kısıtlar ve üretim kapasitesinin dar olması sanayi ve imalatın belirleyici bir sektör hâline gelmesini engellemekte, bu alanlar daha çok destekleyici bir işlev üstlenmektedir. Kamu yönetimi, eğitim ve sağlık gibi kamusal hizmetler ise bölgesel istikrar ve istihdam açısından önemli bir pay taşımakta, ekonomik yapının sürekliliğine katkı sağlamaktadır. Genel görünüm, Rize'nin ekonomisinin belirli alanlarda güçlü bir temele sahip olduğunu ve bu yapı sayesinde bölgesel düzeyde istikrarlı bir ekonomik profil sergilediğini göstermektedir. Tarım, hizmetler ve kamusal faaliyetler gibi köklü sektörlerdeki mevcut kapasite, ilin ekonomik işleyişinin sürekliliğini desteklerken; sanayi, bilgi-iletişim ve finans gibi alanların gelişime açık olması, gelecekte ekonomik çeşitlenmenin artırılmasına yönelik önemli bir fırsat sunmaktadır. Bu durum, Rize'nin mevcut gücünü korurken yeni sektörlerde büyüme potansiyeli taşıdığını da işaret etmektedir.

Tablo 3 ile Rize ili SEGE gösterge ve değerlerine yer verilmiştir. Türkiye'de illerin ve bölgelerin sosyo-ekonomik gelişmişlik düzeylerinin karşılaştırmalı olarak değerlendirilmesinde Sosyo-Ekonomik Gelişmişlik Sıralaması (SEGE) Araştırmaları önemli bir referans niteliği taşımaktadır. SEGE çalışmaları aracılığıyla iller ve bölgeler

arasındaki gelişmişlik farklılıkları nicel göstergeler üzerinden belirlenebilmekte; gerçekleştirilen kademelendirme analizleri sayesinde her bir ilin ve bölgenin hangi gelişmişlik grubunda yer aldığı ortaya konulabilmektedir. Bu kapsamlı değerlendirme süreci, kamu kaynaklarının daha etkin ve rasyonel biçimde tahsis edilmesine olanak sağlarken, aynı zamanda bölgesel gelişmişlik farklarının azaltılmasına ve dengeli kalkınma politikalarının oluşturulmasına yönelik sağlam bir analitik altyapı sunmaktadır.

Table 3. Rize İli SEGE Değerlendirmesi

Gösterge	Değer
İl	Rize
SEGE 2011 İl Sıralaması	34
SEGE 2017 İl Sıralaması	36
En Ön Sıradaki İlçe (2022)	Merkez
En Ön Sıradaki İlçenin SEGE 2022 Sırası	119
En Son Sıradaki İlçe (2022)	İkizdere
En Son Sıradaki İlçenin SEGE 2022 Sırası	631

Kaynak: T.C. Sanayi ve Teknoloji Bakanlığı, 2024

Rize ilinin sosyo-ekonomik gelişmişlik düzeyine ilişkin göstergeler incelendiğinde, ilin SEGE 2011 döneminde 34. sırada yer alırken, 2017 yılında 36. sıraya gerilediği görülmektedir. Bu durum, söz konusu dönemde Rize'nin göreceli sosyo-ekonomik konumunda sınırlı bir gerilemeye işaret etmektedir. İlçe düzeyindeki 2022 SEGE verileri, Rize ili içerisinde gelişmişlik farklılıklarının belirgin olduğunu ortaya koymaktadır. Buna göre, Merkez ilçe 119. sırayla ilin en gelişmiş ilçesi konumunda bulunurken, İkizdere ilçesi 631. sırada yer alarak sosyo-ekonomik açıdan en düşük performansa sahip ilçe olarak öne çıkmaktadır. Merkez ilçe ile en alt sırada yer alan ilçe arasındaki bu fark, il içi bölgesel ve yapısal eşitsizliklerin varlığını göstermektedir. Bu bulgular, Rize ilinde uygulanacak bölgesel kalkınma politikalarının il geneli yerine ilçe temelli ve farklılaştırılmış stratejiler çerçevesinde ele alınmasının önemini ortaya koymaktadır.

Özellikle sosyo-ekonomik açıdan geri konumda bulunan ilçelere yönelik hedefli müdahalelerin, il içi gelişmişlik farklarının azaltılmasına katkı sağlayabileceği belirtilmektedir (T.C. Sanayi ve Teknoloji Bakanlığı, 2024). Nitekim İyidere Lojistik Projesi, Rize'nin mevcut sosyo-ekonomik yapısını dönüştürme potansiyeline sahip stratejik bir yatırım olarak değerlendirilebilir. Projenin hayata geçirilmesiyle birlikte ilin ulaşım ve lojistik altyapısının güçlenmesi, Rize'nin Karadeniz Havzası ve hinterlandı ile olan ekonomik entegrasyonunu artırarak ticaret, istihdam ve üretim faaliyetlerini çeşitlendirebilecektir. Bu gelişmelerin, orta ve uzun vadede Rize'nin SEGE sıralamasına olumlu yönde yansımaları muhtemeldir. Ayrıca, lojistik merkez odaklı gelişimin yalnızca Merkez ilçe ile sınırlı kalmayıp çevre ilçelere de yayılması durumunda, ilçe düzeyinde ortaya çıkan sosyo-ekonomik farklılıkların azaltılmasına katkı sunma potansiyeli bulunmaktadır. Bu yönüyle İyidere Lojistik Projesi, Doğu Karadeniz Projesi Bölge

Kalkınma İdaresi Başkanlığı (DOKAP, 2026) çerçevesinde öngörülen bölgesel dengeli kalkınma hedefleriyle uyumlu bir müdahale niteliği taşımaktadır.

4. İyidere Lojistik Liman Projesi

Rize İyidere Lojistik Limanı, yaklaşık 170 hektarlık dolgu alanı üzerinde konteyner, genel kargo ve Ro-Ro (Roll on Roll off) operasyonlarına hizmet verecek şekilde planlanmıştır. Liman yerleşimi, bölgeye ait jeoteknik ve hidrografik veriler dikkate alınarak oluşturulmuş; yapılan mühendislik analizleri sonucunda 4.000 TEU (Yirmi Ayak Eşdeğer Birimi “Twenty-Foot Equivalent Unit”) kapasiteli gemilerin yanaşabileceği bir altyapı tasarlanmıştır. Proje kapsamında hazırlanan jeolojik-jeoteknik etüt, zemin yapısının güncel deniz çökellerinden oluşması ve sıvılaşma riskinin varlığı nedeniyle mühendislik açısından özel önlemler gerektiğini ortaya koymaktadır (Çevre ve Şehircilik Bakanlığı, 2019).

Tablo 4, bölgedeki iki önemli limanın kapasite ve altyapı özelliklerini karşılaştırarak, her birinin lojistik açıdan hangi yönleriyle öne çıktığını göstermektedir. Hopa Limanı, farklı türlerdeki yükleri elleçleyebilme yeteneği ve geniş depolama alanlarıyla çok yönlü bir operasyon yapısına sahip olduğunu ortaya koyarken; Trabzon Limanı, yüksek hacimli yük kabul kapasitesi, geniş depolama imkânları ve yoğun gemi trafiğini karşılayabilecek altyapısıyla bölgesel ölçekte daha büyük bir lojistik merkez konumunda olduğunu göstermektedir. Bu karşılaştırma genel olarak, Rize’ye en yakın limanların bölge ticareti açısından tamamlayıcı nitelikte güçlü lojistik işlevler sunduğunu, ancak kapasite ve ölçek bakımından aralarında belirgin farklılıklar bulunduğunu ortaya koymaktadır.

Table 4. Hopa ve Trabzon Limanları

Liman / İşletmeci	Kapasite / Özellik	Açıklama / Not
Park Denizcilik & Hopa Limanı	320.000 TEU / yıl (konteyner)	Dökme, genel, sıvı, Ro-Ro, konteyner, proje yükü elleçleyebilme kapasitesi mevcut.
	2.500.000 ton/yıl (kuru yük), 600.000 ton/yıl (genel yük), 900.000 ton/yıl (sıvı yük)	Yıllık yük elleçleme kapasitesi.
	Liman sahası 216.000 m ² ; açık saha 102.462 m ² ; kapalı ambar 18.220 m ²	Depolama ve terminal alanı bilgisi.
Trabzon Limanı	10 milyon ton/yıl yıllık elleçleme kapasitesi	Limanın beyan edilen yıllık yük kapasitesi.
	5 milyon ton/yıl depolama kapasitesi; 8 rıhtım ile toplam 2.235 m rıhtım uzunluğu	Fiziki altyapı ve depolama kapasitesi.
	350.000 TEU/yıl konteyner elleçleme kapasitesi; yıllık gemi kabul kapasitesi 2.500 adet	Konteyner + gemi trafiği potansiyeli.

Kaynak: TÜRKLİM (2025); TRABZONPORT (2025)

4.1. Projenin Teknik Özellikleri ve Hedefleri

Bölgesel ticaret kapasitesini artırmak amacıyla tasarlanan liman, yüksek tonajlı gemilerin yanaşabileceği ileri mühendislik özelliklerine sahip bir altyapı sistemi üzerine inşa edilmektedir. Proje kapsamında oluşturulan ana mendireğin yaklaşık 2,9 km uzunluğa ulaşması, tali mendireğin ise 395-470 metre aralığında planlanması, limanın Karadeniz'in zorlu deniz koşullarına uygun şekilde yapılandırıldığını göstermektedir (UAB, 2025).

Yıllık toplam 13 milyon tonluk yük kapasitesi; genel kargo, dökme yük, konteyner ve Ro-Ro taşımacılığını kapsayacak biçimde planlanmıştır. Ayrıca 100 bin TEU konteyner ve 100 bin araçlık Ro-Ro kapasitesi, limanı Doğu Karadeniz'in yeni bir aktarma merkezi haline getirmektedir (UAB, 2024).

Projenin hedefleri arasında, bölgenin mevcut lojistik ağlarını karayolu, demir yolu ve deniz yolu taşımacılığıyla entegre ederek kombine taşımacılık zincirini güçlendirmek; Kafkasya–Orta Doğu–Avrupa hattında Türkiye'nin konumunu lojistik açıdan daha görünür ve rekabetçi hale getirmek bulunmaktadır (Rize Valiliği, 2025).

4.2. Paydaşlar ve Uygulama Süreci

Projenin hayata geçirilmesinde çok paydaşlı bir yönetim modeli benimsenmektedir. Başta Ulaştırma ve Altyapı Bakanlığı ile Çevre, Şehircilik ve İklim Değişikliği Bakanlığı olmak üzere çeşitli kamu kurumları teknik, hukuki ve çevresel süreçlerde sorumluluk üstlenmektedir (UAB, 2021). Yerel yönetimler, özellikle Rize Valiliği ve ilçe belediyeleri, proje alanında koordinasyon ve bölgesel planlama işlevi görmektedir.

Özel sektör ise hem inşaat hem de liman işletmeciliğine yönelik teknik uzmanlık sağlamaktadır. Ayrıca akademik kurumlar—özellikle lojistik ve ulaşım alanında çalışan üniversiteler—bölgesel talep analizleri ve lojistik master plan çalışmalarına katkı sunmaktadır (Rize Valiliği, 2025).

Süreç içerisinde bazı çevresel tartışmalar gündeme gelmiş olsa da resmî kurumların açıklamalarına göre proje, kontrollü uygulama yöntemleri ve Çevresel Etki Değerlendirmesi (ÇED) süreçleri doğrultusunda yürütülmekte; dolgu ve taş tedariki çalışmalarının geçici nitelik taşıdığı belirtilmektedir (UAB, 2021).

4.3. Beklenen Ekonomik ve Sosyal Etkiler

Projenin ekonomik etkileri hem bölgesel üretim hem de ulusal ticaret hacmi açısından dikkate değerdir. Yapılan hesaplamalara göre limanın gayri safi yurtiçi hasılası (GSYH) yaklaşık 192 milyon dolar, üretime ise 427 milyon dolar düzeyinde katkı sunması öngörülmektedir (UAB, 2021). Bu etki, özellikle Karadeniz kıyısındaki lojistik faaliyetlerin artmasıyla bölgesel rekabet gücünün yükselmesine katkıda bulunacaktır.

Sosyal etkiler açısından proje, doğrudan yaklaşık 1.000 kişiye, dolaylı olarak ise 8.000 kişiye istihdam yaratma potansiyeline sahiptir. Böylece bölgedeki iş gücü piyasasının çeşitlenmesi ve yeni iş alanlarının oluşması beklenmektedir. Tedarik zinciri

bağlamında ise limanın, Kafkasya ve Orta Doğu'dan gelen lojistik akışların Karadeniz üzerinden Avrupa'ya yönlendirilmesinde stratejik bir aktarma merkezi işlevi göreceği ifade edilmektedir. Bu durum, mevcut taşımacılık sürelerinin azaltılması ve maliyetlerin optimize edilmesi açısından önemli avantajlar sağlayacaktır (UAB, 2025).

5. Bölgesel Kalkınma Perspektifinden Değerlendirme

İyidere Lojistik Liman Projesi, Doğu Karadeniz'in jeostratejik konumu ve uluslararası taşıma koridorları üzerindeki yeri göz önüne alındığında, bölgesel kalkınmayı çok boyutlu bir biçimde etkileme potansiyeline sahiptir. Proje, yalnızca bir liman inşasını değil; aynı zamanda Endüstriyel Gelişme Bölgesi, lojistik üs yapılanması, karayolu bağlantıları ve uluslararası ticaret akışlarının yeniden düzenlenmesi gibi bölgesel ve ekonomik dönüşüm hedeflerini kapsamaktadır (Çevre ve Şehircilik Bakanlığı, 2019).

5.1. Bölgesel Ulaşılabilirlik, Koridor Bağlantıları ve Ticaret Akışlarının Yeniden Yapılanması

Doğu Karadeniz'in yüksek dağ sıraları nedeniyle kuzey-güney doğrultusunda tarihsel olarak sınırlı olan ulaşım kapasitesinin, Ovit Tüneli ve devamındaki yol iyileştirmeleriyle köklü biçimde değişeceği öngörülmektedir. Ovit koridorunun açılması, Erzurum ve Doğu Anadolu üzerinden gelen yüklerin yıl boyunca Karadeniz kıyısına erişmesine olanak sağlayacaktır. Bu bağlamda proje, yalnızca yerel değil, bölgesel ölçekte lojistik süreçleri güçlendiren belirleyici bir altyapı niteliği taşımaktadır (Çevre ve Şehircilik Bakanlığı, 2019; İnşaat Mühendisleri Odası, 2021):

- İran'ın Tebriz ve kuzey eyaletleri için en kısa deniz yolu çıkışı niteliği kazanacağı; Dubai üzerinden bir ay süren mevcut rotanın 15 güne düşeceği belirtilmektedir.
- GAP bölgesindeki tarım ve endüstri ürünlerinin Karadeniz'e yönlendirilmesi ile Orta Asya ve Kafkasya pazarlarına daha kısa sürede erişim sağlanabileceği ifade edilmektedir.
- Bölge ülkeleri olan Gürcistan, Rusya Federasyonu ve Azerbaycan ile yaklaşık 60 milyar dolarlık ticaret hacminin liman aracılığıyla destekleneceği vurgulanmaktadır.

Bu veriler, İyidere'nin yalnızca bir kıyı tesisi olmadığını; uluslararası yük akışlarını yeniden yapılandırmayı amaçlayan bir dış ticaret kapısı olarak kurgulandığını göstermektedir.

5.2. Bölgesel Ekonomide Sektörel Çeşitlenme ve Üretim-Ticaret Entegrasyonu

Proje ile birlikte kurulan Endüstriyel Gelişme Bölgesi, bölgenin mevcut tarım ve hizmet ağırlıklı ekonomik yapısına yeni üretim, depolama ve ticaret fonksiyonları eklemeyi hedeflemektedir (Çevre ve Şehircilik Bakanlığı, 2019):

- Alanın, ihracata yönelik üretim, paketlenme-ambalajlama, ticari depolama, gümrük işlemleri, liman geri sahası faaliyetleri gibi birbirini tamamlayan süreçleri kapsayacak şekilde planlandığı belirtilmektedir.

- Bölgenin sınırlı kara parseli nedeniyle, liman geri sahası fonksiyonlarını desteklemek amacıyla deniz dolgusu üzerinde lojistik tesis alanı oluşturulması, bölge planlamasında yenilikçi bir çözüm olarak sunulmuştur.

- Lojistik sektörünün çok sayıda alt hizmeti (sigorta, danışmanlık, bankacılık, elleçleme, depolama, ayrıştırma vb.) aynı mekânda toplayarak yeni istihdam türleri ve nitelikli iş gücü talebi yaratacağı ifade edilmektedir.

Bu yapı, Doğu Karadeniz'in uzun vadede yalnızca üretim değil, lojistik odaklı bir hizmet ekonomisine sahip olabileceğini göstermektedir.

5.3. Mevcut Bölgesel Altyapı, Rekabet Koşulları ve Demir Yolunun Olmaması

Projenin bölgesel kalkınma hedeflerine rağmen hem bölgesel hem de ekonomik ölçeklerde etkili olabilecek bir dizi sınırlayıcı unsur bulunmaktadır. Bunlar aşağıda sıralanmıştır:

Demir yolu bağlantısının olmaması: Çevre ve Şehircilik Bakanlığı (2019) değerlendirmesinde, limanın yalnızca karayoluna bağımlı yapısının önemli bir zayıflık olduğu ifade edilmiştir. Çok modlu taşımacılığın temel bileşeni olan demir yolu hattının bulunmaması şu sonuçları doğurmaktadır:

- Lojistik maliyetlerde artış,
- Hinterlanda erişimin kısıtlanması,
- İhracat yükleri için rekabet gücünün azalması,
- Büyük ölçekli transit taşımacılıkta kapasite daralması.

Bu durum, İyidere'nin etkili bir bölgesel aktarma merkezi olmasını zorlaştıran yapısal bir sınırlılık olarak değerlendirilmektedir.

GAP bölgesiyle rekabet analizi ve Mersin Limanı karşılaştırması: GAP illeri coğrafi olarak Mersin Limanı'na daha yakın olduğu için, İyidere'nin bu bölge için birincil tercih olması lojistik olarak mümkün değildir (Çevre ve Şehircilik Bakanlığı, 2019). Bu nedenle proje daha çok:

- İran, Kafkasya ve Karadeniz ülkelerine yönelik taşımalar,
- Kısa mesafe deniz yolu taşımacılığı,
- Bölgesel ticaret hareketleri üzerine kurgulanmalıdır. Bu tespit, İyidere'nin ülke genelindeki limanlar arasında bir "alternatif merkez" olarak değil, bölgesel ölçekli tamamlayıcı bir lojistik üs olarak görülmesi gerektiğini göstermektedir.

5.4. Çevresel Etkiler ve Sürdürülebilir Kalkınma Boyutu

İyidere Liman Projesi, bölgesel kalkınmayı destekleyen çok boyutlu bir yatırım olarak öne çıkmaktadır. Proje, Birleşmiş Milletler'in (BM) Sürdürülebilir Kalkınma Hedefleri (SKH)

(United Nations “UN”, 2015) bağlamında değerlendirildiğinde, özellikle (Hedef 8) İnsana Yakışır İş ve Ekonomik Büyüme hedefiyle uyumlu olarak istihdam yaratabilir ve yerel üretim ile ticaret hacmini artırabilir. Ayrıca, (Hedef 9) Sanayi, Yenilik ve Altyapı hedefi doğrultusunda modern liman altyapısı ve lojistik sistemleri ile teknolojik ve sürdürülebilir taşımacılığın benimsenmesine olanak sağlayabilir. (Hedef 11) Sürdürülebilir Şehirler ve Topluluklar hedefi çerçevesinde ise, liman ve bağlantılı altyapı planlaması çevresel etkileri azaltarak yerel toplulukların yaşam kalitesini iyileştirebilir ve kent içi yük dağılımının düzenlenmesine katkıda bulunabilir.

Proje, (Hedef 13) İklim Eylemi hedefi kapsamında düşük karbonlu taşımacılık yöntemleri ve enerji verimli altyapı kullanımı ile bölgesel sera gazı emisyonlarının kontrolüne destek olabilirken, (Hedef 14) Sudaki Yaşam hedefi ile deniz ekosistemi korunarak biyolojik çeşitliliğe katkı sağlayabilir. Bunun yanı sıra, (Hedef 17) Hedefler için Ortaklıklar hedefi doğrultusunda kamu-özel sektör iş birlikleri ve uluslararası lojistik ağlarla entegrasyon, bölgesel kalkınma için güçlü bir iş birliği modeli sunabilir. Bu bütüncül yaklaşım, limanı yalnızca ekonomik bir altyapı yatırımı olmaktan çıkarıp, çevresel ve sosyal sürdürülebilirliği destekleyen kapsamlı bir proje hâline getirmektedir. Bu noktada Tablo 5, İyidere Liman Projesi’nin BM tarafından belirlenen SKH ile olan ilişkisini sistematik bir çerçevede ele almaktadır.

Table 5. İyidere Liman Projesi ve SKH İlişkisi

SKH No	Hedef Adı	Proje ile İlişkisi	Beklenen Katkıları
SKH 8	İnsana Yakışır İş ve Ekonomik Büyüme	Bölgesel ekonomik faaliyetleri destekleyen bir yatırım niteliği taşımaktadır.	İstihdam artışı, yerel üretim ve ticaret hacminde genişleme
SKH 9	Sanayi, Yenilik ve Altyapı	Modern liman altyapısı ve lojistik sistemlerin geliştirilmesini içermektedir.	Teknolojik dönüşüm, yenilikçi ve sürdürülebilir taşımacılık uygulamaları
SKH 11	Sürdürülebilir Şehirler ve Topluluklar	Liman ve bağlantılı altyapının planlı gelişimini kapsamaktadır.	Çevresel etkilerin azaltılması, yaşam kalitesinin artırılması, kent içi lojistiğin düzenlenmesi
SKH 13	İklim Eylemi	Düşük karbonlu taşımacılık ve enerji verimli altyapı kullanımını teşvik etmektedir.	Sera gazı emisyonlarının azaltılması ve iklim değişikliğiyle mücadeleye katkı
SKH 14	Sudaki Yaşam	Deniz ekosisteminin korunmasını dikkate almaktadır.	Biyolojik çeşitliliğin korunması ve sürdürülebilir deniz kullanımı
SKH 17	Hedefler için Ortaklıklar	Çok paydaşlı iş birliklerine dayalı bir yapı öngörmektedir.	Kamu-özel sektör iş birlikleri, uluslararası lojistik ağlarla entegrasyon

Kaynak: BM SKH (UN, 2015) baz alınarak yazar tarafından hazırlanmıştır.

Tablo 5 aracılığıyla, projenin sadece ekonomik nitelikli bir altyapı yatırımı olmadığı; istihdam oluşturma, üretim ve ticaret kapasitesinin geliştirilmesi, altyapı ve teknolojik dönüşümün desteklenmesi, çevresel sürdürülebilirliğin gözetilmesi ve çok paydaşlı iş birliklerinin teşvik edilmesi gibi farklı boyutlarda kalkınma süreçlerine katkı sunduğu açıklanmaktadır. Bu kapsamda hazırlanan tablo, her bir SKH özelinde projenin etkili olabileceği alanları ve bu etkilerin potansiyel sonuçlarını bütüncül bir yaklaşımla ortaya koyarak, İyidere Liman Projesi'nin sürdürülebilir kalkınma perspektifindeki yerini değerlendirmektedir.

Nitekim bölgenin dar kıyı şeridi, eğimli topoğrafik yapısı ve yoğun dolgu ihtiyacının taş ocağı kullanımını zorunlu kılması, projeyi çevresel etkiler bakımından öne çıkan bir değerlendirme konusu haline getirmektedir. Bu kapsamda projenin kalkınma hedefleri ile çevresel sürdürülebilirlik arasındaki dengenin dikkatle kurulmasını gerektiren bulgulara aşağıda yer verilmiştir (Çevre ve Şehircilik Bakanlığı, 2019):

- Deniz dolgusu ve set yapıları, kıyı formunu dönüştürecek niteliktedir; bu nedenle kıyı ekosisteminin korunmasına yönelik ek önlemler gereklidir.
- Dolgu için kullanılacak taşların çıkarılacağı ocak alanları, erozyon, habitat kaybı, gürültü ve toz kirliliği gibi etkiler yaratacaktır.
- Balıkçılık, kıyı erişimi ve rekreasyon alanları üzerinde orta ve uzun vadeli baskılar oluşabilecektir.

6. Araştırma Yöntemi ve Bulguları

SWOT analizini literatüre kazandıran isim, San Francisco Üniversitesi'nde görev yapan Prof. Heinz Wehrich'tir (Şahin & Tektaş, 2021). SWOT (GZFT) kavramı, İngilizcedeki "Strengths" (Güçlü Yönler), "Weaknesses" (Zayıf Yönler), "Opportunities" (Fırsatlar) ve "Threats" (Tehditler) kelimelerinin baş harflerinden oluşan analitik bir değerlendirme çerçevesidir. Bu yaklaşım, bir örgüt, sektör ya da bölgenin iç ve dış çevresiyle etkileşim içinde sistematik biçimde incelenmesine olanak sağlayan stratejik bir planlama aracıdır. Planlama sürecinde SWOT analizinin amacı, mevcut güçlü yönlerin ve ortaya çıkabilecek fırsatların nasıl daha etkin kullanılabileceğini belirlemek; buna karşılık zayıf yönlerin ve tehditlerin olası olumsuz etkilerini en aza indirecek stratejiler geliştirmektir. Bu yönüyle SWOT, karar alma süreçlerinde stratejik yönelimlerin oluşturulmasına temel bir ön-analiz niteliği taşımaktadır.

SWOT analizi bilimsel anlamda durum analizi yapmaya olanak sunan tekniklerden birisidir. SWOT analizinin uygulanmasında çoğu zaman beyin fırtınası yaklaşımından yararlanılmaktadır. Beyin fırtınası, belirli bir problem alanına ilişkin mümkün olduğunca fazla sayıda fikir üretmeyi hedefleyen; katılımcıların düşüncelerini kısa sürede bir araya getirerek ortak bir çözüm arayışına yönlendiren demokratik ve katılımcı bir grup çalışma yöntemidir. Bu yöntemin temel işlevi, farklı bakış açılarını aynı

ortamda buluşturarak analiz sürecinin derinliğini ve çeşitliliğini artırmaktır (Kansız vd., 2008; Erdinç & Aydınbaş, 2022).

Bölgesel kalkınma alanındaki kuramsal yaklaşımlar (bölgesel rekabetçilik, ulaşılabilirlik, lojistik merkezler, çok modlu taşımacılık, sürdürülebilir liman yönetimi vb.) ile stratejik yönetim literatüründe yer alan SWOT yönteminin bir araya getirilmesiyle oluşturulan analitik sentez, Tablo 6’da sunulmaktadır.

Table 6. SWOT Analizi: İyidere Lojistik Limanı ve Rize Örneği

GÜÇLÜ YÖNLER	ZAYIF YÖNLER
Ovit koridoru sayesinde stratejik konum	Demir yolu bağlantısının olmaması
Lojistik–ticaret–depolama entegrasyonu	Hinterland erişim kapasitesinin sınırlı olması
Bölgesel istihdam ve hizmet sektörü artışı	Yük talebine ilişkin belirsizlikler
Potansiyel yeşil liman uygulamaları	Yerel sanayi tabanının sınırlılığı
FIRSATLAR	TEHDİTLER
Orta Asya-Orta Doğu ticaretine açılım	Bölgedeki diğer limanlarla rekabet
Yeni sanayi ve lojistik kümelenmeleri	Küresel ticaretteki dalgalanmalar
Yenilenebilir enerji ve dijital liman uygulamaları	İklim değişikliği ve kıyı riskleri
Yerel girişimcilik ve genç istihdamı	Toplumsal kabul ve ekosistem baskıları

Kaynak: Yazar tarafından hazırlanmıştır.

İyidere Lojistik Limanı’na ilişkin SWOT analizine dayalı değerlendirme, bölgenin sahip olduğu stratejik konumun ve ulaşım ağlarıyla kurabileceği bağlantıların projeyi güçlü bir lojistik aktör hâline getirebilecek nitelikte olduğunu göstermektedir.

Ovit koridorunun sağladığı erişilebilirlik, limanın hem Karadeniz kıyı hattı hem de Doğu Anadolu ve Kafkasya yönünde önemli bir lojistik merkez olma potansiyelini artırmakta; bu durum liman, ticaret ve depolama faaliyetlerinin bütünleşik biçimde yürütülebilmesine olanak veren planlama yaklaşımıyla birleştiğinde bölgesel istihdamı ve hizmet sektöründeki çeşitliliği güçlendirebilecek bir kapasite ortaya çıkarmaktadır. Ayrıca limanın yeşil liman prensiplerine uygun şekilde yapılandırılabilmesi, uzun vadeli rekabetçiliği destekleyebilecek sürdürülebilirlik odaklı bir avantaj sunmaktadır.

Analiz, limanın sahip olduğu bu güçlü yönler karşın önemli zayıf noktaları da olduğunu ortaya koymaktadır. Özellikle demir yolu bağlantısının bulunmaması, limanın çok modlu taşımacılık sistemine tam olarak entegre olmasını engellemekte; bu durum hem maliyetleri yükseltmekte hem de hinterland erişimini sınırlamaktadır. Bölgenin mevcut ekonomik yapısının görece zayıf olması, kısa vadede yeterli yük hacmi oluşturulmasını güçleştirirken, talep projeksiyonlarındaki belirsizlikler ve ulusal ölçekte güçlü limanlarla rekabet ihtiyacı ekonomik kırılganlık yaratmaktadır. Bununla birlikte bölgenin topoğrafik yapısı, kıyı dolgusu ve taş ocağı faaliyetleri gibi unsurlar çevresel açıdan önemli riskler doğurmakta; bu durum limanın uzun vadeli sürdürülebilirlik performansını doğrudan etkileyebilecek bir başka zayıflık olarak öne çıkmaktadır.

Analizden elde edilen bir diğer önemli bulgu, projenin potansiyel fırsat alanlarının oldukça geniş olduğudur. Orta Asya, Güney Kafkasya ve Orta Doğu pazarlarına açılım sağlayabilecek bir liman olması, İyidere'yi bölgesel bir aktarma merkezi hâline getirebilecek stratejik kapılar açmaktadır. Buna ek olarak liman çevresinde yeni sanayi kümelenmeleri, lojistik hizmetler, depolama faaliyetleri ve girişimcilik ekosistemi gelişebilir; bu durum bölgenin ekonomik yapısında önemli bir dönüşümü tetikleyebilir. Yenilenebilir enerji uygulamaları, dijital liman sistemleri ve düşük karbonlu lojistik modelleri gibi teknolojik yeniliklerin bu proje kapsamında uygulanabilir olması da geleceğe dönük bir rekabet avantajı yaratmaktadır.

SWOT analizinde yer alan tehditler ise, limanın dışsal riskler açısından belirli bir kırılganlığa sahip olduğunu göstermektedir. Ulusal düzeyde daha köklü limanların rekabeti, küresel ticaret akışlarındaki dalgalanmalar ve ekonomik krizler gibi dış faktörler limanın performansını olumsuz etkileyebilir. Çevresel tehditler de önemli bir risk alanıdır; kıyı erozyonu, deniz seviyesi yükselmesi, yoğun dolgu faaliyetlerinin ekosistem üzerindeki baskısı ve çevreye yönelik toplumsal duyarlılığın artması, projenin sosyal kabulünü ve sürdürülebilirliğini etkileyebilir. Bu unsurlar, limanın uzun vadeli başarısının yalnızca fiziksel altyapı ile değil, aynı zamanda çevresel ve toplumsal etkilerin yönetilmesiyle de doğrudan ilişkili olduğunu göstermektedir.

Sonuç olarak SWOT analizi, İyidere Lojistik Limanı'nın yüksek potansiyele sahip bir proje olduğunu, ancak bu potansiyelin hayata geçirilebilmesi için altyapı bütünlüğünün güçlendirilmesi, çevresel etkilerin dikkatle yönetilmesi, gerçekçi talep analizlerinin yapılması ve bölgenin lojistik ekosisteminin desteklenmesi gerektiğini göstermektedir. Projenin başarısı, güçlü yönler ve fırsatlardan yararlanırken zayıflıkların ve tehditlerin etkin biçimde yönetilmesine bağlıdır.

7. Sonuç

İyidere Lojistik Limanı, Rize'nin lojistik kapasitesini bölgesel ölçekte güçlendirme potansiyeli taşıyan stratejik bir projedir. Ovit Tüneli ile sağlanacak Kuzey-Güney bağlantısı, bölgeyi Kafkasya ve Orta Doğu ticaret koridoruna entegre edebilecek önemli bir altyapı avantajı sunmaktadır.

Bu çalışma, İyidere Lojistik Limanı'nın sürdürülebilir bölgesel kalkınmadaki rolünü SWOT analizi ile bütüncül bir çerçevede değerlendirmiştir. SWOT analizi çerçevesinde yapılan değerlendirmeler, limanın coğrafi konumu ve hinterland erişimi sayesinde Doğu Karadeniz'in ticaret ve lojistik kapasitesini artırabilecek fırsatlar sunduğunu göstermektedir; lojistik, depolama ve ticaret faaliyetlerinin entegre planlanması ise bölgesel iş gücü çeşitliliğini ve hizmet sektörü büyümesini destekleyebilecek imkânlar yaratmaktadır. Buna karşın demir yolu bağlantısının bulunmaması, mevcut sanayi yapısının sınırlılığı ve çevresel riskler, limanın ekonomik ve ekolojik sürdürülebilirliği açısından başlıca zayıflıklar ve tehditler olarak öne

çıkılmaktadır.

Küresel ticaret dalgalanmaları, ulusal liman rekabeti ve iklim değişikliğine bağlı kıyı riskleri de projenin dışsal belirsizliklerini artırmaktadır. Limanın potansiyelini gerçekleştirebilmesi, ulaştırma entegrasyonu, ekonomik teşvikler ve beşerî sermaye geliştirme gibi alanlarda eşgüdümlü politikaların uygulanmasına bağlıdır. Bu kapsamda demir yolu ve çok modlu taşımacılık bağlantılarının güçlendirilmesi, lojistik kümelenmelerin desteklenmesi ve çevresel risklerin etkin yönetimi, limanın rekabet gücünü ve sürdürülebilir katkısını artıracaktır. Proje, ekonomik altyapı yatırımı olmanın ötesinde, istihdam yaratma, modern lojistik sistemlerin geliştirilmesi, kentsel yaşam kalitesinin iyileştirilmesi ve düşük karbonlu taşımacılık uygulamaları ile çevresel koruma gibi unsurları birleştiren sürdürülebilir kalkınma perspektifi taşımaktadır. Bu bağlamda İyidere Limanı, BM SKH ile uyumlu olarak ekonomik, çevresel ve sosyal boyutlarda katkı sağlayabilecek stratejik bir yatırım niteliği taşımaktadır.

Gelecekte, liman talep projeksiyonlarının güncel ve veri odaklı modellerle yeniden yapılandırılması; çevresel ve sosyal etkilerin detaylı olarak incelenmesi; lojistik kümelenmelerin etkilerinin saha çalışmalarıyla ortaya konması ve dijital liman ile yeşil teknoloji uygulamalarının performansının sistematik biçimde değerlendirilmesi gerekmektedir. Bu yaklaşım ve politika önerilerinin hayata geçirilmesi, İyidere Lojistik Limanı'nın Doğu Karadeniz'in lojistik dönüşümünde belirleyici bir aktör olarak konumlanmasını ve bölgesel kalkınmaya somut katkı sağlamasını mümkün kılacaktır.

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Yazar, bu makalenin araştırılması, yazarlığı ve/veya yayınlanması ile ilgili olarak herhangi bir potansiyel çıkar çatışması olmadığını beyan eder.

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Corporate Governance and Financial Performance Under Environmental and Sustainability Challenges: A Bibliometric Analysis (2015-2025)

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ABSTRACT

Purpose – This research seeks to methodically chart or trace the development of scientific research regarding the linkage between corporate governance and financial performance in the background of environmental and sustainability issues from the year 2015 to 2025. It seeks to clarify how governance mechanisms have adapted to sustainability pressures and how these adaptations affect firms' financial outcomes and long-term resilience.

Design/data/methodology – In this scenario, a bibliometric research design will be used for this research as it will involve a data set of 609 peer-reviewed articles retrievable from the Scopus database. Scientists mapping methods such as co-citation analysis, co-author analysis, and co-word analysis have been employed to understand publishing trends in this field.

Findings – Our findings show a strong and non-linear annual growth rate of 37.02%, with a sharp acceleration after 2019, reflecting the global turn toward sustainability-oriented governance. The geography of knowledge production is multipolar, and China has unmistakably emerged as a core node in the network of international research collaboration. Thematic evolution analysis offers clear signals of paradigmatic changes in conceptual perspectives: from fragmented to integrated approaches of governance ESG-aligned.

Originality/value – This research provides a concise bibliometric synthesis of a rapidly expanding field, clarifying its intellectual and thematic evolution, and demonstrates that corporate governance has moved beyond a procedural role to become a key driver of financial value under environmental and sustainability challenges.

Keywords: Corporate Governance, Financial Performance, Sustainability

Çevresel ve Sürdürülebilirlik Zorlukları Bağlamında Kurumsal Yönetişim ve Finansal Performans: Bibliyometrik Bir Analiz (2015-2025)

ÖZET

Amaç – Bu araştırma, 2015–2025 döneminde çevresel ve sürdürülebilirlik sorunları bağlamında kurumsal yönetim ile finansal performans arasındaki ilişkinin bilimsel literatürdeki gelişimini sistematik ve metodik bir biçimde haritalandırmayı amaçlamaktadır. Çalışma, yönetişim mekanizmalarının sürdürülebilirlik baskılarına nasıl uyum sağladığını ve bu uyumun firmaların finansal sonuçları ile uzun vadeli dayanıklılığı üzerindeki etkilerini açıklamayı hedeflemektedir.

Tasarım/veri/metodoloji – Bu çalışmada, Scopus veri tabanından elde edilen 609 hakemli makaleden oluşan bir veri setine dayanan bibliyometrik bir araştırma tasarımı benimsenmiştir. Alanın yayın eğilimlerini ve entelektüel yapısını ortaya koymak amacıyla ortak atıf analizi, ortak yazarlık analizi ve anahtar kelime (co-word) analizi gibi bilimsel haritalama teknikleri kullanılmıştır.

Bulgular – Bulgular, yıllık %37,02 oranında güçlü ve doğrusal olmayan bir büyüme hızına işaret etmekte ve özellikle 2019 sonrasında sürdürülebilirlik odaklı yönetime yönelik küresel yönelimi yansıtan belirgin bir ivmelenme göstermektedir. Bilgi üretiminin coğrafyası çok kutuplu bir yapı sergilemekte olup, Çin uluslararası araştırma iş birliği ağında açık biçimde merkezi bir düğüm olarak öne çıkmaktadır. Tematik evrim analizi, kavramsal perspektiflerde paradigmatic bir dönüşüme işaret etmekte; yönetişimin parçalı yaklaşımlardan ESG ile uyumlu bütünleşik yaklaşımlara doğru evrildiğini ortaya koymaktadır.

Özgünlük/değer – Bu çalışma, hızla genişleyen bir araştırma alanına ilişkin özlü ve sistematik bir bibliyometrik sentez sunmakta; alanın entelektüel ve tematik evrimini netleştirmekte ve kurumsal yönetimin çevresel ve sürdürülebilirlik zorlukları altında yalnızca prosedürel bir işlev olmaktan çıkarak finansal değerin temel belirleyicilerinden biri hâline geldiğini göstermektedir.

Anahtar Kelimeler: Kurumsal Yönetişim, Finansal Performans, Sürdürülebilirlik

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1. Introduction

The area of corporate governance (CG) and financial performance (FP) has undergone a significant transformation in recent years, evolving from a peripheral academic concern into one of the central pillars of modern firms confronting increasingly demanding environmental and sustainability challenges. This development reflects a broader change in management and finance scholarship, where the traditional doctrine of shareholder primacy is gradually giving way to the triple bottom line approach. It also signals an important evolution in governance thinking and analysis, as ESG considerations are no longer viewed as marginal to corporate governance strategy but are increasingly recognized as essential factors in assessing corporate resilience and long-term sustainability (Rodriguez-Fernandez, 2016).

The conceptual bases that form the CG-ESG-FP link take their roots in several concepts. First, the Stakeholder Theory stands as a main conceptual framework. According to it, a firm's success is closely linked to stakeholder relationship management. This has been argued as encompassing a firm's relationship with a wide range of stakeholders. They include employees, customers, communities, as well as the natural environment (Donaldson & Preston, 1995). According to the conceptual framework, good firm performance stems from establishing congruity between firm goals and stakeholder interests. Another conceptual framework that supports the relationship workflow link is the concept of Stewardship Theory.

On the other hand, Agency Theory highlights the importance of strong governance frameworks as a mechanism for dealing with potential conflicts-of-interest issues arising between management and shareholders in relation to sustainable investment opportunities that often require now-cash flows in the future (Jensen & Meckling, 1976). Finally, Signaling Theory & Legitimation Theory provide a theoretical framework explaining how ESG reporting serves as a strong validation mechanism that reduces issues associated with adverse information asymmetry by allowing companies to gain their social license to operate in a highly regulated and more sustainable environment (Suchman, 1995).

Furthermore, board independence enhances oversight effectiveness and reduces managerial opportunism, thereby strengthening the credibility and transparency of ESG disclosures, while gender-diverse boards contribute broader perspectives and stakeholder-oriented decision-making that support the adoption of sustainable business practices and improved long-term corporate performance. Consequently, the composition and characteristics of the board of directors are widely regarded as fundamental determinants of a firm's ability to integrate ESG considerations into its strategic objectives and value-creation processes.

Share of gender-diverse boards has been one area of research interest, and findings have revealed that for women to have any real say regarding covering divested

environments, there needs to be a critical mass of women on company boards, known as three women or more (Cosma et al., 2024; Patekar & Mahajan, 2025). Greater representation of women on company boards has been linked to inclusive decision-making, ethical perspectives, and risk management practices, ultimately contributing to strong financial performance measured by Return on Equity (ROE) (Sahu et al., 2025).

Besides board composition, corporate governance structures and practices are emerging to have a mediatory/moderating effect between sustainability practices and financial performance. The evidence illustrated through empirical studies of the energy industry within China shows that financially performing corporations often have surplus resources devoted to sustainability practices when good corporate governance structures are embedded, hence promoting long-term sustainability. In other environments, for instance, Jordanian corporations, independence and composition of the audit committee are deep-rooted mediators for sustainability disclosure and firm value because it ensures disclosure practices remain more non-opportunistic and oriented towards shareholders (Elmanaseer & Gerged, 2025). Similarly, the establishment of dedicated Board Sustainability Committees (BSCOM) has proven effective in the banking sector, where these committees enhance oversight of climate-related risks and transform environmental responsibility into a financially value-enhancing strategy (Adu et al., 2024).

The implications of CG-ESG-FP dynamics in terms of finances are also considered a self-reinforcing cycle in which spending on Social and Environmental projects translates into a gain of finances in a sustainable approach reinforcing more sustainability engagement activities (Rodriguez-Fernandez, 2016). Yet, a different reality emerges when examining global empirical evidence. Several studies report that early-stage adoption of sustainability practices may exert downward pressure on short-term profitability due to substantial capital expenditures and increased operational costs (Shaikh, 2022). Notwithstanding, it has been consistently found that ESG performance is a strong risk mitigation tool. Companies' enhanced sustainability performance is associated with smaller idiosyncratic risk, since investors regard them as more stable than their peers and therefore less susceptible to macro-level shocks (Sciarelli et al., 2024). This is associated, in turn, with a cost of capital advantage, since investors are willing to accept smaller returns as they perceive smaller risk, as verified in more developed markets such as the United Kingdom (Gonçalves et al., 2022; Hazaea et al., 2025).

From the knowledge production side, bibliographic data from the period of 2015-2025 indicates an explosive increase in ESG-related research post-2019. This is no surprise in light of the international events such as the Paris Climate Treaty and the shocks of the COVID-19 pandemic, which raised the focus on the subject of sustainable governance (Chytis et al., 2024; Patekar & Mahajan, 2025). For the subject of sustainable governance, research up to the present had been led by the United States and Europe. Over the past few years, there has been an explosive entrance of the developing world of research, in

the form of China, Indian, and Malaysian researchers, in the ESG research domain (Marzuki et al., 2023). Despite this expansion, persistent challenges remain, notably the absence of standardized ESG measurement frameworks, which has generated methodological inconsistency and interpretive ambiguity, as well as the ongoing risk of greenwashing, whereby firms engage in symbolic disclosure without substantive sustainability performance (Lin, 2024; Patekar & Mahajan, 2025).

Despite the fact that there is considerable literature on corporate governance, financial performance, and sustainability, it remains highly fragmented across disciplines, journals, and geographical contexts, with uneven citation patterns and divergent methodological approaches. This fragmentation obscures the intellectual structure of the field and limits cumulative knowledge development. In light of this scientific gap, this research study has conducted a Scopus-based bibliometric analysis for the period 2015–2025 to systematically map the evolution of scientific production and explain the conceptual, social, and thematic foundations underlying research at the CG–FP–sustainability nexus. In particular, this research attempts to answer the following research questions:

1. How has the quantity and trend level of research output on corporate governance and financial performance during environmental and sustainability issues changed from 2015 to 2025?
2. What are the journals, authors, and publications that represent the core of this research field in terms of their productivity and citation data?
3. What kind of distribution of publications is observed regarding geographical areas, as well as the role played by global publication networks?
4. What are the dominant conceptual themes and emerging research fronts within corporate governance–financial performance studies in environmental and sustainability contexts, and how have these themes evolved over time?

2. Literature Review

The interaction between corporate governance (CG) and financial performance (FP) has evolved from a marginal area of research discourse to become one of the foundation stones for current corporate strategies amidst burgeoning environmental and sustainability issues. Recent research contends that while shareholder value maximization stands to be supplanted by a “triple bottom line philosophy,” consideration for societal, environmental, and governance (ESG) components is now increasingly acknowledged to be pivotal to successful value-creation and sustainability institutions. The current discussion intends to condense current research (2015–2025) regarding how sustainability practices are facilitated and shaped through different corporate governance structures and practices worldwide.

2.1. Theoretical Foundations of the CG-ESG-FP Nexus

The academicians' dialogue is mainly rooted in Stakeholder Theory, whose assumption is that for a company to be successful, it is necessary to fulfill different needs pertaining to employees, customers, communities, or the environment (Donaldson & Preston, 1995; Rodriguez-Fernandez, 2016). According to Stakeholder Theory, different cooperative interests can be fulfilled by satisfying these needs. Complementary to this, Stewardship Theory proposes that the interests of managers align with those of the firm's long-term success due to ethical and professional motives, whereas Agency Theory allows governance to control or mitigate conflicts between managers and shareholders through severe monitoring of sustainability initiatives. It was supported by Jensen & Meckling (1976) and Rodriguez-Fernandez (2016). According to Signaling Theory and Legitimacy Theory, good-quality ESG disclosures are a type of hard signals that would communicate verifiable information about a firm's commitment to growth in a sustainable manner, reducing the informational gap between stakeholders and supporting the "social license to operate" (Suchman, 1995).

2.2. The Role of Board Composition and Diversity

A critical consensus in the literature identifies the board of directors as the central authority for decisions regarding CSR and ESG policies. Recent studies have continued to underscore that board size and board independence are positively associated with the quality of sustainability reporting. Larger boards often bring wider expertise and strategic control, which is all the more useful in emergent markets such as that of Pakistan, where an expanded board can assure superior financial value owing to greater diversity of view (Shah et al., 2024).

In addition, board gender diversity has become a very influential variable in determining the enhancement of ESG transparency and performance. Research underscores the importance of a "critical mass"—typically at least three female directors—to significantly influence strategic decisions, such as divesting from carbon-intensive industries or improving social sustainability reporting (Cosma et al., 2024; Patekar & Mahajan, 2025). Female directors are frequently associated with higher levels of empathy and innovative problem-solving, which collectively reduce firm risk and improve Return on Equity (ROE) (Sahu et al., 2025).

2.3. Corporate Governance as a Mediator and Moderator

Corporate governance serves as a pivotal bridge between a firm's financial success and its social responsibility initiatives. In the Chinese power industry, it has been found through research that during high-performance periods, corporations leverage "slack resources" to focus on sustainability by acting as sustainable governance mechanisms (Imran et al., 2023). In emerging countries such as Jordan, it has been found critical to have the support

of the Audit Committee (AC); in fact, it has been found to have a significant impact in making sure that published reports are in favor of stakeholder value as opposed to management goals (Elmanaseer & Gerged, 2025). In this regard, Board Sustainability Committees (BSCOM) have been found beneficial in handling climate risks as well as improving financial performance by making it a “win-win” opportunity to take action on environmental issues (Adu et al., 2024).

2.4. Financial Implications: The "Virtuous Circle" vs. Short-term Trade-offs

There is also the presence of the "virtuous circle," whereby social investments lead to profit, and the profit made subsequently leads to further social investments (Rodriguez-Fernandez, 2016). However, other international evidence provides a more sobering view, suggesting that the initial phases of sustainability practice can lead to short-term decreases in profitability due to high capital expenditure (Capex) and operational overhead (Shaikh, 2022).

In spite of these expenses, ESG performance is growing in prominence as a method for risk management purposes as well. A strong sustainability performance is viewed as having a strong effect in decreasing idiosyncratic corporate risk, as investors see such companies as more stable and less vulnerable to events such as regulatory or corporate crises (Sciarelli et al., 2024). In the United Kingdom, companies that have a strong ESG performance are viewed as having a lowered cost of capital, whether it be equity, debt, or weighted average cost, since investors have accepted that such companies are non-risk or less-risk, thus earning them lowered gains (Hazaea et al., 2025). Notably, there is an "optimal level" regarding sustainability, where investors treat "laggers" and their underinvestment poorly and may treat "leaders" who overinvest, thus wasting resources, poorly by lenders (Gonçalves et al., 2022).

2. 5. Bibliometric Trends and Emerging Challenges (2015–2025)

Bibliometric studies show "explosive growth" of literature related to ESG starting from 2019, triggered by various global events like the Paris Accord and the COVID-19 outbreak (Chytis et al., 2024; Patekar & Mahajan, 2025). Though the United States and Europe have long been leaders in this area of research, developing countries like China, India, and Malaysia have come up as prominent producers of literature in recent times (Marzuki et al., 2023; Patekar & Mahajan, 2025).

Nevertheless, a number of ongoing issues still exist. These begin with a lack of uniform methods for ESG rating systems, creating a problem of "aggregate confusion" relative to different rating institutions (Patekar & Mahajan, 2025). Also, the problem of "greenwashing," or using proxy reporting to conceal poor performance, is still a problem (Lin, 2024). To separate true improvements in operations from only disclosing improvements on the surface, authors use a system termed the Sustainable Growth Rate (SGR) in references to a company's endogenous growth rate that does not require external

investments (Lin, 2024).

In general, it seems that the literature that has been generated between 2015 and 2025 represents an important paradigmatic shift in understanding corporate governance issues from an environmental/sustainability point of view. That is, moving from considering corporate governance mechanisms from an administrative angle to considering them from a strategic point of view, which has far-reaching implications for financial performance, sustainability, and value creation. The existing literature confirms that issues such as board composition, committees, transparency, and stakeholder-oriented corporate governance have played an important mediating role in linking environmental pressures to financial performance.

The existing literature is, however, very scattered. All of this makes it imperative that there exists an overarching bibliometric study that seeks to map out the progress of scientific production and citation impact, uncover key journals, prominent authors, core literature defining this area of study, study geographical and institutional deployment of knowledge and collaboration patterns, and lastly tap into this body of knowledge to uncover its underlying structure of concepts, key ideas, or evolving research frontages in this area of corporate governance linkages to financial performance and sustainability. To this effect, this study presents an in-depth Scopus examination of this ever-expanding body of research.

3. Method

This study employs a systematic bibliometric research design to quantitatively map and analyze the scholarly literature on corporate governance and financial performance under environmental and sustainability challenges over the period 2015–2025. The objective is to examine the field's structural evolution, intellectual foundations, and thematic development by integrating performance analysis with science-mapping techniques. In particular, it aims to: (i) discern the conceptual and theoretical framework of the literature, (ii) analyze collaboration patterns of authors, institutions, and countries, and (iii) identify dominant and emerging themes of future studies.

3.1. Data Source and Scope

To obtain the bibliometric details, only the Scopus database was employed for the search because it is very inclusive with respect to good quality peer-reviewed journals indexed for citation analysis. While conducting the search, only articles published between 2015 and 2025 were included on January 3, 2026, for a Scopus search with a certain query string based on the title, abstract, and authors' keywords.

It provides an analysis of research that is situated at the juncture between corporate governance and financial performance that has specifically focused on environmental sustainability, ESG performance, corporate social responsibility, climate-related financial risks, and sustainable finance. The papers analyzed were limited to peer-

reviewed journal articles published in English and indexed under Business, Management and Accounting and Economics, Econometrics and Finance subject areas.

3.2. Data Collection and Screening

The document selection process followed the PRISMA 2020 framework. The initial search conducted in Scopus on January 3, 2026 yielded 1,271 records. Since the search was performed exclusively in the Scopus database, no duplicate records were identified. A sequential screening procedure was then applied. First, records were restricted to journal articles, excluding conference papers, book chapters, reviews, editorials, notes, and other document types. Second, only publications written in English were retained. Third, the dataset was limited to the subject categories of Business, Management and Accounting and Economics, Econometrics and Finance.

Finally, titles, abstracts, and keywords were manually examined to exclude studies that did not simultaneously address corporate governance, financial performance, and environmental or sustainability-related issues. Following the application of these inclusion and exclusion criteria, the final dataset comprised 609 articles. the final List of bibliometric data extracted from Scopus database reported in Appendix A.

3.3. Bibliometric Techniques

To capture the multidimensional structure of the research field, multiple complementary bibliometric techniques were applied:

- Co-citation analysis to identify the field's intellectual foundations and influential theoretical frameworks.
- Analyze co-authorship on national level for collaboration and knowledge sharing.
- Co-word analysis was used to detect the dominant themes and emergent topics, which may indicate possible future research trajectories based on the co-occurrence of keywords.

3.4. Data Analysis Tools

Data analysis and visualisation were performed using dedicated bibliometric tools. Descriptive statistics, performance indicators and longitudinal analyses were performed using Bibliometrix and its web interface Biblioshiny (R environment). Cluster structures in the literature were identified using co-citation, co-authorship and co-word networks built and visualised with VOSviewer. Data organization and additional descriptive analyses were conducted using Microsoft Excel.

The analysis of co-authorship, co-citation and keyword co-occurrence was carried out using full counting, which assigns equal weight to all occurrences or links, regardless of the number of co-authors or co-occurring items. In VOSviewer, the network visualisations were normalised using the Association Strength method, which is the

default and recommended normalisation method for bibliometric mapping. Specifically, bibliometric analyses were performed using Bibliometrix 4.3 in R 4.4.0 via Biblioshiny, network visualisation was performed using VOSviewer 1.6.20, and Microsoft Excel 365 was used for data pre-processing and descriptive statistics.

3.5. Ethical Considerations and Reproducibility

The study relies exclusively on secondary bibliometric data obtained from publicly available sources and does not involve human subjects; therefore, ethical approval was not required. The dataset does not include any personal or confidential data.

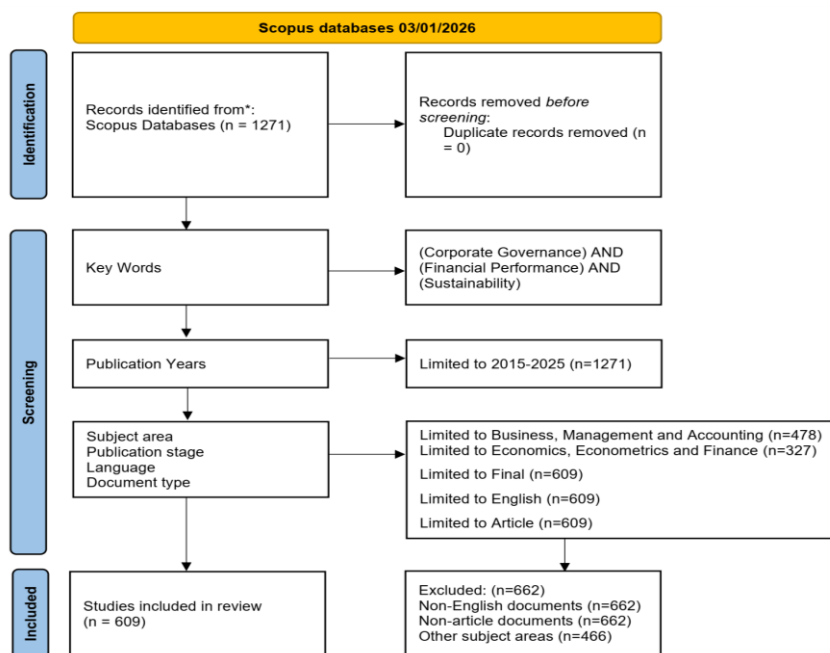
Table 1. PRISMA-Based Screening and Selection Process

Screening stage	Records remaining
Initial Scopus search	1271
Duplicate removal	1271
English language only	662
Article document type only	662
Publication Stage	662
Subject area filtering	466
Relevance screening (title, abstract, keywords)	609

Source: Extracted from Scopus; detailed data is in Appendix A.

The search strategy and analytical methods are entirely transparent and reproducible. Processed datasets and visualization outputs are available from the corresponding author upon reasonable request.

Figure 1. Analytical framework and data selection process



Source: Prepared by the Authors

4. Findings

4.1. Evolution of Scientific Production (RQ1)

Table 2 synthesizes the core descriptive statistics of the Scopus-based dataset and provides an empirical baseline for addressing RQ1 by characterizing the volume, growth dynamics, and citation impact of research on corporate governance and financial performance under environmental and sustainability challenges over the period 2015–2025. The corpus includes 609 peer-reviewed articles dispersed over 269 unique sources, which indicate a very wide and interdisciplinary spread of this particular subject among Governance, Finance, Sustainability, and Management Journals. The annual growth rate of 37.02% demonstrates a strong and sustained expansion of scientific production, confirming that this research domain has experienced accelerated scholarly attention over the last decade. This growth trajectory is further supported by the relatively low average document age (3.08 years), which signals the topical novelty and ongoing relevance of the field rather than a mature or saturated research stream.

Regarding the impact, the corpus fares well in terms of citation intensity, with an average of 30.96 citations per document and a cumulative reference base of 3,886 cited works. Looking at the citation analysis, it can be inferred that research related to the nexus of corporate governance, financial performance, and sustainability challenges is not only quantitatively increasing but is also getting adequately noted in the domain of academic literature. The authorship analysis also brings into focus the research structure of co-authored research, as is evident from the fact that there are 1,634 research contributors and the average of co-authors per document is 3.03, and solo-authored research is very limited. Notably, international co-authorships account for 31.53% of publications, indicating a significant level of cross-country collaboration and reinforcing the global relevance of sustainability-driven governance and performance debates.

Taken together, the dataset cited within Table 2 illustrates that a significant trend within research concerning corporate governance and financial performance amidst environmental/sustainability issues exists between 2015 and 2025, such that the development of research on this subject matter has shifted towards a rapidly increasing international network that is also very highly cited. This empirical trend directly answers RQ1 in regard to assessing a strong positive trend for production, a strong citation impact, and a collaborative production pattern.

Figure 2 synthesizes the temporal evolution of scientific production on corporate governance and financial performance under environmental and sustainability challenges over the 2015–2025 period and provides direct evidence to address RQ1. The results reveal a non-linear but clearly accelerating growth trajectory of the literature. Regarding the first period (2015–2018), it appears that the number of publications is quite modest and fluctuating, reflecting a reconnaissance process where sustainability-driven corporate

governance did not turn into a central research thread yet. Then, from 2019 on, a clear structural shift emerges, which corresponds to an increased annual number of publications.

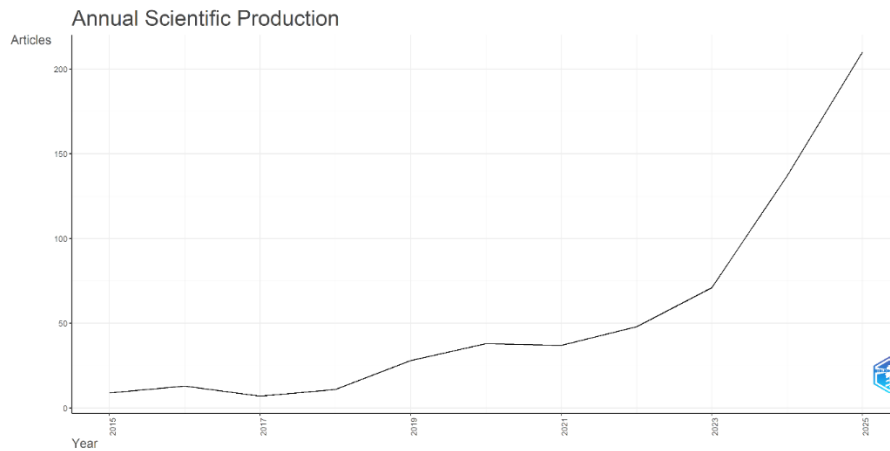
Table 2. Descriptive statistics of the dataset

Description	Results
Timespan	2015:2025
Sources (Journals, Books, etc)	269
Documents	609
Annual Growth Rate %	37,02
Document Average Age	3,08
Average citations per doc	30,96
References	3886
Keywords Plus (ID)	514
Author's Keywords (DE)	1630
Authors	1634
Authors of single-authored docs	61
AUTHORS COLLABORATION	
Single-authored docs	69
Co-Authors per Doc	3,03
International co-authorships %	31,53
DOCUMENT TYPES	
Article	609

Source: Extracted from Bibliometrix

The most prominent implication is evident within the post-2021 period, and the publication number jumps significantly with an utmost increase by 2025. It is apprehended that it indicates the end of the incremental increase and the beginning of exponential growth due to the worldwide adoption of ESG reporting, the pull of improved regulatory measures for corporate governance, and increased research focus on the financial impact of environmental and sustainability issues on the economy and financial markets. The largely increased publication numbers indicate that the corresponding publication push may also result in utmost citation impact due to the exponential increase of research boundaries found on expanding fronts.

As can be evidenced in Figure 2, overall, it is apparent that the scientific production within this specific domain is no longer a nascent subject matter, having increased instead into a significant growth sector. Finally answering directly RQ1, it is apparent that scientific production within this domain indeed marks a significant growth pattern in publication production towards 2015-2025. This points towards a subsequent maturation process within this domain concerning citation impact.

Figure 2. Annual growth of publications (2015–2025)

Source: Extracted from Bibliometrix

4.2. Intellectual Structure: Core Sources, Authors, and Foundational Works (RQ2)

Table 3 identifies the most productive journals publishing research on corporate governance and financial performance under environmental and sustainability challenges over the period 2015–2025. The distribution of articles shows that there is a core of highly concentrated journals, and this core is what determines the intellectual structure of this particular area of study. Specifically, it is apparent that Corporate Social Responsibility and Environmental Management is the top source with 32 publications, and this is followed closely by Business Strategy and the Environment with 29 publications. The preponderance of such journals indicates that the academic discourse is chiefly centered around the intersection point of corporate governance tools, sustainability approaches, and environment-related accountability, and not necessarily around more traditional journals that are exclusively geared towards finance as a field of study.

Additionally, it is worth noting that the presence of such journals as Journal of Risk and Financial Management, Finance Research Letters, and Journal of Sustainable Finance and Investment indicates a growing convergence of performance assessment, risk, and sustainability-focused governance structures and approaches.

These results empirically support, from the perspective of RQ2, the fact that only a few interdisciplinary journals shape the intellectual structure of research on corporate governance, financial performance, and sustainability challenges as central knowledge hubs that enable the flows of citations and thematic convergence, and the diffusion of foundational contributions across governance, sustainability, and financial research streams.

Table 3. Most relevant journals

Source Title	Articles
Corporate Social Responsibility and Environmental Management	32
Business Strategy and The Environment	29
Journal of Risk and Financial Management	21
Journal of Cleaner Production	16
Cogent Business and Management	15
Business Strategy and Development	14
Corporate Governance (Bingley)	11
Finance Research Letters	11
Social Responsibility Journal	10
Journal of Sustainable Finance and Investment	9

Source: Extracted from Bibliometrix

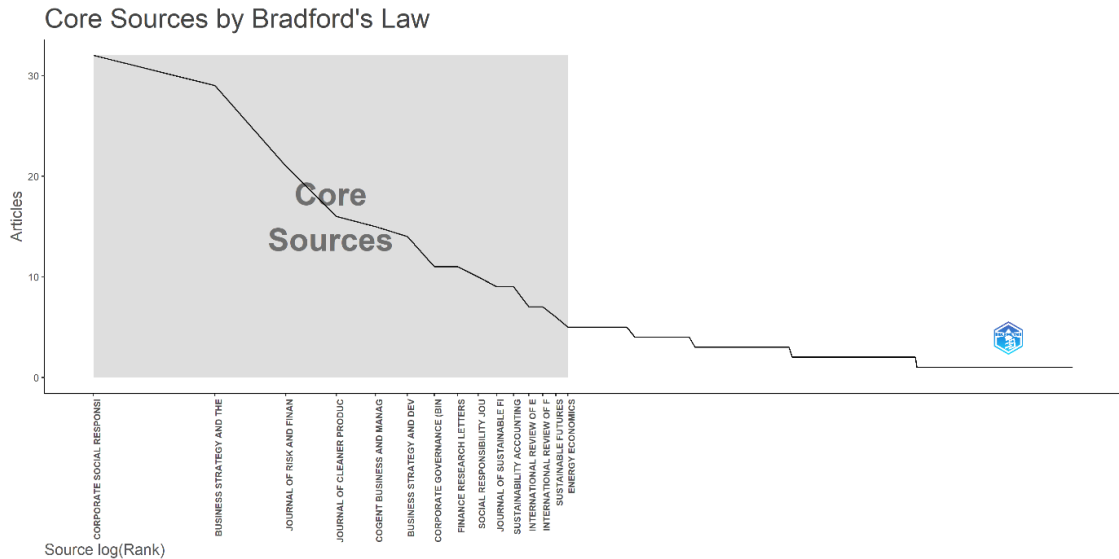
Figure 3 applies Bradford's Law to identify the core journals that structure the intellectual base of research on corporate governance and financial performance under environmental and sustainability challenges over the period 2015–2025. The Bradford distribution reveals a pronounced concentration of scholarly output within a limited nucleus of sources, confirming a highly unequal yet systematic dispersion of articles across journals. In particular, it is a subset of highly prestigious outlets that publishes disproportionately many articles, while the rest are spread over a long tail of less significant sources with productivity declining sharply. This points towards the existence of a well-recognized core literature that is the central place for theorization and empirical justification of methods in this specific area of research.

Looking from the perspective of intellectual structures, the essential sources, as shown in Figure 3, serve as important hotspots where discussions on corporate governance tools, financial performance results, and sustainability pressures meet. Primarily, their dominance can be attributed to their frequency of articles, but also to their ability to drive the research agenda, legitimate new topics (ESG integration, stakeholder governance, and sustainability-oriented performance measurement), and distribute basic studies that are further distributed to secondary and tertiary sources. Conversely, the drastic reduction in article numbers after the Bradford core indicates thematic fragmentation, where selective, often specialized, or interdisciplinary publications contribute peripherally to a particular subject.

The evidence from Figure 3, which speaks directly to RQ2, provides evidence that this intellectual structure of the literature rests on a small core group of journals that play a key role as conduits for influential authors and foundational publications. These journals provide the main platforms through which citation-based relationships are formed and reinforced, thereby shaping the field's cumulative knowledge base. Consequently, the Bradford core delineated here represents not merely a productivity

concentration, but a structural backbone of scholarly influence, indicating where the most impactful contributions to corporate governance, financial performance, and sustainability challenges are most consistently produced and recognized.

Figure 3. Bradford's Law



Source: Extracted from Bibliometrix

The data is synthesized in Table 4 to outline the patterns of productivity among the most fruitful authors within the indexed literature on corporate governance and financial performance in environmental & sustainability challenges during the period 2015-2025. The findings indicate a moderately diversified authorship pattern whereby a limited set of persisting authors is responsible for their extensive share within the published studies, hence determining the trajectory of thought within the domain. The most fruitful set of authors comprises Matuszewska-Pierzynka & Velte with five published studies followed by Rezaee & Yilmaz with four published studies. These sets of authors tend to engage progressively within the domain rather than episodically, suggesting the existence of a set of thought leaders within the domain.

The other authors in Table 4, who have three publications each, constitute a second tier of contributors whose work bolsters and expands dominant research streams without reconfiguring them. All these findings together already answer RQ2 by showing that, instead of being highly diffused, the intellectual structure of the field rests on the work of a few highly influential authors whose sustained productivity indicates agenda-setting for integrating mechanisms of corporate governance with financial performance outcomes under sustainability and environmental constraints. Productivity-based evidence here supplements citation-based analyses by underlining the contribution that sustained authorial output makes to consolidation and maturation processes in the research field.

Table 4. Most productive authors

Author Name	Articles
Matuszewska-Pierzynka, A.	5
Velte, P.	5
Rezaee, Z.	4
Yilmaz, M.K.	4
Adhariani, D.	3
Aksoy, M.	3
Alahdal, W.M.	3
Arayssi, M.	3
Doni, F.	3
Gull, A.A.	3

Source: Extracted from Scopus

Table 5 provides citation-based evidence on the foundational publications and influential authors that structure the intellectual core of research on corporate governance, financial performance, and sustainability challenges during the 2015–2025 period. From an interpretive standpoint, the table does not merely rank highly cited papers; rather, it reveals the theoretical anchors, dominant empirical questions, and core publication outlets that have shaped cumulative knowledge in this field, thereby directly addressing RQ2.

Findings show that the intellectual foundation upon which the body of literature is based is deeply rooted in research on the ESG–financial performance relationship, with Xie et al. (2019) being the most cited publication in absolute and relative values. The very high number of total citations (786) and its citation rate per year emphasize its importance for other research activities: it is a pioneering publication that legitimizes ESG activities not only for ethical but for financial reasons taken into account in a corporate setting. Also prominent is Garcia et al. (2017) in *Journal of Cleaner Production*, underpinning the importance of sector sensitivity, board structure, and sustainability performance issues for the explanation mechanism in being the core area that shapes research activities in its field. Another publication is Naciti (2019) in *Journal of Cleaner Production*, putting emphasis on the same topic.

Apart from the absolute number of citations, the normalized citation values indicate another important measure of influence. Studies such as Nirino et al. (2021) and Naciti (2019) display comparatively high normalized citation scores, indicating strong intellectual relevance relative to publication year. This indicates that recent research emphasizing corporate controversies, ESG moderation effects, and governance mechanisms is quickly solidifying their position in the knowledge base, indicating a change in focus toward more conditional governance-performance relationships. In this sense, influence is not confined to early movers but is dynamically reconstituted through methodological and theoretical refinement.

Moreover, it has been observed that the existence of many highly cited articles in journals like Business Strategy and the Environment, Journal of Cleaner Production, Journal of Corporate Finance, and Sustainability Accounting, Management and Policy Journal supports core-journals pattern. These outlets function as epistemic hubs where governance, sustainability, and financial performance intersect, thereby shaping citation-based relationships and guiding research trajectories. The fact that researchers such as Arayssi keep reappearing, and board diversity, ESG disclosure, and responsible investing remain topics of emphasis, is further evidence that governance characteristics and transparency methods remain research frontiers.

Table 5. Most cited documents

Author	Title	TC	TC per Year	Normalized TC
Xie et al., (2019)	Do environmental, social, and governance activities improve corporate financial performance?	786	98,25	7,99
Garcia et al., (2017)	Sensitive industries produce better ESG performance: Evidence from emerging markets	642	64,20	3,37
Naciti, (2019)	Corporate governance and board of directors: The effect of a board composition on firm sustainability performance	517	64,63	5,25
Ng & Rezaee, (2015)	Business sustainability performance and cost of equity capital	454	37,83	4,76
Arayssi et al., (2020)	The impact of board composition on the level of ESG disclosures in GCC countries	365	52,14	4,25
Nirino et al., (2021)	Corporate controversies and company's financial performance: Exploring the moderating role of ESG practices	361	60,17	5,69
Albitar et al., (2020)	ESG disclosure and firm performance before and after IR: The moderating role of governance mechanisms	335	47,86	3,90
Widyawati, (2020)	A systematic literature review of socially responsible investment and environmental social governance metrics	301	43,00	3,50
Rodriguez-Fernandez, (2016)	Social responsibility and financial performance: The role of good corporate governance	285	25,91	3,70
Arayssi et al., (2016)	Women on boards, sustainability reporting and firm performance	272	24,73	3,53

Source: Extracted from Bibliometrix

In sum, as shown in Table 5, there is a clear set of foundational literature that influences the intellectual structure of the research, with a core set of journals that help to define the research questions and method of inquiry. In addressing RQ2, the results

indicate that productivity and citation influence are centered on governance literature from the perspective of ESG that is published in sustainability-oriented but finance-relevant journals, plus a few highly cited sources that provide a conceptual and empirical point of reference to guide other literature on corporate governance and finance related to sustainability threats.

Figure 4 addresses RQ2 by revealing the intellectual structure of research on corporate governance, financial performance, and sustainability challenges through a co-citation analysis of foundational references. By applying a strict threshold of 15 citations, the work identifies 20 highly influential publications out of 3886 cited references. This highly concentrates the knowledge base, which is anchoring the field. Three clusters are thus identified to indicate different yet interrelated theoretical and empirical streams that collectively shape scholarly understanding in this domain.

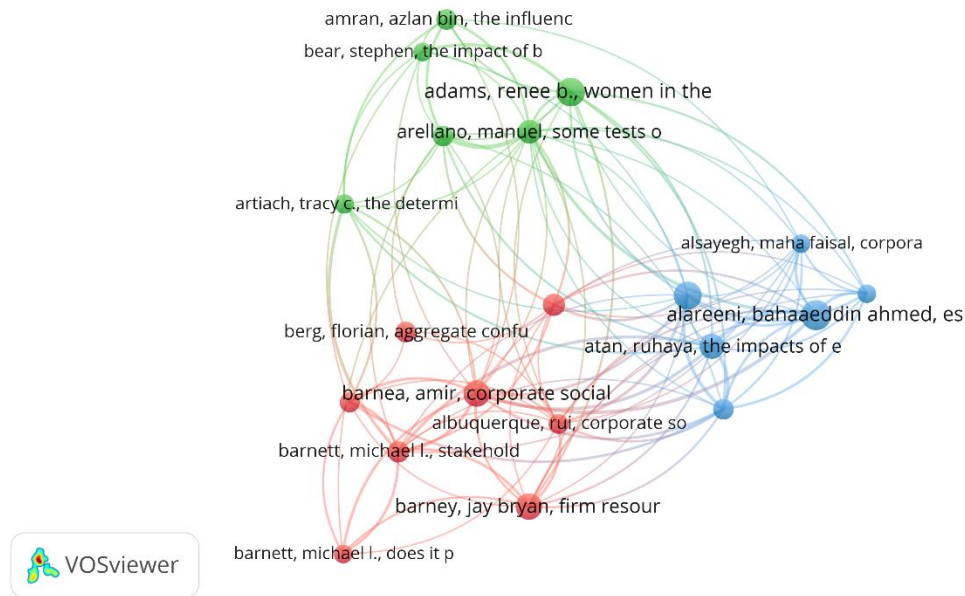
“First cluster (Cluster 1)” comprises the theoretical and conceptual foundations of this literature and encompasses stakeholder theories, resource-based models, as well as Risk-Return trade-offs for corporate social responsibility. Key foundational research by Barney (1991) as well as Barnett (2007), Barnett & Salomon (2012) illustrates the strategic rationale underlining the relationship between firm resources and stakeholder power and their impact on returns to financial assets. More contemporary perspectives by Barnea & Rubin (2010) and later research by Albuquerque et al (2019) are then seen to apply agency theories as well as Risk-based frameworks to both Corporate Social Responsibility and ESG Engagement. The addition of Berg et al (2022) to this cluster then also reflects a level of maturity in this field to critically evaluate issues regarding valid measurements in ESG data and their subsequent impact on inference.

The second cluster (Cluster 2) reflects the governance aspects and methodological basis of literature. Governance studies focusing on board attributes and structures, gender diversity, or gender effects (ESG), like (Adams & Ferreira, 2009; Bear et al., 2010; Amran et al., 2014), are strongly co-cited with methodological papers of dynamic panel analysis for panel data sets (Arellano & Bond, 1991; Arellano & Bover, 1995). This interpretation shows again that research literature on sustainability-related governance-performance analysis has its methodological roots in dynamic panel analysis because of its ability to correct for endogeneity and individual effects of observed values for panel data analysis of various studies to measure their effects of ESG and good corporate governance.

The third cluster reflects the applied ESG disclosure-performance nexus, with an emphasis on firm-level value implications across both developed and emerging markets. High co-citation of studies like (Aboud & Diab, 2018; Alareeni & Hamdan, 2020; Aouadi & Marsat, 2018; Atan et al., 2018) center on ESG disclosure quality, controversies, and performance sensitivity, hence, really shifting toward context-specific and market-based validation of sustainability claims. Incoherence of the cluster would mean ESG disclosure has presently become the main empirical channel in which governance and sustainability

are measured in financial performance research.

Figure 4. Co-citation of references



Source: Extracted from VOSviewer

On the whole, it is clear from Figure 4 that the intellectual landscape of the area of interest is organized around three integrative pillars: (i) foundational theories that interrelate governance, CSR/ESG, and financial performance; (ii) governance characteristics and econometric approaches that make it possible to establish causality; and (iii) practical applications of ESG disclosure and value relevance analysis. Furthermore, that the number of highly co-cited references is relatively low also suggests that a relatively small number of central journals and foundational works—such as Academy of Management Journal, Strategic Management Journal, Journal of Business Ethics, Journal of Financial Economics, and Management Science—noted in these references has a disproportionate influence on the scholarly debate. The above points have formed a definitive and systematic response to Research Question 2.

4.3. Social and Geographical Structure of Research Collaboration (RQ3)

Table 6 reports the most productive institutional affiliations contributing to research on corporate governance and financial performance under environmental and sustainability challenges during the 2015–2025 period. The findings indicate a degree of moderate concentration but also geographic diversity in the institutional setting, which is dominated by Asian and European universities. The Malaysian institutions stand out as very prominent in this setting since they occupy four out of the top ten affiliations. This is followed by the University Technology Mara, which publishes the most research on the topic (9 publications). The existence of research centers now rooted in their national settings through this institutional aggregation supports the idea that there is a strategic

focus on the topic of sustainable corporate governance. The presence of top-tier institutions in Europe, such as the University of Lodz, Sapienza Università di Roma, or the Bucharest University of Economic Studies, also testifies to the global spread of knowledge production on issues pertaining to sustainability in corporate governance.

Importantly, this relatively comparable set of publication counts across institutions from different countries would point out that the field is not dominated by any single global center but rather is organized around various mid-scale institutional nodes. This pattern therefore fits a research domain characterized by international collaboration networks and not by hierarchical dominance, as the production and dissemination of knowledge are facilitated by inter-institutional linkages across Asia and Europe. With regard to RQ3, these findings showed that the geographical and institutional distribution of knowledge in this field is patterned around regionally concentrated centers of expertise which remain internationally connected, thus enabling the cross-national flow of research output and fostering the global consolidation of sustainability-driven corporate governance research.

Table 6. Most productive affiliations

Affiliation	Country	Articles
University Technology MARA	Malaysia	9
University of Lodz	Poland	7
Sapienza Università di Roma	Italy	7
University Malaysia Terengganu	Malaysia	7
Bucharest University of Economic Studies	Romania	7
The Hong Kong Polytechnic University	Hong Kong	6
University of Southampton	England	6
University Putra Malaysia	Malaysia	6
Leuphana Universität Lüneburg	Germany	6
University Sains Malaysia	Malaysia	5

Source: Extracted from Scopus

Table 7 synthesizes the country-level scientific production in the field of corporate governance and financial performance under environmental and sustainability challenges over the period 2015–2025. Results reflect a strongly asymmetrical geography of knowledge production, dominated by a few countries. China leads the contributions with 178 publications, followed by India (114) and Italy (96), which attests to the strong positioning of both emerging and established economies in terms of setting the research agenda of this domain. The leading positions of Asian countries—China, India, Indonesia (80), and Malaysia (71)—underline a clear shift of scholarly activity toward regions facing rapid economic growth in concert with sharp sustainability and governance challenges. At the same time, European countries such as Italy, the UK (75), and Spain (46) remain important contributors reflective of institutionalized research on sustainability-oriented

governance within mature regulatory environments. Finally, the United States scores a relatively low output of 52, implying that though influential, its contribution is less volumetric and therefore presumably more concentrated in high-impact or collaborative research streams.

Taken together, Table 7 reveals that knowledge generation in this area has both been geography-constrained but is also tending towards becoming multipolar, thereby verifying RQ3 by illustrating how imbalances in research capability at the regional levels affect global patterns of knowledge generation. The imbalances at this juncture also have the implication that knowledge networks across the global regions might have an important facilitating function for knowledge diffusion from regions of emerging global economies to already established research knowledge hubs in Europe and North America.

Table 7. Countries' scientific production

Country	Freq
China	178
India	114
Italy	96
Indonesia	80
UK	75
Malaysia	71
USA	52
Spain	46
Australia	32
Saudi Arabia	32

Source: Extracted from Bibliometrix

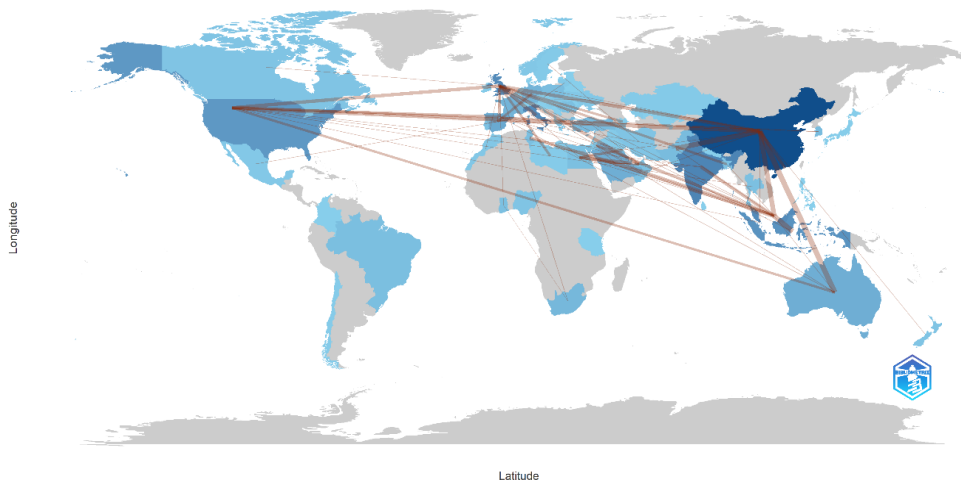
Figure 5 provides empirical evidence on how knowledge production in the field of corporate governance and financial performance under environmental and sustainability challenges is geographically structured and internationally diffused through cross-country collaboration networks. In direct response to RQ3, the collaboration map demonstrates a highly centralized and asymmetrical global research network, in which a limited number of countries function as core knowledge hubs, while the majority of others participate as peripheral or intermediary contributors. Specifically, East Asia—most notably China—emerges as a dominant node with extensive transcontinental collaboration ties, indicating both high research output and strong integration into international co-authorship networks. This centrality is also reflected by strong collaborative links to research systems in Europe and North America and reflects a situation where global knowledge diffusion for this theme domain is to a large extent facilitated by partnerships between emerging economies of high output and Western research institutions.

In addition, from the results of the network structure, it is found that the

international collaboration has a structuring function rather than an enabling function, meaning that those countries which have been positioned at the core of this structure not only produce an outsize number of publications but also serve as bridges for transferring methods, framing thoughts, and setting research agendas for different regions of the world. The present structure of this study is still comparatively disorganized in terms of existing research outputs in Africa, Latin America, and developing economies of Asia. Altogether, it is clear from Figure 5 that knowledge distribution in this study is imbalanced from a geographical & institutional perspective, while the global networks of collaboration serve to be an important mechanism which addresses RQ3 by emphasizing that global research partnerships have played an important role in unprecedented concentration of research diffusion in the global intellectual structure of sustainability-oriented corporate governance research.

Figure 5. Collaboration world map

Country Collaboration Map



Source: Extracted from Bibliometrix

Figure 6 addresses RQ3 by mapping the international co-authorship network in research on corporate governance and financial performance under environmental and sustainability challenges over the period 2015–2025. Using a threshold of a minimum of five documents per country and no citation restriction, 45 of the 83 identified countries met the inclusion criteria, resulting in a network of 44 countries organized into six distinct collaboration clusters. This map displays how the worldwide knowledge system is very much clustered and hierarchical, showing that research production and diffusion across this field of knowledge are driven by regional collaboration blocs and relatively few internationally central actors.

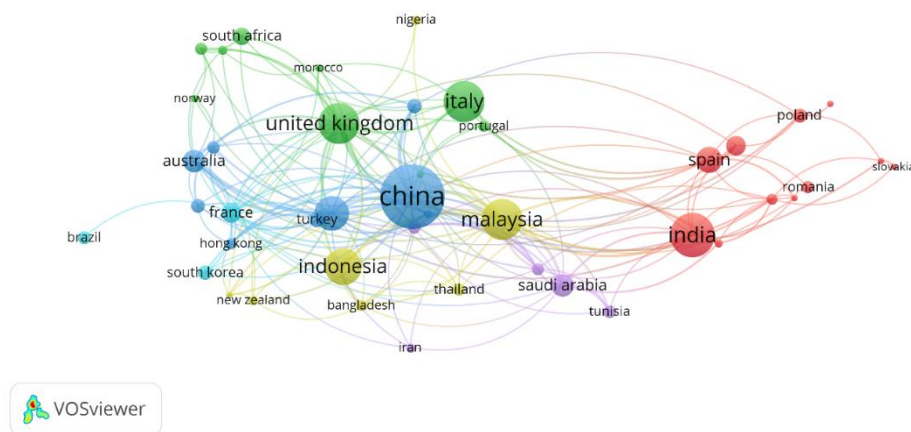
Within the heart of the network, China stands out as the foremost global center, having the strongest connectivity among various clusters. China's central place indicates that it has an important role in integrating research communities in Asia, Europe, and the

Middle East. Additionally, the United Kingdom and Italy serve as secondary centers, hence Europe's integrating role is reemphasized through the bridge created among established research infrastructures, new research systems, new economies, as well as among developed nations.

At the cluster level, there appears to be strong strategic and geographical specialization. Cluster 1, centered in India and Spain, groups a range of East and Central European countries, hinting at joint efforts based on common strategic concerns in the area of sustainability governance, harmonization, and emerging market financial performance. Cluster 2, centered in the United Kingdom and Italy, has strong connections within Europe and Africa-European countries, reflecting established research networks and strategic associations. Cluster 3, centered in China, the United States, and Australia, comprised of core, transcontinental research centers, covers strong research collaboration for impactful corporate sustainability, ESG analysis, and corresponding firm-level finance performance.

On the other hand, Clusters 4 & 5, dominated by countries in South-East and Middle-East regions like Malaysia, Indonesia, Saudi Arabia, and UAE, tend to have regional patterns of co-operation with limited international links. Though their publication productivity in research is rising, their international diffusion of knowledge is relatively localized. Cluster 6, including countries like France, Brazil, and South Korea, is the smaller cluster with bridging roles in linking peripheral areas with the overall network but with low internal density.

Figure 6. Co-authorship network



Source: Extracted from VOSviewer

In general, the structure of co-authorship shown in Figure 6 above indicates that global collaboration contributes to research on corporate governance and financial performance related to sustainability in defining research in this field. Knowledge production is unevenly distributed and concentrated around a small number of globally central countries that act as brokers between regional research systems. This

interconnected yet asymmetric configuration confirms that institutional capacity, international openness, and cross-border collaboration are critical mechanisms through which research in this field gains visibility and impact, thereby providing a direct and robust answer to RQ3.

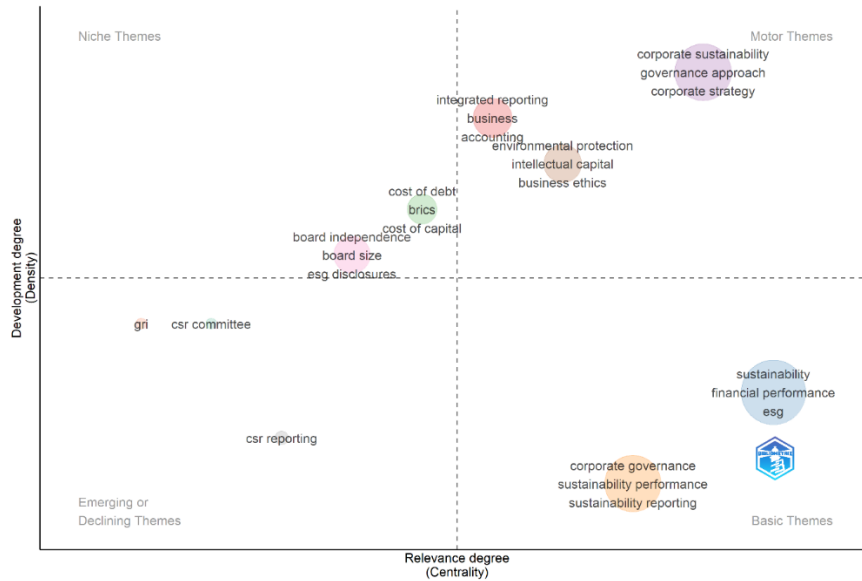
4.4. Conceptual and Thematic Evolution of the Field (RQ4)

Figure 7 synthesizes the conceptual and thematic architecture of corporate governance–financial performance research under environmental and sustainability challenges by positioning clusters according to their centrality and density, thereby capturing both thematic relevance and internal development. In direct response to RQ4, the map reveals a stratified and evolving knowledge structure in which a limited number of highly central themes anchor the field, while several governance- and disclosure-oriented topics occupy transitional or emergent positions. Specifically, the basic themes quadrant is dominated by the tightly connected cluster linking ESG, financial performance, and sustainability, indicating that the ESG–performance nexus constitutes the conceptual backbone of the literature and functions as a shared analytical foundation across studies.

This indicates that sustainability issues are now firmly embedded in mainstream literature related to finance and financial performance rather than being considered marginal issues. Closely related but slightly less developed is the literature cluster focusing on corporate governance, sustainability performance, and sustainability reporting, as it prominently shows that governance structures are widely recognized as having major structural significance despite being comparatively fragmented in terms of analytical integration in literature.

On the other hand, the motor themes Quadrant sheds light on a mature stream of research focusing on the concepts of corporate sustainability, governance approach, and corporate strategy, illustrating a strategic shift in focus within the literature towards the creation of sustainability value through a governance-based approach. At the same time, themes clustering around the center of the map including integrated reporting, Accounting & Management Accounting, Business & Business Ethics, Intellectual Capital, as well as Environmental Protection, play a bridging-role indicative of a theoretical integration between the structure of governance, non-financial disclosure systems, and sectors related to ethical & environmental issues.

Lastly, the incorporation of CSR Reporting, GRI, & CSR Committees within the Emerging/Declining Quadrant indicates a paradigm shift towards strategy-infused frameworks rather than traditional CSR views. Collectively, Figure 7 demonstrates that the field has evolved from descriptive CSR disclosure research toward a more conceptually integrated architecture in which corporate governance operates as a strategic lever linking sustainability practices to financial performance outcomes, thereby clarifying both dominant research trajectories and future research frontiers.

Figure 7. Thematic map

Source: Extracted from Bibliometrix

Figure 8 explains the conceptual and thematic developments of corporate governance-financial performance studies within environmental and sustainability contexts during the period 2015-2025, thus directly answering RQ4. Trend analysis shows a successive transformation of the research structure, with a shift in early focuses on social performance, corporate social performance, and sustainability disclosure towards more inclusive, governance-focused and ESG-based concepts. Previous themes (2018-2020) prevail over accountability and reporting tools, showing an early stage of interest in transparency, stakeholder relationships and the consolidation of methods through content and empirical analyses.

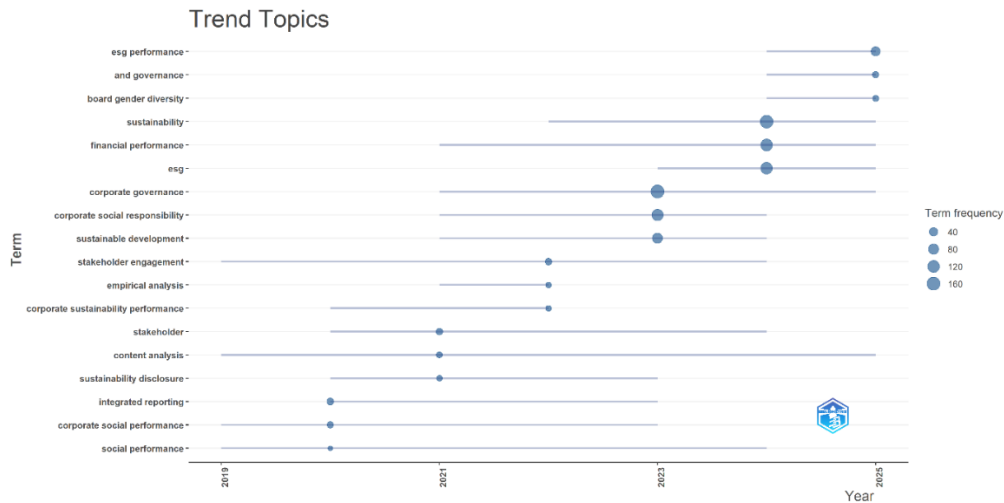
Starting in 2021, the conceptual thickness of the literature really comes into its own, with a good deal of central organizing around the linking of mechanisms of governance to financial outcomes as a function of sustainability pressures: corporate governance, corporate social responsibility, and sustainable development. The latter phase reflects a move beyond descriptive, disclosure-based studies toward causal and structural tests of how governance attributes condition firm performance in environmentally constrained contexts.

Most notably, the recent surge (2023–2025) in ESG, financial performance, sustainability, board gender diversity, and ESG performance signals the formation of an advanced research frontier, where governance structures are increasingly analyzed through multidimensional ESG lenses. This also shows a kind of maturity or evolution in the area towards a focus on strategic governance effectiveness over sustainability.

Figure 8, taken as a whole, illustrates the progression of the thematic structure of the literature from disintegrated social and disclosure-focused models of analysis to a

unified, ESG-integrated paradigm of governance and performance, pointing to the recognition of consensus among scholars and experts which views financial performance as being fundamentally affected by the quality of governance and its adaptation to the environment and sustainability. This evolution confirms that contemporary research is converging toward holistic, performance-oriented governance frameworks, thereby answering RQ4 by mapping both dominant themes and emerging conceptual trajectories over time.

Figure 8. Trend topics



Source: Extracted from Bibliometrix

Figure 9 presents the co-word analysis network that delineates the conceptual and thematic architecture of research on corporate governance and financial performance within environmental and sustainability contexts. Applying a stringent occurrence threshold of 20 keywords reduced the conceptual space to 21 core terms (out of 1950), which cluster into three thematically coherent but interlinked knowledge domains. This structure directly addresses RQ4 by revealing how dominant themes are organized and how emerging research fronts are positioned within the field.

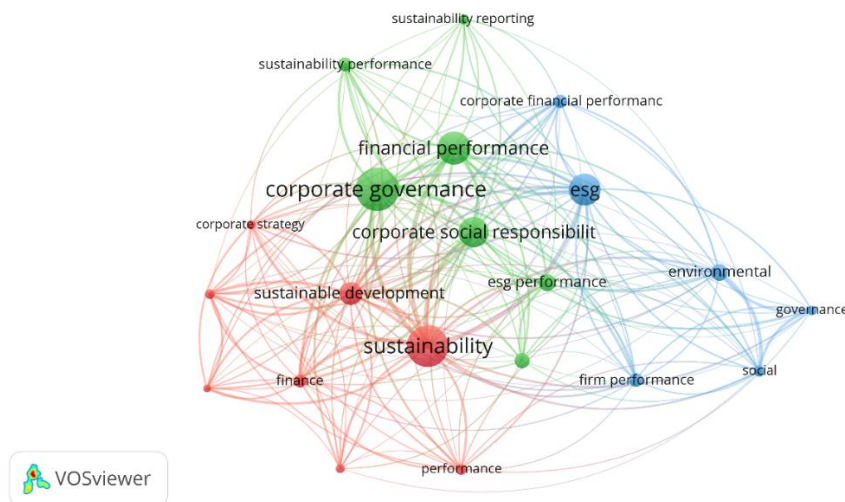
The first cluster represents a macro-level sustainability–performance nexus, integrating sustainability, sustainable development, environmental economics, environmental performance, and finance with strategic and performance-oriented constructs. This cluster corresponds to a research stream which conceptualizes sustainability issues as systemic economic and strategic concerns. This composition of themes points to a research development pathway in which sustainability research began with being conceptualized as either a constraint or a context for financial outcomes.

The second cluster constitutes the core governance–performance architecture of the field and occupies a structurally central position in the network. Anchored by corporate governance, corporate social responsibility, financial performance, ESG performance, sustainability performance, and sustainability reporting, this cluster

evidences the consolidation of governance mechanisms as the primary analytical lens through which sustainability and financial outcomes are jointly examined. The dense interconnections within this cluster indicate a mature research paradigm in which governance structures, disclosure practices, and CSR policies are theorized as mediating and moderating channels linking environmental and sustainability pressures to financial performance. This cluster therefore represents the dominant intellectual backbone of the literature.

The third cluster captures a disaggregated ESG–performance research front, structured around environmental, social, governance, ESG, firm performance, and corporate financial performance. Unlike the integrative governance-focused second cluster, this domain reflects a more granular analytical shift toward isolating ESG dimensions and assessing their differentiated impacts on firm-level financial outcomes. Its strong connectivity with both the governance and sustainability clusters suggests an ongoing thematic evolution toward performance measurement, ESG scoring, and empirical validation of ESG–financial performance linkages, marking this cluster as an emergent and rapidly expanding research frontier.

Figure 9. Co-word network



Source: Extracted from VOSviewer

Taken together, the co-word network in Figure 9 demonstrates a clear thematic evolution from broad sustainability–development concerns (Cluster 1), toward governance-centered integrative frameworks (Cluster 2), and further into ESG-specific, performance-driven empirical inquiry (Cluster 3). This layered architecture confirms that contemporary corporate governance–financial performance research is no longer conceptually fragmented but increasingly structured around ESG-oriented governance mechanisms as the principal interface between environmental sustainability challenges and firm financial outcomes, thereby providing a comprehensive answer to RQ4.

5. Discussion and Results

5.1. Discussion

The bibliometric evidence demonstrates that research on corporate governance (CG) and financial performance (FP) under environmental and sustainability challenges has entered a phase of accelerated and structural expansion between 2015 and 2025. The extremely rapid rate of annual growth (37.02%), together with the sharp increase in momentum post-2019, serves to support the notion of a shift in focus for sustainability as a niche ethical issue towards becoming a key consideration in governance and investment choices. The point of shift shows a congruent connection to exogenous events such as the Paris Agreement and particularly the COVID-19 pandemic in redefining a focus for sustainability as a necessary ingredient of resilience and a key area of risk management in its own right. The results relate to earlier bibliographic analysis evidence of a post-2018 shift towards a focus on investor-related literature as a key area of sustainable finance research in ESG considerations.

5.1.2. *Intellectual Foundations and Theoretical Evolution*

The intellectual landscape depicts a prominent paradigm transformation towards more value-based creation models and away from the shareholder maximization model. Stakeholder Theory has continued to offer the most prominent theoretical foundation to further support the assumption of corporations' financial sustainability for creating value for all interested parties by balancing economic interests with social and environmental concerns (Donaldson & Preston, 1995). Nevertheless, a trend of theoretical amalgamation emerges, and one of these blends or amalgamations has been achieved by subsuming Agency Theory and Stewardship Theory. Governance structures, rather than acting solely to limit managerial opportunistic behaviors for controlling corporate self-interest (Jensen & Meckling, 1976), encompass enablers of long-term sustainability-oriented investments.

Groundbreaking research such as that conducted by Xie et al. (2019) has been the catalyst that ensured ESG engagement became recognized not just as a means of improving governance but also as a cost not left to discretion. Furthermore, Garcia et al. (2017) have also emphasized that studying institutional and sectoral contexts, more specifically in emerging markets that have different structures of governance and different methods of enforcement of rules from the more developed economies. Concerning the analysis procedures of such studies, it has moved from merely explaining the disclosure of CSR information towards methods that are ESG-driven financial models that use dynamic panels and methods that correct endogeneity.

5.1.2. *Governance Mechanisms and Board Dynamics*

Thematic mapping identifies the board of directors as the focal point of sustainability governance. Consensus is strong that board size, independence, and expertise are

positively related to ESG disclosure quality and strategic alignment with sustainability. The most impactful among these board-level mechanisms is board gender diversity. There is consistent empirical support for the "critical mass" hypothesis that one needs at least three female directors to have possible influence on strategic orientation toward decarbonization, transparency, and social accountability (Cosma et al., 2024; Patekar & Mahajan, 2025).

At the same time, the importance of specialized board committees as a mediation factor is emphasized in contemporary literature. Sustainability committees improve the ability to identify Risks related to finance on a climate level in banks and capital-intensive industries. Audit committees in emerging countries act as a means for governance that ensures alignment with stakeholder interests rather than pushing the signaling hypothesis (Adu et al., 2024; Elmanaseer & Gerged, 2025). Taken together, these observations illustrate support for the idea that the quality of governance is more significant than sustainability engagement on whether ESG activities impact finance.

5.1.3. Financial Implications: Risk, Performance, and Value Creation

From a financial standpoint, the findings strongly support the "virtuous circle" hypothesis, which states that investment in sustainability strengthens firm reputation, reduces risk exposure, and, in turn, strengthens financial performance (Rodriguez-Fernandez, 2016). While short-run profitability pressures, associated with high levels of capital expenditure, are still relatively apparent in specific industries (Shaikh, 2022), the consensus over the longer run emanating from the literature is not ambiguous. High ESG performance is characterized by low idiosyncratic risk, low cost of capital, and high earnings stability, as markets increasingly view sustainability engagement as a signal of better governance and regulatory preparedness (Sciarelli et al., 2024; Hazaea et al., 2025).

Significantly, the new focus on risk management rather than return optimization marks a paradigm shift in financial reasoning in the literature on governance. Sustainability is no longer conceived as an antidote to returns in a solely positive manner but also in a protective context of environmental and reputational risks.

5.1.4. Geographical Reconfiguration and Persistent Challenges

Geographically, the field shows a clear transition toward a multipolar knowledge structure. While the early conceptual and empirical underpinning was laid in the US and Europe, the period 2015–2025 is marked by the rapid rise of China, India, and Southeast Asian economies. China, in particular, becomes a strong hub in international collaboration, reflecting both its regulatory push toward green finance and its growing academic influence.

Notwithstanding this cognitive maturity, there remain many open issues that continue to shape the research agenda in this area. The lack of standardization in these ESG rating approaches, characterized as "aggregate confusion" in the literature, is still an

issue (Berg et al., 2022; Patekar and Mahajan, 2025). Furthermore, the threat of greenwashing is still an open issue, where researchers have turned to more result-focused measures, like the Sustainable Growth Rate (SGR), in order to distinguish between actual process upgrades and mere disclosure activities.

5.2. Conclusion

The current research highlights and focuses on a holistic bibliometric mapping process regarding the research intensity and development state pertaining to corporate governance (CG) and financial performance (FP) issues under environmental and sustainability factors and challenges over the period from 2015 through 2025 through 609 scholarly pieces reviewed.

The data show that there has been an intense growth of scientific output with an average growth rate of 37.02% per annum. The research trend is non-linear, displaying what might be termed an 'explosive growth' phase from 2019 onwards, driven by worldwide factors such as the Paris Climate Agreement and COVID-19. The research trend is also very visible in academia, with an average of 30.96 citations per document, which indicates that this area of research has moved from an explore/establish phase to a strategically central phase of research. The young average document age of 3.08 years further reinforces the fact that this issue of CG-FP sustainability is recent and of immediate importance.

The intellectual foundations are built upon an intense core of inter-disciplinary journals, only comprising Corporate Social Responsibility and Environmental Management, Business Strategy and the Environment, and others. The core is supported by influential studies such as that by Xie et al. (2019), that provided credentials for ESG activities as value-enhancing instruments of governance. The foundations have migrated from classical theories for maximizing shareholder value towards a 'triple bottom-line approach,' and Stakeholder Theory has become the principal anchor for examinations concerning value creation. However, co-citation analysis also reveals a maturity in methodology, in that studies now dynamically apply panel data methodologies in treating endogeneity in studies concerning governance and performance.

The knowledge production process in this field is geographically imbalanced and is therefore becoming multipolar. Although European and North American institutions laid the groundwork with their research output, China, India, and Malaysia are emerging as strong contributors between 2015 and 2025. China is particularly taking center stage as the leading global hub and is thereby allowing inter-regional knowledge flow and creation through strong global collaboration networks. Universiti Teknologi MARA (Malaysia) is particularly evident as the leading productive affiliation and thereby reflects on the emphasis placed on sustainability research with particular higher educational systems. International co-authorships contribute largely (31.53%) to this dataset and are

thereby a strong determinant for inter-regionalization on methodological rigor and theories.

The thematic evolution of the field unveils a paradigmatic shift from descriptive disclosure on CSR issues to integrated, ESG-oriented governance-performance frameworks. The conceptual backbone is defined by the nexus between ESG and performance, which over the last two decades has become established in mainstream financial research. Board gender diversity and board independence show up as high-impact variables in the analysis, and there is evidence that "critical mass" is required in terms of the number of female directors to see any impact on strategic pivots toward sustainability. Finally, risk mitigation is an emergent research front where high ESG performance is associated with lower idiosyncratic firm risk and lower cost of capital.

In conclusion, corporate governance has moved from a mere compliance-oriented mechanism to become a strategic driver of institutional resilience and financial success in view of environmental constraints. Yet, despite the recognition of the importance of corporate sustainability, such areas still present a series of challenges: "aggregate confusion" associated with non-standardized ESG ratings, such as the risk of greenwashing. Indeed, more future research is needed regarding the mitigation of these information frictions and the investigation of the "virtuous circle" of social investment and profit across varied regulatory environments. This review systematically sets the baseline for scholars and practitioners who seek to address the complex, rapidly evolving landscape of sustainability-driven corporate governance.

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Conflict of interest

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APPENDICES

Appendix 1. List of bibliometric data extracted from Scopus

Githublink: <https://github.com/aissaguettala/Appendix-A.-List-of-bibliometric-data-extracted-from-Scopus.git>

Rethinking Sustainability Under Siege: The Socio-Political Transformation of Environmental Practices in Gaza

Abdallah Abukalloub ^a , Sedat Çağlar ^b , Filiz Kutluay Tutar ^c 

ABSTRACT

Purpose – This study questions the common assumption in academic and policy debates that environmental sustainability is mainly achieved through post-conflict reconstruction, technological progress, and institutional interventions. Focusing on the Gaza Strip, it examines how environmental sustainability practices emerge under prolonged blockade and occupation. The study aims to demonstrate that sustainability in Gaza develops as a necessity-driven practice rather than a planned environmental strategy.

Design/data/methodology – The research adopts a qualitative design based on document analysis. International reports, technical data, and academic literature published between 2010 and 2025 were systematically reviewed. The analysis is guided by the political ecology of the siege framework, which allows environmental practices to be interpreted within broader political, economic, and infrastructural constraints.

Findings – The findings show that environmental practices in Gaza arise not primarily from environmental awareness or formal sustainability policies, but from structural pressures such as enforced scarcity, infrastructural destruction, and political violence. Practices including material reuse, adaptive water management, and alternative energy solutions function as forms of everyday resilience that sustain daily life and community continuity. However, while these practices help mitigate immediate environmental and urban collapse, they do not resolve the structural conditions that produce these challenges.

Originality/value – The article introduces the concept of “sustainability of necessity,” emphasizing sustainability as a survival strategy shaped by conflict conditions. By politicizing sustainability, the study contributes to political ecology and critical urban studies while drawing attention to the risk of depoliticized sustainability agendas and green colonialism.

Keywords: Political Ecology, Sustainability of Necessity, Siege Economy, Gaza Strip

Kuşatma Koşullarında Sürdürülebilirliği Yeniden Düşünmek: Gazze'de Çevresel Pratiklerin Sosyo-Politik Dönüşümü

ÖZET

Amaç – Çalışma, akademik ve politika tartışmalarında yaygın olan, çevresel sürdürülebilirliğin esas olarak çatışma sonrası yeniden yapılanma, teknolojik ilerleme ve kurumsal müdahaleler yoluyla elde edildiği varsayımını sorgulamaktadır. Uzun süreli abluka ve işgal altında çevresel sürdürülebilirlik uygulamalarının nasıl ortaya çıktığını incelemektedir. Çalışma, Gazze'de sürdürülebilirliğin planlı bir çevre stratejisinden ziyade, zorunluluktan kaynaklanan bir uygulama olduğunu göstermektedir.

Tasarım/veri/yöntem – Araştırma, belge analizine dayalı nitel bir tasarım benimsemektedir. 2010 ile 2025 yılları arasında yayınlanan uluslararası raporlar, teknik veriler ve akademik literatür sistematik olarak incelenmiştir. Analiz, çevresel uygulamaların daha geniş siyasi, ekonomik ve altyapısal kısıtlamalar içinde yorumlanmasına olanak tanıyan kuşatma çerçevesinin siyasi ekolojisi tarafından yönlendirilmektedir.

Bulgular – Gazze'deki çevresel uygulamaların öncelikle çevresel farkındalık veya resmi sürdürülebilirlik politikalarından değil, zorunlu kıtlık, altyapı tahribatı ve siyasi şiddet gibi yapısal baskılardan kaynaklandığını göstermektedir. Malzeme yeniden kullanımı, uyarlanabilir su yönetimi ve alternatif enerji çözümleri gibi uygulamalar, günlük yaşamı ve toplumsal sürekliliği sürdüren günlük direnç biçimleri olarak işlev görmektedir. Bununla birlikte, bu uygulamalar acil çevresel ve kentsel çöküşü hafifletmeye yardımcı olsa da, bu zorlukları üreten yapısal koşulları çözmemektedir.

Özgünlük/Değer – Makale, sürdürülebilirliği çatışma koşulları tarafından şekillendirilen bir hayatta kalma stratejisi olarak vurgulayarak, “zorunluluktan kaynaklanan sürdürülebilirlik” kavramını tanıtmaktadır. Sürdürülebilirliği siyasallaştırarak, çalışma politik ekolojiye ve eleştirel kentsel çalışmalara katkıda bulunurken, siyasetten arındırılmış yeşil sömürgeciliğin riskine dikkat çekmektedir.

Anahtar Kelimeler: Politik ekoloji, Zorunlulu Sürdürülebilirlik, Kuşatma Ekonomisi, Gazze

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1. Introduction

I am that five-year-old child from Gaza, weighing less than the water cans I carry, looking around for help. Yes, I am that child, burdened with the world on my shoulders. I have shown my growth by bringing water to my home, which is not really a home anymore because bombs have destroyed it...

Environmental sustainability has become a key issue in current debates on post-conflict rebuilding, urban resilience, and climate adaptation. In both research and policy, sustainability is often seen as a normative goal to be achieved through technological advances, institutional changes, and externally supported development programs (Mason et al., 2011; Almeida et al., 2023). These approaches usually assume conditions of relative stability, sovereign governance, and voluntary participation. However, such assumptions clash with situations shaped by prolonged occupation, blockades, and political violence.

The Gaza Strip exemplifies how environmental sustainability develops amid enforced scarcity and infrastructure destruction. Since the comprehensive blockade began in 2007, Gaza has faced strict restrictions on the movement of people and goods, repeated military attacks, and the ongoing deterioration of water, energy, housing, and sanitation systems (Hassoun, 2025). In this context, sustainability cannot be seen as a mere policy choice or a post-conflict goal. Instead, it manifests as a set of material practices through which residents strive to maintain daily life amid a continuous siege.

Although existing literature has extensively documented Gaza's humanitarian crises, infrastructural failures (Asi et al., 2024), and environmental decline (Musallam et al., 2023; UNEP, 2024a), a notable research gap persists concerning the conceptualization of environmental sustainability within the context of the ongoing siege. Prior studies predominantly analyze sustainability from two principal perspectives. The first adopts a technocratic viewpoint, considering sustainability as a post-conflict reconstruction objective contingent upon institutional stability and external assistance (Barakat et al., 2018). The second perspective depicts local environmental practices merely as depoliticized humanitarian "coping mechanisms" or informal adaptations to crises (Mason et al., 2011). Consequently, mainstream sustainability frameworks, such as resilience or just transition, frequently overlook the political ecology inherent in a siege economy, where resource deprivation is structurally mandated rather than incidental.

This study addresses this gap and advances current knowledge by politicizing sustainability in conflict zones. It offers three distinct contributions to the literature on political ecology and critical urban studies:

Conceptual Innovation: It introduces the concept of sustainability of necessity, distinguishing it from mainstream sustainability of choice. The study demonstrates that environmental practices in Gaza arise not from normative environmental awareness but from non-voluntary survival strategies driven by infrastructural violence and enforced scarcity (Lubitz, 2018; Mashaqi et al., 2025).

Re-theorizing Local Agency: Unlike previous research that treats local material adaptations, such as rubble reuse, decentralized solar adoption, and water rationing, as marginal informalities, this study analyzes them as a form of "resistance ecology" (Banerjee et al., 2023). It shows how these practices sustain everyday life, collective presence (sumud), and limited spatial autonomy without dismantling military authority.

Critique of Depoliticized Frameworks: By situating these practices within the political ecology of siege, the paper provides a critical corrective to externally imposed, depoliticized environmental agendas, drawing attention to the risks of green colonialism where structural violence is masked as a neutral development challenge (Blanc, 2022; Hamouchene, 2023).

The article is organized as follows. Section 2 explains the theoretical framework, introducing the political ecology of siege along with concepts of resistance ecology and sustainability of necessity. Section 3 offers background on Gaza's siege economy. Section 4 describes the research methodology. Section 5 presents the findings and analysis. Section 6 discusses the importance of politicizing sustainability and concludes by considering how sustainability of necessity can inform environmental governance in ongoing conflict settings.

2. Theoretical Framework

This study draws on an interdisciplinary theoretical framework that combines insights from political ecology, urban conflict studies, and critical sustainability scholarship. The framework is organized around four interconnected analytical pillars. First, the concept of siege is used to examine how prolonged restrictions on mobility, materials, and infrastructure shape environmental governance and everyday life. Second, the concept of urbicide highlights the deliberate destruction of urban infrastructure and the spatial dimensions of violence. Third, environmental governance provides a lens for understanding how access to water, energy, housing, and other essential resources is regulated under conditions of political constraint. Finally, the concept of scarcity-driven innovation explains how communities develop adaptive environmental practices in response to prolonged deprivation and infrastructural disruption. Together, these perspectives provide the theoretical basis for conceptualizing sustainability not as a voluntary environmental transition but as a necessity-driven practice emerging under conditions of siege.

The empirical foundation of this research rests on the argument that the systematic destruction of infrastructure, especially water, energy, housing, and sanitation networks, has intensified social and spatial inequalities across Gaza's urban landscape. These processes have not only worsened material living conditions but have also actively created uneven patterns of environmental vulnerability. Infrastructure destruction under occupation acts as a mechanism of spatial control, reshaping access to resources and

changing everyday life. To place these dynamics within their political context, this study adopts a political ecology of siege framework that highlights the causal relationships between occupation governance, demolition practices, and socio-environmental deprivation (Mashaqi et al., 2025; Hassoun, 2025).

Within Gaza, the siege creates a paradoxical situation. On the one hand, it increases public and institutional focus on resource scarcity and sustainability. On the other hand, it frames these issues through depoliticized representations such as humanitarian infrastructure projects or emergency services that detach environmental degradation from its political roots (Mason et al., 2011).

Such framings obscure the structural forces that cause deprivation and reframe sustainability as a technical or humanitarian issue rather than a socio-political practice driven by long-term enclosure, restriction, and violence. Environmental and social discourses in Gaza center on two main narratives, *sumud* and resilience. *Sumud* emphasizes rootedness in land, collective endurance, and political attachment to place, portraying sustainability as the act of staying resilient despite dispossession. Resilience discourse, on the other hand, often reflects feelings of abandonment and loss and tends to normalize adapting to worsening conditions rather than addressing their root causes. The tension between these narratives has led to ongoing debates about which forms of sustainability are realistic or achievable, especially when referencing nostalgic memories of pre-occupation times (Lubitz, 2018; El-Zakka & Diab, 2023).

Under siege conditions, sustainability practices in Gaza go beyond mere survival strategies. They represent an intensified expression of what can be called the innovation of scarcity, where scarcity is not only a limit but also a seed for alternative socio-environmental visions. The problems caused by the blockade therefore involve not just material survival but also the ability to imagine different ways of living amid structural violence. Locally, this is expressed through historical and cultural ideas of loss and constraint, involving a reinterpretation of deprivation as a resource to sustain daily life and to envision alternative futures rooted in environmental care and political struggle (Abreek-Zubiedat, 2025; Samman, 2025).

2.1. Political Ecology of Siege

Understanding environmental domination under siege requires attention to the spatial, temporal, and organizational dimensions of resource access. In Gaza, these dimensions shape access to land, water, and energy resources that are difficult to produce in sufficient quantities and whose prolonged overuse has led to declining availability and quality. As scarcity worsens, access becomes more unequal, creating significant disparities between communities and neighborhoods (Hassoun et al., 2025). Access to land, water, and energy directly affects life chances and is therefore a matter of social justice. Mapping the political regulation of these resources provides a clearer understanding of Gaza's socio-political

crisis than analyses focused solely on economic indicators. This approach aligns with political ecology scholarship that highlights how power relations, governance regimes, and territorial control shape unequal access to environmental resources (Khan, 2013). The political ecology of siege also resonates with literature on uneven development and spatial injustice, which shows how capitalist and colonial governance produce geographically diverse outcomes. Market-based logics generate enclavization and undercapitalization, disconnecting certain spaces from global economic circuits.

Gaza exemplifies an extreme case of enforced disconnection, where mobility restrictions and physical controls fragment urban space and social life (Ahn & Juraev, 2024). Urban analysis should therefore focus on scarcity governance, including negotiations among undercapitalized localities, governing authorities, and humanitarian actors, as well as the adaptive practices that emerge during prolonged deprivation. Within this framework, indicators of resource scarcity can be combined with measures of equity and distribution. Mapping affordability and access to housing and construction materials offers insight into how scarcity is experienced unevenly. Building on arguments that persistent over-extraction requires circular practices, this study explores whether the siege economy enables alternative reconstruction pathways based on resource reuse and social equity rather than growth-driven development (Hassoun, 2025).

2.2. Urbicide and Spatial Violence

The concept of urbicide describes a form of violence directed at the city itself, rather than merely its residents. In Gaza, infrastructural destruction cannot be dismissed as accidental or collateral damage. It is a deliberate strategy to dismantle the physical foundations of urban life and to turn civilian spaces into areas of persistent vulnerability. Urban infrastructure supports daily social activities, mobility, and public health. Its destruction hampers recovery and functions as a tool of modern urban warfare, intensified by the ongoing blockade (McFarlane, 2023; Truelove & Ruszczyk, 2022). Indicators of damage to water, health, education, and electricity systems do more than reveal material loss. They highlight the spatial violence embedded in Gaza's siege economy and provide a lens for analyzing the non-human aspects of urban destruction.

2.3. Sumud Versus Resilience

Resilience has become a dominant framework in sustainability discussions and refers to the ability of social and ecological systems to absorb shocks and adapt while keeping their essential functions. Resilience literature usually sees disruption as occasional and views adaptation as a process of adjustment over time. Sumud, a key concept in Palestinian life, understands siege as a persistent and structurally imposed condition rather than a temporary shock. Explaining sumud highlights the limitations of resilience frameworks in situations of prolonged occupation.

Sumud represents rootedness, political attachment to land, and refusal to be

displaced, operating through collective effort, land-based practices, and participation in local governance (Lubitz, 2018). Practices related to sumud, such as reuse, recycling, and local production, promote environmentally sustainable extraction while building social capital, maintaining public order, and supporting public health. Therefore, sustainability is inseparable from political endurance and collective presence. In this way, sustainability under siege cannot be fully understood through resilience models alone but must be seen within broader struggles over land, resources, and spatial justice (Mashaqi et al., 2025).

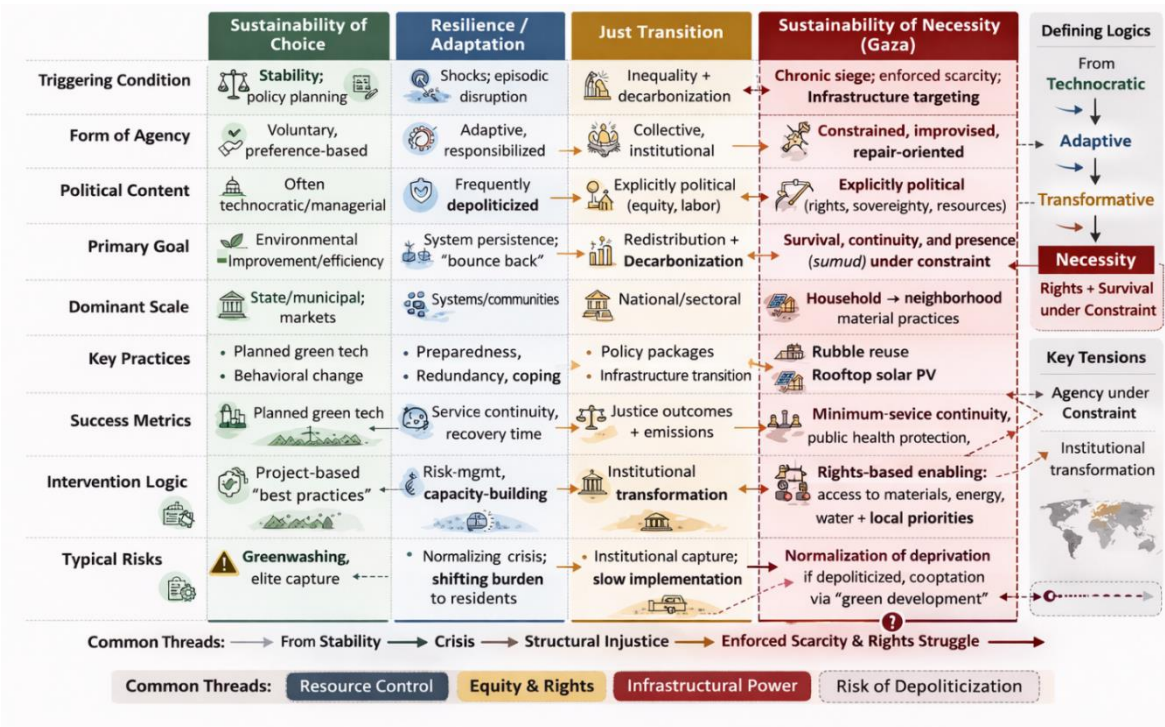
2.4. Innovation of Scarcity

Extreme resource deprivation can encourage circular economy practices that emphasize reuse, recycling, and local production (Chaturvedi et al., 2019). In Gaza, where access to water, energy, and construction materials is severely limited, circular approaches provide immediate material benefits while easing pressure on scarce resources. These practices also address broader socio-economic issues by extending the lifespan of urban assets and lowering the financial burden associated with large-scale reconstruction (Qu, 2025). Scarcity also influences behavior and decision-making. Resource deprivation limits choices and changes evaluation processes, often increasing resource awareness and strategic planning (Hosany and Hamilton, 2023). Under siege, scarcity raises awareness of the political factors affecting access and links humanitarian shortages to military actions targeting civilian infrastructure. This awareness guides sustainability efforts that focus on land, housing, and infrastructure, positioning circular practices as politically informed responses rather than just technical solutions.

Recent studies on Gaza and other conflict-affected contexts show that scarcity and infrastructure disruption can produce localized forms of adaptation and improvisation that go beyond simple coping mechanisms. In the Gaza Strip, prolonged restrictions on electricity, water infrastructure, and construction materials have contributed to the emergence of decentralized solar energy systems, small-scale water treatment practices, and the reuse of rubble in reconstruction (Rantissi et al., 2024; World Bank, 2023). Recent research further highlights that large quantities of demolition waste have been systematically recycled into construction materials such as aggregates and building blocks, forming part of post-conflict recovery practices (AbuHamed et al., 2023). Similarly, energy studies show increasing reliance on decentralized renewable systems, particularly solar energy, in response to chronic electricity shortages (Rantissi et al., 2024; El-Khozondar & El-batta, 2022). However, the literature emphasizes that these practices should not be interpreted as linear innovation processes but as necessity-driven survival strategies shaped by structural constraints, infrastructure breakdown, and political-economic limitations (Hilhorst & Jansen, 2010; Graham & Thrift, 2007). While they demonstrate significant local agency and adaptive capacity, they do not substitute for rights-based reconstruction or equitable access to infrastructure and essential services

(World Bank, 2023; UN OCHA, 2023).

Figure 1. Positioning “Sustainability of Necessity” Among Dominant Sustainability Frameworks Under Conflict Conditions.



Sources: Author’s conceptual synthesis based on Lubitz (2018), Mason et al. (2011), Fischhendler et al. (2022), Blanc (2022), Hamouchene (2023), and Almeida et al. (2023).

As illustrated in Figure 1, sustainability of necessity occupies a distinct analytical position within contemporary sustainability debates. Unlike sustainability of choice, which presupposes relative stability and voluntary policy planning, sustainability of necessity emerges under chronic siege, infrastructural targeting, and enforced scarcity. While resilience frameworks frame disruption as episodic and emphasize system persistence or “bouncing back,” the Gaza case reflects a condition where crisis is continuous rather than exceptional. Similarly, just transition frameworks focus on redistribution and decarbonization within institutional reform processes, whereas sustainability of necessity operates at the household and neighborhood scale through materially grounded practices such as rubble reuse, rooftop solar adoption, and water coping strategies.

The figure highlights three defining features. First, agency under siege is constrained and improvised rather than voluntary or institutionally coordinated. Second, sustainability practices are explicitly political, rooted in claims over rights, sovereignty, and resource control rather than technocratic environmental management. Third, the primary goal shifts from efficiency or transition toward survival, continuity, and presence (sumud) under constraint. The figure also identifies key tensions, particularly the risk that externally driven environmental interventions may depoliticize scarcity and reproduce

forms of green colonialism by reframing structural violence as a neutral development challenge.

By positioning sustainability of necessity alongside dominant frameworks, the figure clarifies that the concept does not reject sustainability as an ideal. Rather, it re-situates sustainability as historically contingent, politically embedded, and shaped by unequal infrastructural power.

2.5. Green Colonialism and Depoliticized Sustainability

Green colonialism refers to the process through which environmental and sustainability agendas become embedded within existing structures of political domination, territorial control, and unequal resource governance. Rather than directly exploiting natural resources, green colonial practices often operate by framing environmental problems as technical or managerial challenges while obscuring the political conditions that produce ecological degradation (Blanc, 2022; Hamouchene, 2023). Within this framework, sustainability interventions may unintentionally legitimize unequal power relations by prioritizing efficiency, adaptation, and resilience without addressing questions of sovereignty, resource rights, and environmental justice.

In conflict-affected territories, environmental programs frequently depend on international donors, development agencies, and humanitarian institutions. While these actors often provide essential support, their interventions may also contribute to the depoliticization of environmental crises when environmental degradation is treated primarily as a problem of infrastructure management rather than a consequence of military occupation, blockade, or territorial fragmentation. Political ecologists therefore argue that sustainability initiatives should be evaluated not only according to environmental outcomes but also according to their implications for local autonomy, resource governance, and political self-determination (Hughes vd., 2023).

In the Gaza context, the risk of green colonialism emerges when sustainability projects focus exclusively on adaptation to scarcity while leaving intact the political and institutional mechanisms that generate scarcity itself. Under such conditions, environmental interventions may improve short-term living conditions yet simultaneously normalize prolonged restrictions and dependency. This distinction is particularly important for understanding sustainability of necessity, which arises from structurally imposed deprivation rather than from voluntary environmental transition (Khalidi, 2020).

3. Contextual Background: The Siege Economy

Israeli restrictions on access and movement, officially called a blockade, have deeply influenced Gaza's socioeconomic structure. The siege mainly functions through a dual-use regulatory system that bans the import of materials considered to have potential military uses. Construction materials like cement, steel, and pipes are central to this system, even

though they are vital for civilian housing, infrastructure repairs, and urban renewal. Regulating these materials has not only been a security measure but also a way to control the economy and space, disproportionately impacting civilian life (Jones et al., 2024; Capone, 2025). Since the 1990s, the construction sector has constituted one of the primary sources of employment for engineering graduates in Gaza and has played a central role in urban development processes. Following the establishment of the Palestinian Authority, construction activities expanded significantly, contributing to private sector growth and labor absorption (World Bank, 2015). However, after the imposition of the blockade in 2007, the sector's development trajectory became structurally constrained due to severe restrictions on the import of construction materials classified as "dual-use" items (UNCTAD, 2015).

Although a limited degree of expansion occurred between 2010 and 2015—largely driven by internationally funded reconstruction initiatives and the temporary easing of certain import channels—the sector remained heavily dependent on externally regulated material flows (World Bank, 2015). The 2014 Gaza conflict further intensified the housing deficit, with extensive destruction of residential infrastructure. By 2015, approximately 40,000 housing units were reported as unfinished or pending reconstruction due to material shortages, regulatory controls, and bureaucratic constraints embedded in the Gaza Reconstruction Mechanism (GRM) framework (UNCTAD, 2015). These conditions indicate the presence of systemic structural barriers rather than temporary cyclical disruptions in the construction market.

Limited access to planning data, uncertainty over permit approvals, and fragmented governance further hindered construction efforts under siege. Meanwhile, strict restrictions on cement, steel, and pipes have led to adaptive practices. These include material replacement and reuse, informal procurement networks, and incremental building methods. Such strategies highlight the dual nature of a siege economy, where scarcity creates both deprivation and innovation, reshaping how people produce and survive without formal rebuilding options. Gaza mostly depends on the coastal aquifer as its only source of freshwater. Power generation and industry rely on limited desalination plants, centralized power stations, and water treatment systems. Electricity production is inadequate, especially in outer urban areas, while wastewater treatment is well below capacity. Less than one-fifth of sewage is properly treated, and only a small part undergoes secondary or tertiary processing, putting heavy pressure on soil, groundwater, and coastal ecosystems (Musallam et al., 2023; Noui & Guesbaya, 2025). Rainwater drainage systems are inadequate for seasonal flooding, causing frequent inundation of urban underground levels and informal housing zones. These conditions worsen water pollution and accelerate infrastructure deterioration. As water quality drops, access to safe drinking water for households has sharply declined, increasing health risks and harming livelihoods (Shomar & Rovira, 2023; Farajallah & Farajallah, 2024).

3.1. The Blockade and the Institutionalization of Protracted Reconstruction

Israel imposed a comprehensive blockade on the Gaza Strip in June 2007 following Hamas's takeover of the Palestinian Authority in Gaza. Officially framed as a security measure, the blockade quickly evolved into a highly institutionalized regime of restrictions on movement and materials, particularly through the classification of "dual-use" items (Barakat et al., 2018; Jones et al., 2024). Construction materials, including cement, steel, aggregates, and certain electrical and water infrastructure components, were either severely restricted or required complex approvals. Although justified on security grounds, these measures effectively constrained large-scale reconstruction and urban development, embedding structural limitations in Gaza's housing and infrastructure sectors (UNCTAD, 2015).

Between 2007 and 2014, Gaza experienced repeated cycles of destruction and partial reconstruction. Material entry was controlled through quota systems and case-by-case approvals, leading to chronic shortages. The blockade not only restricted the supply of construction materials but also limited access to the technical expertise and equipment needed for infrastructure maintenance. As a result, housing deficits widened steadily, while existing infrastructure, including electricity grids, water networks, and sewage systems, degraded at an accelerated pace (Farrant, 2018; Field, 2023; Middle East Institute, 2024).

International donors pledged substantial reconstruction funds following successive escalations. However, implementation remained slow and fragmented due to excessive coordination requirements, permit delays, funding suspensions, and unpredictable border closures. Reconstruction thus became conditional, externally mediated, and politically contingent rather than rights-based and development-oriented (Barakat et al., 2018).

Following the 2014 war, reconstruction efforts were channeled through monitoring frameworks such as the Gaza Reconstruction Mechanism (GRM), which introduced digital tracking and approval systems for construction materials. While intended to facilitate reconstruction, the mechanism further bureaucratized material access. Approval processes, layered verification procedures, and shifting eligibility criteria prolonged rebuilding timelines (UNCTAD, 2015).

During this period, reconstruction increasingly resembled what scholars describe as "protracted recovery" or "permanent temporariness," a condition in which rebuilding is technically ongoing yet structurally incomplete. Despite international aid initiatives often exceeding one million USD per project, only a fraction reached full completion and final approval. Development was hindered not only by material scarcity but also by funding interruptions, donor fatigue, and political volatility (Alagha & Hussein, 2024).

Spatially, new housing developments began emerging on the urban periphery due to land scarcity and planning constraints within central areas. This peripheralization

deepened socio-spatial fragmentation, distancing residents from employment hubs, extended family networks, healthcare services, and educational institutions. Consequently, housing reconstruction did not merely address physical damage but reshaped urban geography and intensified social inequality within the Strip (Guardian, 2026).

The escalation beginning in 2023 marked a structural rupture in Gaza's built environment. The destruction of Gaza's infrastructure during the Israeli military campaign in October and November 2023 was unprecedented in both scale and intensity. Over forty-six days, critical civilian facilities, including health, education, water, and energy systems, were extensively damaged or destroyed across all governorates. The concentration of damage around key civilian infrastructure suggests systematic targeting and raises serious concerns about violations of international humanitarian law (Asi et al., 2024). The extensive destruction of residential neighborhoods, public facilities, and infrastructure drastically reduced the housing stock, transforming an already chronic deficit into an unprecedented shelter crisis. Unlike previous cycles, the scale of damage overwhelmed existing reconstruction frameworks and rendered prior mechanisms functionally inadequate (Jones et al., 2024).

By 2024–2026, reconstruction efforts faced compounded constraints:

- Severe material shortages under tightened entry controls,
- Institutional fragmentation,
- Damaged administrative capacity,
- Funding uncertainty amid shifting geopolitical priorities,
- And the erosion of local construction sector capabilities (Middle East Institute, 2024).

Under these conditions, reconstruction shifted from a development challenge to a humanitarian emergency. Many residents resorted to informal, self-built, or makeshift housing solutions, often lacking compliance with engineering standards, safety regulations, or urban planning codes. The normalization of informal construction further institutionalized precarity within the housing sector (OCHA, 2025).

Moreover, prolonged displacement altered demographic distribution patterns, intensifying overcrowding in certain areas while depopulating others. Urban fragmentation, already present before 2023, deepened into spatial discontinuity, weakening economic networks and social cohesion. Reconstruction, once envisioned as a pathway to recovery, increasingly appeared as an indefinite and politically contingent process (UNCTAD, 2015).

Across the 2007-2026 period, the blockade evolved from an immediate security response into a structural condition shaping Gaza's urban trajectory. Rather than producing temporary hardship followed by recovery, the regime of restriction institutionalized chronic underdevelopment, infrastructural fragility, and housing

precarity. Recurrent destruction combined with constrained reconstruction has generated a cyclical system in which rebuilding rarely restores pre-destruction capacity, let alone enables growth (Barakat et al., 2018; UNCTAD, 2015).

In this sense, Gaza's reconstruction cannot be understood as a linear post-conflict recovery process. Instead, it represents a prolonged, externally mediated, and structurally constrained condition in which urban life is continuously rebuilt yet persistently destabilized (Jones et al., 2024; Middle East Institute, 2024; OCHA, 2025).

3.2. The Environmental Crisis

The blockade has triggered a serious environmental crisis in Gaza, notably impacting groundwater resources, electricity supply, and waste management systems. The coastal aquifer, Gaza's main water source, is near collapse. Water is available for an average of only fifteen hours a day, and about 95 percent of groundwater is unsafe for drinking due to salinization and pollution (Zeitoun et al., 2017; Shomar & Rovira, 2023). Electricity shortages worsen these issues. Insufficient power disrupts hospital operations, food storage, wastewater treatment, and schools, undermining basic living conditions. Waste management systems are also overwhelmed. Daily solid waste ranges from 2,600 to 3,500 metric tons, yet less than a quarter is collected regularly. Accumulated waste blocks drainage channels and damages urban environments (Davidson, 2006). Wastewater treatment covers only a small part of sanitation needs. Untreated sewage is often discharged into soil and waterways, increasing the risk of waterborne diseases such as cholera, hepatitis, and other infectious illnesses. These environmental pressures together threaten the long-term survival of civilian life in Gaza.

The water crisis is one of Gaza's most severe environmental challenges. Decades of over-extraction, seawater intrusion, and inadequate infrastructure maintenance have significantly degraded the quality of the coastal aquifer, which remains the territory's primary freshwater source. Studies indicate that the vast majority of groundwater fails to meet safe drinking-water standards, increasing reliance on desalination facilities, bottled water, and household filtration systems (Shomar & Rovira, 2023; Musallam et al., 2023). Restrictions on infrastructure repair and the import of essential materials have further limited water authorities' capacity to address long-term deterioration.

Energy insecurity is a second major dimension of the environmental crisis. Chronic electricity shortages affect nearly every aspect of daily life, including healthcare delivery, education, food preservation, water pumping, and wastewater treatment. Limited fuel availability and repeated damage to energy infrastructure have contributed to a persistent gap between electricity demand and supply. In response, many households and institutions have increasingly relied on decentralized energy solutions, particularly rooftop solar systems, to compensate for unreliable grid access (Fischhendler et al., 2022; El-Khozondar & El-batta, 2022). At the same time, deficiencies in solid-waste management

and wastewater treatment continue to pose significant environmental and public-health risks, contributing to pollution of coastal ecosystems, groundwater resources, and densely populated urban areas (UNEP, 2024a; Musallam et al., 2023).

3.3. Aid Dependency and Local Agency

The blockade has systematically restricted access to construction materials and dual-use items, constraining both public and private investment in housing, infrastructure, and essential service provision (Miller, 2016). These restrictions have not only delayed reconstruction but have also weakened long-term infrastructural planning and maintenance capacity. In response to deteriorating water quality and persistent material shortages, local authorities and households have adopted a range of adaptive coping strategies. Within the Strip, neighborhoods have developed different coping strategies by negotiating access to materials and services through local collective mobilization. These strategies include the drilling of additional (often informal) wells, the installation of household-level filtration systems, and the expansion of small-scale reverse osmosis units. While such measures provide short-term mitigation and reflect localized forms of agency under constraint, they remain technically palliative rather than structurally transformative (Musallam et al., 2023; Hassoun, 2025).

4. Methodology

4.1. Research design

This study employs a qualitative research design based on document analysis. Ongoing access restrictions caused by the blockade make sustained fieldwork in Gaza impossible. In these conditions, document-based qualitative inquiry offers a rigorous and ethically suitable way to examine socio-environmental dynamics under siege. Rather than replacing the lack of field data, this approach aligns methodologically with the study's goal of analyzing structural conditions, governance regimes, and material practices shaping sustainability in Gaza.

4.2. Data sources

The primary empirical material for this study consists of institutional and policy reports published between 2010 and 2025 by the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), the United Nations Environment Programme (UNEP), and the World Bank. These documents provide longitudinal assessments of environmental degradation, infrastructure damage, access to basic services, and reconstruction constraints under prolonged blockade conditions. Reports addressing water and sanitation systems (WASH), environmental impact assessments, conflict-generated rubble, and large-scale infrastructure damage constitute the core documentary basis of the environmental analysis.

Rather than relying on independently collected primary datasets, the study draws

on technical data as reported within these institutional assessments. These include documented figures and sectoral analyses concerning electricity supply deficits, fuel dependency, construction debris volumes, groundwater quality and salinization trends, and wastewater treatment capacity and discharge practices. The analysis interprets these reported technical indicators as evidence of cumulative environmental stress and infrastructural attrition associated with repeated military escalations and movement restrictions.

To contextualize and critically assess institutional reporting, the study triangulates these documents with a systematic review of peer-reviewed academic literature on Gaza's infrastructure, urban development, water security, and environmental governance. Academic studies are treated not as independent primary data, but as analytical sources that provide sectoral depth, methodological clarification, and political-economic interpretation. This three-layered approach combining humanitarian documentation, reported technical sectoral data, and scholarly analysis strengthens interpretive reliability and enables a governance-oriented understanding of how sustainability practices evolve under conditions of structural restriction and recurrent infrastructural disruption.

4.3. Analytical strategy

A total of 58 documents were systematically analyzed using thematic analysis. These documents comprised institutional policy reports (e.g., World Bank, UNEP, UN-OCHA), technical environmental assessments, and peer-reviewed academic literature. To manage, organize, and code the textual data, manual coding was used instead of qualitative data analysis software, given the relatively contained dataset and the iterative, interpretive nature of the analysis.

The thematic analysis followed a structured five-stage process to ensure methodological rigor and analytical transparency. First, during the familiarization stage, all selected documents were read repeatedly to develop a comprehensive understanding of the dataset and the broader context of the Gaza siege economy. Second, in the initial coding stage, data were systematically coded to capture meaningful segments related to resource access, infrastructure deterioration, adaptive material practices, and spatial governance challenges. Third, during the theme development stage, these initial codes were grouped into broader analytical themes, with particular focus on how scarcity is framed, governed, and reinterpreted by both local actors and international institutions. Fourth, in the review stage, the emerging themes were continuously checked against coded extracts and the full dataset to ensure conceptual coherence, internal consistency, and representational accuracy. Finally, in the interpretation stage, the themes were refined and synthesized into an integrated analytical narrative.

This entirely desk-based document analysis, which excludes any fieldwork or interviews due to access constraints and methodological design, does not aim to measure

causal impact or evaluate program effectiveness. Instead, it seeks to understand how sustainability practices emerge and evolve under conditions of prolonged restriction and structural deprivation. Through this analytical approach, sustainability is conceptualized as a necessity-driven process rather than a product of voluntary environmental choice.

4.4. Contextual and temporal framing

The analysis is situated within the broader environmental governance regime that has shaped Gaza since the imposition of the blockade in 2007. The blockade operates through a dual-use regulatory system that restricts the import of materials categorized as potentially usable for military purposes, including cement, steel, and essential piping. These restrictions have systematically constrained reconstruction capacity, infrastructure maintenance, and long-term service provision across water, sanitation, energy, and housing systems (World Bank, European Union, & United Nations, 2021). In governance terms, the regulatory framework has limited not only material inflows but also institutional planning capacity, thereby embedding infrastructural fragility within the territory's development trajectory.

The study's temporal scope (2010–2025) was chosen to capture a full cycle of environmental degradation, reconstruction, and adaptation under prolonged siege conditions. The period encompasses several major military escalations and their environmental consequences, including the 2012 conflict (Operation Pillar of Defense), the 2014 war (Operation Protective Edge), the May 2021 escalation, the 2022 conflict (Operation Breaking Dawn), and the ongoing war that began in October 2023 and remained active throughout the study period. Examining these successive episodes within a single analytical framework allows the study to trace how sustainability practices evolved across repeated cycles of destruction and reconstruction, rather than as responses to a single conflict event. The endpoint of 2025 was selected because it represents the most recent period for which comprehensive institutional assessments and environmental reports were available at the time of writing.¹

The 2014 hostilities resulted in widespread destruction of housing and critical infrastructure, with thousands of residential units destroyed and extensive damage reported across electricity and water networks. Although reconstruction initiatives followed, persistent movement and access restrictions continued to constrain recovery processes. The May 2021 escalation generated additional physical damages estimated between US\$ 290–380 million, while economic losses were assessed between US\$ 105–190 million. Immediate and short-term recovery and reconstruction needs were projected between US\$ 345–485 million, with the housing sector accounting for the largest share of

¹ One of the authors is a native resident of Gaza and has personally witnessed the major military escalations that occurred during the study period, including the conflicts of 2012, 2014, 2021, 2022, and the ongoing war that began in October 2023. While this experience did not constitute a primary data source, it informed the contextual understanding of the temporal scope selected for the study.

losses (World Bank, European Union, & United Nations, 2021).

More recently, the 2025 Interim Rapid Damage and Needs Assessment (IRDNA) identified a substantial intensification of infrastructural damage. The report estimated approximately US\$ 30 billion in physical damages and US\$ 19 billion in economic losses, with total recovery and reconstruction needs projected at over US\$ 53 billion over the coming decade (World Bank, United Nations, & European Union, 2025). From an environmental governance perspective, these successive assessments demonstrate not merely episodic destruction but the cumulative consequences of prolonged material restrictions, fragmented reconstruction authority, and constrained institutional capacity. Rather than enabling adaptive or resilient governance, the regulatory environment has generated recurrent infrastructural disruption and limited sustainability planning capacity under conditions of chronic instability.

4.5. Empirical focus

The empirical data highlight significant deficiencies in basic services. Gaza's population of approximately 2.28 million residents living within 365 square kilometers experiences only a few hours of electricity daily. Access to safe drinking water and proper sewage treatment remains severely limited. Nearly two million tons of rubble from repeated bombings impede reconstruction efforts, while groundwater sources often do not meet national water-quality standards for much of the population (Al Butmah et al., 2013). Energy consumption data from 2006 to 2023 reveal notable fluctuations linked to military escalations and infrastructure damage. Estimates suggest that the rubble amounts to several million tons of concrete and debris scattered across densely populated areas, including large piles in Gaza City and other centers. These conditions form the empirical basis for analyzing sustainability practices under siege.

4.6. Availability of data and materials

The study is based on publicly available institutional reports and peer-reviewed publications. All documents analyzed in this research are accessible through the official websites of the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), the United Nations Environment Programme (UNEP), the World Bank, and academic journal databases. No new primary datasets were generated or analyzed during the current study.

4.7. Analytical scope and limitations

Data limitations prevent a quantitative assessment of the environmental or social impact of sustainability initiatives. Instead, the analysis focuses on identifying material practices that continue despite urban violence and infrastructural collapse. Three such practices are examined: the repurposing of construction rubble to reduce reliance on imported aggregates; the decentralized adoption of rooftop solar photovoltaic systems to lessen dependence on external electricity sources; and water-related measures including

rainwater harvesting and small-scale desalination. Although often pursued for immediate household or community benefits, the cumulative expansion of these practices helps restore social support structures and collective capacity. The study conceptualizes these emerging dynamics as a form of non-violent resistance ecology, rooted in everyday material practices rather than formal political mobilization.

5. Findings and Analysis

Civil infrastructure in Gaza was already fragile before 2007 due to long-term occupation governance, chronic underinvestment, and fragmented public administration. The blockade did not just add pressure to this system; it transformed pre-existing vulnerabilities into a low-intensity siege economy where external funding seldom results in locally initiated, context-appropriate construction and rehabilitation. In this environment, humanitarian efforts tend to maintain minimal service provision while leaving the political and material barriers that hinder infrastructural recovery largely unchanged (Mason et al., 2011; Hassoun, 2025). Across key sectors, the evidence shows ongoing deterioration of environmental and infrastructural standards. Water insecurity remains the most documented issue. OCHA reports have long shown that approximately 97 percent of groundwater drawn in Gaza is unsafe for drinking according to WHO standards, due to over-extraction, salinization, pollution, and restrictions that limit system-wide repairs (OCHA, 2018). After October 2023, UNEP's preliminary assessment described water, sanitation, and hygiene systems as nearly non-functional, with all five wastewater treatment plants shut down, worsening contamination risks across coastal waters, soils, and freshwater sources (UNEP, 2024a).

Peer-reviewed studies on the aquifer further support these findings by highlighting how human pressures and seawater intrusion are driving declining groundwater quality (Musallam et al., 2023). Similarly, geospatial analysis shows that critical civilian infrastructure has been extensively affected. Data from the first phase of the October to November 2023 military campaign reveal widespread damage to health, education, and water facilities, with clustering around essential infrastructure, raising important legal and governance concerns and clarifying the material limits for any reconstruction efforts (Asi et al., 2024). The key point is that reconstruction is not a separate post-conflict phase outside the siege; it is an ongoing struggle over access to materials, energy, and repair capacity under conditions of enforced scarcity. Meanwhile, the findings also reveal that sustainability practices in Gaza are not merely auxiliary to reconstruction agendas; they constitute a vital parallel infrastructure for survival, repair, and partial autonomy. These practices have expanded into gaps created by stalled formal reconstruction and limited institutional capacity, serving as socio-technical responses to structural deprivation rather than purely environmental initiatives (Fischhendler et al., 2022; Hassoun, 2025).

5.1. Material Practices: From Rubble to Reconstruction

The blockade-era construction economy is characterized by two interacting dynamics: limited access to cement, steel, and aggregates, and the repeated generation of conflict-related debris. The result is a material landscape where rubble serves both as a hazard and a resource. UNEP estimates that conflict-related debris occurs on an unprecedented scale, highlighting the environmental and logistical challenges of debris management and the risk of hazardous contamination within mixed rubble streams (UNEP, 2024a; UNEP, 2024b). This shifts the analytical focus from traditional reconstruction supply chains to localized material recovery and reprocessing.

Table 1. Indicators of the Gaza Environmental and Infrastructure Crisis (2010–2025)

Sector	Indicator	Estimated Condition	Structural Drivers	Source
Water	Groundwater is unfit for human consumption	95–97%	Over-extraction, salinisation, and infrastructure repair restrictions	Zeitoun et al. (2017); OCHA (2018); Shomar & Rovira (2023)
Water	Average daily piped water supply	~12–15 hours/day	Electricity shortages, restrictions on pipe imports	Mason et al. (2011); Noui & Guesbaya (2025)
Wastewater	Treated wastewater share	<20% (secondary/tertiary treatment extremely limited)	Power deficits, damaged treatment facilities	Musallam et al. (2023); UNEP (2024a)
Energy	Average daily electricity availability	4–8 hours/day (with spatial variation)	Fuel access constraints, power plant damage	Fischhendler et al. (2022); Hassoun (2025)
Energy	Household-level solar PV adoption	Rapidly increasing but fragmented	Avoidance of dependence on the central grid	El-Khozondar & El-batta (2022)
Solid Waste	Daily solid waste generation	2,600–3,500 tons/day	Insufficient collection capacity	Davidson (2006); UNEP (2024b)
Built Environment	Conflict-generated rubble volume	Several million tons (sharp increase after 2023)	Recurrent bombardment, reconstruction restrictions	UNEP (2024a); Abdelnour (2025)
Housing	Incomplete housing units (2015)	~40,000 units	Cement and steel import restrictions	Mason et al. (2011)

Within this context, rubble recycling and on-site material recovery become practical workarounds for reconstruction. Evidence shows that small crushers and local processing networks have been in operation for years, producing substantial monthly amounts of recycled aggregates that support low-grade construction and limited repairs when imports are restricted (Abdelnour, 2025). These practices reduce reliance on imported aggregates and help reopen economic opportunities for local entrepreneurs, even though they cannot fully replace access to standardized construction materials.

Analytically, rubble recycling should be viewed as a form of infrastructural pragmatism under siege rather than a green transition. It serves as a technical adaptation to enforced scarcity that also carries social meaning: rebuilding becomes an act of maintaining social continuity and livability under conditions where formal planning is repeatedly disrupted (Molavi, 2024; Hassoun, 2025).

Table 1 summarizes key indicators of Gaza's environmental and infrastructural crisis under siege conditions, showing how water insecurity, energy shortages, waste buildup, and lack of construction materials form a system of deprivation that is structurally produced rather than due to isolated sector failures.

5.2. Energy Sovereignty: The Solar Transition

Chronic electricity deficits and fuel insecurity have made rooftop photovoltaic systems one of the most visible and scalable bottom-up energy solutions. Household-level solar adoption in Gaza is widely documented as a response to unreliable grid supply and fuel dependency, with systems designed to ensure minimal continuity for domestic life and small institutions (El-Khozondar & El-batta, 2022). Rather than reflecting a traditional policy-driven renewable transition, this expansion is better understood as a necessity-driven pursuit of energy sovereignty. Political economy research further explains why and how this transition happens under contested governance. Fischhendler et al. (2022) demonstrate that renewable energy development in Gaza is influenced by the interplay between geopolitical conflict, permissions, and infrastructural control, creating a paradox where decentralized solar systems serve as both a coping strategy and a partial workaround for centralized energy vulnerabilities (Fischhendler et al., 2022). In other words, solar adoption functions as a de facto energy policy generated from below, not as a government-led transition.

The findings thus support a core argument of this study: sustainability practices under siege are fundamentally rooted in survival and repair. They are not primarily driven by environmental awareness narratives but by infrastructural deprivation, disrupted supply chains, and the need to stabilize everyday life through decentralized systems.

5.3. Water and Urban Resistance

Water-related practices demonstrate how sustainability becomes part of daily resilience during crises. The ongoing decline in groundwater quality and limited institutional repair capacity have led communities to develop coping strategies at the household and neighborhood levels, such as small desalination units, filtration systems, and water storage solutions. Although these measures do not solve structural scarcity, they help shift risk and offer some protection against supply disruptions and system failures (OCHA, 2018; Farajallah & Farajallah, 2024). Moreover, increased groundwater extraction accelerates aquifer depletion and salinization, intensifying long-term environmental degradation and obscuring the structural drivers of infrastructure decline. Hydrogeological studies highlight the critical nature of the water crisis, showing how seawater intrusion and human activities threaten the future of coastal aquifers, making recovery impossible without major infrastructure intervention (Musallam et al., 2023). In sanitation, governance-focused research points to issues with incentives and coordination that hinder service delivery, explaining why sanitation systems remain vulnerable despite available technical solutions (Zaqout, 2023).

Recent escalations reported by UNEP indicate that wastewater treatment shutdowns and widespread failures in WASH systems have caused serious contamination risks with long-term environmental impacts on marine and land ecosystems (UNEP, 2024a). These conditions transform water practices into an urban politics of endurance: instead of overt conflict, it involves the material work of maintaining life, health, and household routines under structural constraints. Overall, the evidence shows that water, energy, and material recovery practices form a connected web of survival infrastructure. These systems help reduce siege impacts, stabilize aspects of urban life, and expand options for rebuilding when formal reconstruction is blocked.

6. Discussion and Results

This study demonstrates that environmental sustainability in Gaza emerges primarily as a necessity-driven practice rather than a voluntary environmental choice. While sustainability is commonly associated with lifestyle preferences, technological progress, or policy-driven environmental goals, the Gaza case reveals a fundamentally different political and material context. Under prolonged blockade, occupation governance, and repeated infrastructural destruction, sustainability practices develop from the need to manage everyday survival rather than from normative environmental awareness. These practices remain deeply connected to the spatial and political conditions that shape access to land, water, energy, and construction materials (Mason et al., 2011; Hassoun, 2025; Asi et al., 2024).

The findings support the concept of resistance ecology, which refers not to the deliberate adoption of environmentally innovative technologies but to material practices

that enable population survival, preserve social cohesion, and maintain essential infrastructures under conditions of structural constraint. In Gaza, such practices often involve decentralized solar energy systems, rubble reuse in construction, and adaptive water management strategies. These practices partially counter the systematic weaponization of environmental resources—particularly water and energy—by creating limited autonomy through decentralized provision, repair, and improvisation. In this sense, sustainability initiatives function as nonviolent strategies of persistence that allow continued presence on the land despite severe restrictions (Banerjee et al., 2023; Fischhendler et al., 2022).

However, the analysis also highlights the limitations and risks associated with externally driven sustainability interventions. Sustainability initiatives designed outside the local political context, or those prioritizing technocratic environmental goals while ignoring occupation and structural violence, risk reproducing forms of green colonialism. In such cases, sustainability becomes detached from lived experience and is reframed as politically neutral development, potentially reinforcing existing power asymmetries and systems of deprivation (Blanc, 2022; Hamouchene, 2023; Almeida et al., 2023). External support may strengthen local initiatives only when it acknowledges political rights over environmental resources and aligns with local priorities and practices.

From a political ecology perspective, the Gaza case illustrates that access to and control over environmental resources are central political questions rather than peripheral environmental concerns. Local adaptations and innovations do not dismantle the broader structures of domination that shape everyday life. Nor should they be interpreted as evidence of inherent resilience detached from political conditions. Instead, they represent pragmatic responses to enforced scarcity that stabilize fragments of urban life without addressing the structural causes of vulnerability (Mason et al., 2011; Hassoun, 2025).

These practices therefore fall within what this study conceptualizes as sustainability of necessity. Unlike sustainability of choice—typically associated with environmentally conscious development in relatively stable contexts—sustainability of necessity is characterized by material reduction, incremental adaptation, and collective improvisation under conditions of deprivation. Interpreting these practices through a political ecology lens restores their political significance, which is often obscured when they are framed merely as coping mechanisms or technical fixes. Sustainability, in this context, should be understood not as a universal model but as a historically and politically situated practice shaped by unequal power relations (Banerjee et al., 2023; Almeida et al., 2023).

Importantly, survival in Gaza cannot be understood solely as passive endurance or humanitarian crisis. The findings indicate that survival itself can become an active form of nonviolent resistance. Through everyday practices related to housing reconstruction, decentralized energy generation, and water management, communities sustain social life

despite extremely limited access to basic resources. Survival and spatial degradation are therefore not equivalent processes. Instead, survival practices represent deliberate attempts to maintain social continuity within a landscape shaped by structural violence (Lubitz, 2018; Fischhendler et al., 2022; Asi et al., 2024).

The study also reveals that development and reconstruction policies in Palestine are rarely politically neutral. Many sustainability-oriented interventions are designed externally and implemented through fragmented institutional mechanisms. Even when motivated by humanitarian goals, such interventions often operate within a broader political economy that shifts attention away from issues of rights, sovereignty, and resource control toward narrow technical solutions. As a result, sustainability of necessity should not be mistaken for a pathway to transformation as suggested by resilience or just transition frameworks. Instead, it reflects a locally grounded relationship between environmental practices, political ecology, and *sumud*—a form of political endurance rooted in continued presence on the land.

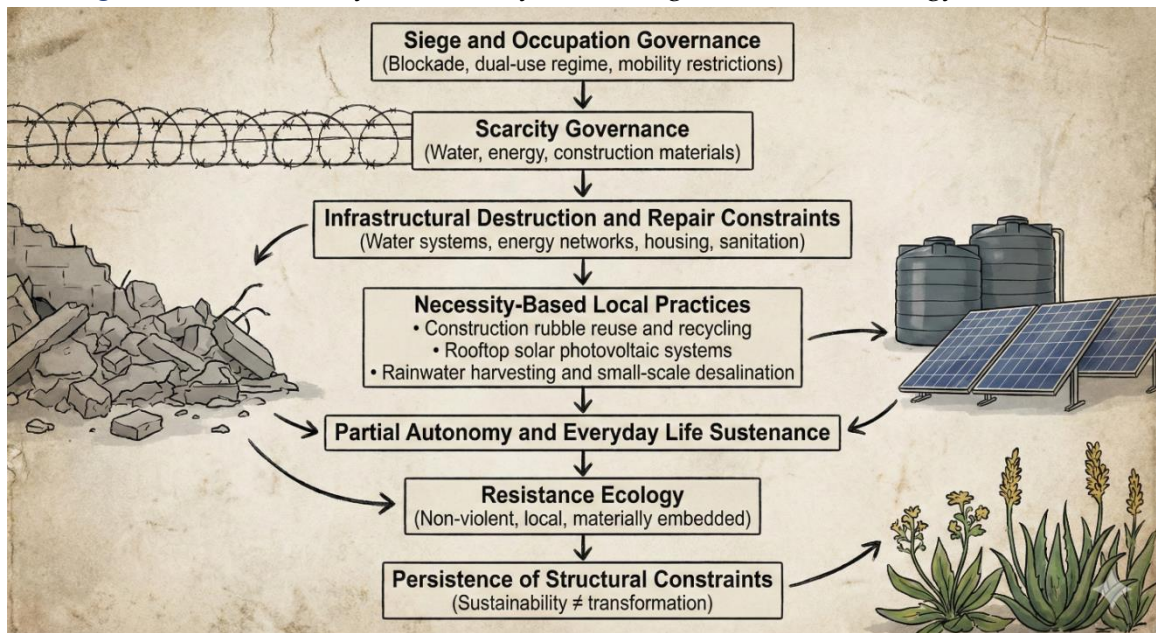
Critiques of green colonialism therefore do not reject sustainability as a normative ideal but emphasize the importance of autonomous and context-specific approaches that are not subordinated to external funding priorities or geopolitical interests (Lubitz, 2018; Blanc, 2022; Hamouchene, 2023). Promoting sustainability without addressing inequality, exploitation, and political violence risks turning environmental discourse into a mechanism of domination rather than a pathway toward justice.

Figure 2 conceptualizes this relationship by illustrating sustainability of necessity as a politically situated process emerging under prolonged siege conditions. Rather than representing a normative environmental policy model, sustainability practices in Gaza arise from structurally produced scarcity and infrastructural destruction. The framework demonstrates how siege governance leads to resource deprivation, which in turn produces locally embedded practices—such as rubble reuse, decentralized solar energy production, and adaptive water strategies—that support everyday survival and partial autonomy. These practices form a type of resistance ecology that mitigates environmental and social collapse without eliminating the structural conditions of domination that produce scarcity.

The analysis further indicates that sustainability of necessity has implications beyond the Gaza context. Similar patterns can be observed in other regions experiencing prolonged conflict, occupation, or infrastructural warfare. In Yemen, for example, the destruction of water systems and energy infrastructure has generated locally improvised practices such as water reuse and decentralized energy production. In the West Bank, fragmented governance and land control regimes produce uneven sustainability practices linked to land retention and agricultural adaptation. The recent conflict in Ukraine also illustrates how rubble reuse, decentralized energy systems, and emergency water supply strategies function as mechanisms of urban survival rather than indicators of green

transition. Across these contexts, environmental practices operate primarily as mechanisms of social reproduction under structural violence rather than as markers of resilience or recovery.

Figure 2. Sustainability of Necessity under Siege: A Political Ecology Framework



Sources: Author's conceptual synthesis based on Mason et al. (2011), Fischhendler et al. (2022), Hassoun (2025), Asi et al. (2024), and UNEP (2024a).

These findings suggest that sustainability frameworks developed for stable, post-industrial contexts cannot be uncritically applied to conflict zones. Instead, recognizing sustainability of necessity as a distinct analytical category enables a more accurate understanding of environmental practices in situations shaped by occupation, siege, and infrastructural destruction. Such recognition also helps prevent the depoliticization of sustainability discourse in contexts where environmental governance is inseparable from questions of power, sovereignty, and justice.

Ultimately, politicizing sustainability is essential for understanding how social life continues under siege conditions. In Gaza, sustainability practices are not expressions of environmental ideology but minimum material requirements for maintaining everyday life. Recognizing this distinction is crucial for designing reconstruction and environmental policies that prioritize justice, autonomy, and collective survival rather than reproducing depoliticized development agendas. Future research should therefore explore how sustainability of necessity operates in other contexts of prolonged political violence and infrastructural warfare, and how environmental governance can support local agency without reinforcing existing structures of domination.

Author Contribution Statement

All authors contributed equally to the conception, design, analysis, and writing of this manuscript. All authors have read and approved the final version of the manuscript.

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Green Finance Without Green Returns? Carbon Compliance, Production Scale and European Steel Export Competitiveness

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ABSTRACT

Purpose – This study examines whether country-level green finance, measured by green bond issuances, translates into measurable improvements in the export performance of the European steel sector, one of the most carbon-intensive and trade exposed industries under the EU's evolving climate regulatory architecture.

Design/data/methodology – The analysis covers 17 European economies over 2015–2024 (N = 170, balanced panel). Panel Quantile Regression (PQR) is employed to capture distributional heterogeneity across the full range of export performance, from the weakest to the most competitive exporters.

Findings –Green bond issuances exert no statistically significant association with steel exports at any quantile, interpreted through a structural temporal mismatch hypothesis. Production capacity is the dominant export driver, with a monotonically declining elasticity from 2.33 at Q10 to 0.75 at Q90. Carbon intensity consistently depresses exports, with a sharply amplified relationship at Q90. Mean-based OLS estimators reverse the sign of the production-export relationship, confirming that quantile regression is a methodological necessity in structurally heterogeneous panels.

Originality/value – This study provides original quantile panel evidence on the green finance, export competitiveness nexus for a major energy intensive sector, addressing a gap at the intersection of sustainable finance, trade economics, and industrial policy. The theorization of the temporal mismatch mechanism, the documented OLS sign reversal, and the differentiated quantile-based policy recommendations constitute contributions to both the green finance literature and the economics of EU carbon market architecture.

Keywords: Green Finance, Green Bonds, Steel Exports, Panel Quantile Regression, Export Competitiveness, Carbon Intensity

Yeşil Finansman, Yeşil Getiri Olmadan Mı? Karbon Uyumu, Üretim Ölçeği ve Avrupa Çelik Sektörünün İhracat Rekabet Gücü

ÖZET

Amaç – Bu çalışma, yeşil tahvil ihracatlarıyla ölçülen ülke düzeyindeki yeşil finansmanın, AB'nin gelişen iklim düzenleyici mimarisi kapsamında en karbon yoğun ve ticarete açık sektörlerden biri olan Avrupa çelik sektörünün ihracat performansında ölçülebilir iyileşmelere dönüşüp dönüşmediğini incelemektedir.

Tasarım/Veri/Yöntem – Analiz, 2015–2024 döneminde 17 Avrupa ekonomisini kapsamaktadır (N = 170, dengeli panel). Panel Kantil Regresyonu (PQR), en zayıf ihracatçılardan en rekabetçi olanlara kadar ihracat performansının tüm dağılımındaki heterojenliği yakalamak amacıyla kullanılmaktadır.

Bulgular – Yeşil tahvil ihracatları, yapısal bir zamansal uyumsuzluk hipotezi çerçevesinde yorumlandığında, hiçbir kantilde çelik ihracatı üzerinde istatistiksel olarak anlamlı bir ilişki göstermemektedir.. Üretim kapasitesi, Q10'da 2,33'ten Q90'da 0,75'e monoton biçimde azalan bir esneklikle baskın ihracat belirleyicisi olarak öne çıkmaktadır. Karbon yoğunluğu ihracatı sürekli olarak baskılamakta olup Q90'da keskin biçimde güçlenen bir etki gözlemlenmektedir. Ortalamaya dayalı EKK tahmin edicileri üretim-ihracat ilişkisinin işaretini tersine çevirmekte ve kantil regresyonunun yapısal olarak heterojen panellerde metodolojik bir zorunluluk olduğunu doğrulamaktadır.

Özgünlük/Değer – Bu çalışma, sürdürülebilir finans, ticaret ekonomisi ve sanayi politikasının kesişimindeki bir boşluğu ele alarak büyük bir enerji yoğun sektörde yeşil finansman ile ihracat rekabet gücü arasındaki ilişkiye yönelik özgün kantil panel kanıtları sunmaktadır. Zamansal uyumsuzluk mekanizmasının teorileştirilmesi, belgelenen EKK işaret terselmesi ve farklılaştırılmış kantile dayalı politika önerileri, hem yeşil finansman literatürüne hem de AB karbon piyasası mimarisinin ekonomisine katkı sağlamaktadır.

Anahtar Kelimeler: Yeşil Finansman, Yeşil Tahviller, Çelik İhracatı, Panel Kantil Regresyon, İhracat Rekabet Gücü, Karbon Yoğunluğu

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1. Introduction

The global expansion of green finance (green bonds, sustainability linked loans, and climate aligned funds) has emerged as one of the defining structural features of contemporary capital markets. Globally, cumulative green bond issuances surpassed USD 3.5 trillion by 2024, with European sovereigns and corporations accounting for the largest regional share of outstanding instruments (Climate Bonds Initiative, 2024). This financial transformation has been accompanied by an equally ambitious policy imperative: the European Union's Green Deal, its Emissions Trading System (EU ETS) now in its most restrictive phase, and most recently the Carbon Border Adjustment Mechanism (CBAM), whose entered its transitional phase on 2023, and enforcement began in January 2026 have collectively created a regulatory architecture that explicitly links financial flows, industrial production costs, and international trade competitiveness. Yet despite the magnitude of these concurrent transformations, a fundamental empirical question remains conspicuously unanswered: does the mobilization of green capital into steel-sector decarbonization strengthen, or at least preserve, export competitiveness?

It is important to note that several key institutional developments; most prominently the full enforcement phase of CBAM and the accelerated withdrawal of EU ETS free allowances, fall outside the study period of 2015–2024. These developments constitute the forward-looking policy context that motivates the research question: as carbon costs escalate and border adjustments take hold, understanding the pre-enforcement relationship between green finance and steel export performance becomes essential for policy design. The findings of this study should therefore be interpreted as establishing a pre-enforcement baseline against which future post-CBAM outcomes can be benchmarked and assessed.

The steel sector occupies a uniquely exposed position at the intersection of climate finance and industrial trade. Responsible for approximately 8–10% of global CO₂ emissions and classified as a hard-to-abate sector by the International Energy Agency (IEA, 2020), it simultaneously represents the largest single commodity group, 69% by weight, covered by CBAM (European Commission, 2025). With Germany, Italy, and France ranking among the world's leading steel exporters, generating annual revenues of over €170 billion (EUROFER, 2023), the question of whether green finance channels capital into steel-sector decarbonization in ways that strengthen or at least preserve export competitiveness carries major implications for both industrial policy and climate finance architecture. The stakes are compounded by the sector's structural exposure to the EU ETS phase-out of free emission allowances, accelerating from 2.5% annual reduction in 2026 to complete elimination by 2034, and by escalating competitive pressure from lower-cost producers in China, India, and Turkey who are not yet subject to comparable carbon compliance obligations.

Despite the rapid growth of empirical literature on both green bond markets and

the economics of the European steel sector, (Costantini (2012), Dechezleprêtre, A (2023), Di Foggia (2024)) their intersection has received remarkably little systematic attention. Existing panel trade studies of European steel focus predominantly on conventional determinants, productive capacity, exchange rate competitiveness, energy costs, and market structure, without incorporating green finance as an explanatory variable. The macroeconomic green finance literature, while increasingly rigorous on corporate environmental and financial performance effects (Flammer, 2021; Fatica and Panzica, 2021), has not extended its analytical framework to the trade competitiveness consequences for capital intensive, hard-to-abate sectors. This paper addresses this gap directly.

We investigate how green finance, measured by country level green bond issuances, (Flammer, 2021; Tang and Zhang, 2020; Fatica and Panzica, 2021), is associated with steel export performance across 17 European economies over 2015–2024, within a Panel Quantile Regression (PQR) framework that captures distributional heterogeneity across the full export performance spectrum. Two features analysis original. First, the explicit focus on green finance, rather than on environmental regulation or industrial policy broadly construed, as the central explanatory variable is new in the panel trade literature on European steel. While the Porter Hypothesis (Porter and van der Linde, 1995) has motivated extensive research on the competitiveness consequences of environmental regulation, the role of green financial markets as a transmission channel between regulatory incentives and real sector outcomes has received far less empirical attention (Hunjra, 2025; Maihaiti, Hunjra, Alharbi and Zhao, 2025). Our study provides original quantile panel evidence on this channel for a major energy intensive sector.

Second, existing research often relies on mean-based estimations, failing to account for the structural heterogeneity inherent in carbon intensive industries. (Fatica, S., and al, (2021), Kim, J, and al, (2022), ElBannan, M. A, and al (2024), Nilsson, A. E, and al, (2025)). The study addresses this by using quantile panel evidence to investigate green finance as the central explanatory variable. It is important to note that Country-level green bond issuances represent the most appropriate proxy for green finance in this analysis. Indeed, green bonds are the dominant instrument through which environmental capital is mobilized in Europe: by 2024, cumulative European issuances exceeded USD 1 trillion, making them the single largest and most traceable channel of climate-aligned finance (Climate Bonds Initiative, 2024). In addition to this, unlike broader green finance indicators, such as ESG fund flows or sustainability-linked loans, green bond proceeds are earmarked for specific environmental projects and subject to third-party certification, providing a more credible and measurable signal of actual green capital deployment (Flammer, 2021; Fatica and Panzica, 2021). Finally, country-level aggregation is theoretically appropriate in this context: sovereign and corporate issuances jointly reflect a national green financial ecosystem: government commitment, private sector appetite, and

institutional capacity, that shapes the overall environment in which steel firms access low-carbon financing.

The study is organized around three formal hypotheses derived from the theoretical framework developed in Section 2. H1: Green bond issuances at the country level show no statistically significant short-run association with steel export performance, consistent with the temporal mismatch hypothesis. H2: Crude steel production capacity is positively associated with export performance, with a declining elasticity across quantiles, consistent with the capacity-driven export hypothesis. H3: Carbon intensity is negatively associated with export performance, with heterogeneous relationship across quantiles reflecting differential exposure to carbon compliance costs.

The remainder of the paper is structured as follows. Section 2 develops the theoretical background and provides a comprehensive, thematically organized literature review that maps the green bond market architecture, the corporate performance effects of green bond issuance, the decarbonizations challenge specific to European steel, the EU carbon regulatory architecture, and the nascent nexus between green finance and trade competitiveness. Section 3 describes the data, variables, and econometric methodology. Section 4 presents results and discussion. Section 5 concludes. Sections 6 and 7 address policy implications and study limitations respectively.

2. Literature review

The intersection of green finance more specifically the green bond market, carbon market architecture, and industrial trade competitiveness has generated three distinct but interconnected bodies of scholarship, each of which informs the present analysis.

2.1. Green bond markets: architecture, performance effects, and the certification nexus

The green bond market has expanded from the European Investment Bank's inaugural issuance in 2007 to over USD 3.5 trillion in cumulative global volume by 2024, underpinned by the ICMA Green Bond Principles (2014) as the de facto governance framework. The canonical empirical contribution is Flammer (2021), whose matched difference-in-differences analysis documents a 27.7% long-run decline in issuer CO₂ emissions following certified green bond issuance, alongside positive cumulative abnormal stock returns of 0.49% at announcement, consistent with a credible environmental signaling interpretation. Critically, these effects are exclusively significant for third-party certified bonds; self-labelled issuances produce no discernible environmental improvement, a finding corroborated by Fatica and Panzica (2021), who document scope 1 emission reductions concentrated in financially material sectors.

The green premium, the pricing advantage conferred by the green label, is real but economically modest (approximately 2 basis points in the European secondary market, (Zerbib, 2019) and is concentrated among large, investment-grade, banking-sector issuers (Fatica, Panzica and Rancan, 2021), raising structural doubts about whether it reliably

benefits capital-intensive industrial issuers.

The corporate performance consequences of green bond issuance are further moderated by managerial and organizational complementarities: De Haas, Martin, Muûls and Schweiger (2024) demonstrate that financial and managerial barriers, costly low-carbon technology, limited patient capital, internal inertia, are the binding constraints on European manufacturing firms' green transitions, while Ordonez-Borrillo et al. (2024) show that environmental performance gains are significantly stronger when senior management commits internal resources to the green bond mandate. Hunjra (2025) theorizes that information asymmetry and credibility signaling are the primary mechanisms through which green capital markets influence real sector decisions, while Yang, Hunjra et al. (2025) demonstrate synergistic interactions between digital economy policies and green investment incentives across both emerging and advanced economies.

2.1. European Steel Decarbonization: Technological Constraints and Financing Requirements

The European steel sector, responsible for 5-7% of total EU greenhouse gas emissions and the largest commodity group covered by CBAM (69% by weight), faces a structural decarbonization challenge that cannot be resolved through incremental efficiency gains. The dominant BF-BOF route generates 1.6–2.0 tCO₂ per tonne of crude steel, and the transition to hydrogen-based direct reduction (H₂-DRI) constitutes the most credible deep decarbonization pathway. Algers, Åhman and Nilsson (2025) conclude that system transformation is required, demanding phased BF-BOF phase-out alongside simultaneous scale-up of EAF and H₂-DRI capacity. Kim et al. (2022), synthesizing 272 studies, find that commercial H₂-DRI viability requires green hydrogen prices below €2/kg, a threshold not yet reached in most European markets.

Fan and Friedmann (2021) quantify the associated cost premium at USD 50–100 per tonne of crude steel over BF-BOF, a structural competitive disadvantage absent carbon pricing or border adjustment. Di Foggia and Beccarello (2024) estimate sector-wide 2030 decarbonization probability at 65-76% depending on corporate commitment, a gap that concessional green finance could theoretically close, while Rinaldi et al. (2024) project steel price increases of 25% by 2030 and 56% by 2050 under scenarios consistent with EU climate targets. Crucially, capital requirements for decarbonizing a single integrated plant range from EUR 2-4 billion (IEA, 2020), far exceeding the scale of individual green bond transactions and implying that aggregate country-level issuances constitute a noisy signal of actual steel-sector green capital formation.

2.2. The EU Carbon Architecture, CBAM, and Distributional Competitiveness Effects

EU ETS Phase IV has tightened the annual linear reduction factor to 4.3%, propelling average carbon prices toward €80/tonne in 2022–2023, with free allowances scheduled for

complete elimination by 2034. Martin et al. (2014) find that free allocation has not significantly undermined regulated firms' economic performance, while Dechezleprêtre, Nachtigall and Venmans (2023) document approximately 11% CO₂ emission reductions among ETS participants, consistent with the Porter hypothesis. Flori, Borghesi and Marin (2024) reveal through quantile regression that ETS financial performance effects are heterogeneous, with lower-tail firms facing the sharpest profitability-carbon tensions, precisely those most in need of green transition financing.

CBAM equalizes the carbon cost faced by EU and foreign steel producers in European markets. Nilsson et al. (2025) find that green hydrogen-based steelmaking achieves EU market cost-competitiveness beginning in 2026, precisely coincident with CBAM enforcement, with transformative implications for comparative advantage. Shuai et al. (2024) confirm through computable general equilibrium modelling that the largest CBAM burdens fall on carbon-intensive producers in India, China, and Turkey, reshaping global steel trade flows in ways that structurally benefit European low-carbon producers.

2.3. Green Finance as a Channel for Industrial Competitiveness

Recent literature identifies several potential mechanisms through which green finance may influence export competitiveness. The investment channel posits that green bond issuances raise capital that finances decarbonization technologies (electric arc furnaces, hydrogen direct reduction, carbon capture) which reduce production costs per unit of carbon and improve the competitive positioning of exporters in markets with high environmental standards. The signaling channel, grounded in Flammer (2021) and Tang and Zhang (2020), suggests that firms or countries with active green bond programs credibly signal to international buyers and supply chain partners a commitment to sustainability, reducing the risk premium they face in procurement decisions and regulatory compliance assessments.

The information channel, elaborated by Hunjra (2025) and Yang et al. (2025), emphasizes that green bond markets aggregate dispersed information about firms' environmental trajectories, potentially improving capital allocation toward the most productive decarbonization strategies. Against these mechanisms, however, a critical countervailing consideration is the temporal mismatch between green finance mobilization and real-sector returns. Green bond proceeds earmarked for steel decarbonizations must pass through a multi-year capital cycle, involving project financing, procurement, installation, commissioning, and operational stabilization, before materializing as lower carbon intensity, improved energy efficiency, or enhanced competitive positioning. Johnson, Åhman, Nilsson and Li (2025) specifically model the steel sector's transition dynamics under the EU ETS and CBAM and show that the capital cycle for transitioning from BF-BOF to H₂-DRI spans ten to fifteen years, far exceeding the temporal window of contemporaneous panel estimators.

Porter and van der Linde (1995) suggest that environmental pressures can push firms to innovate in ways that ultimately improve their competitiveness. Applied here, if green bond proceeds fund new low-carbon technologies in the steel sector, firms may build cost advantages, develop unique production methods, and offer greener products that stand out in international markets, strengthening export performance over time. Costantini and Mazzanti (2012), provide EU-level evidence that carbon intensive production reduces export competitiveness in regulated markets. Three research gaps motivate the present study: no existing panel study treats green finance as an explicit determinant of European steel export performance; formal quantile-based analysis of distributional heterogeneity in steel export determinants is absent from the literature; and the potential for mean-regression sign reversals in this context has not been documented, despite its material policy implications.

3. Data and methodology

3.1. Econometric framework

This study employs Panel Quantile Regression (PQR) as introduced by Koenker (2004) and extended to panel settings by Lamarche (2010) and Harding and Lamarche (2014). PQR estimates the conditional quantile function of the dependent variable given the covariates, rather than the conditional mean. For a quantile $\tau \in (0,1)$, the PQR estimator solves:

$$\beta(\tau) = \operatorname{argmin} \beta \sum_i \sum_t \varrho\tau(\ln(STEXP_{it}) - \alpha(\tau) - X_{it}\beta(\tau)) \quad (1)$$

where $\varrho\tau(u) = u(\tau - 1\{u < 0\})$ is the asymmetric absolute loss function (Koenker and Bassett, 1978) and X_{it} is the vector of regressors. This framework directly addresses the distributional heterogeneity prediction of the theory in Section 2: it reveals how the effects of green finance and the other determinants of export performance differ across the full distribution of exporting countries, from the weakest performers at Q10 to the dominant exporters at Q90. Bootstrap inference uses 1,000 replications following Davidson and MacKinnon (2000), Efron and Tibshirani (1993), and Júnior, Fialho, and Gabriel (2015). The methodological case for PQR over conventional mean-regression estimators rests on two arguments. First, the theoretical reasoning in Section 2 predicts heterogeneous effects: the capacity-driven export hypothesis implies decreasing production elasticities across quantiles, while the temporal mismatch in green finance returns implies a stable null result across the distribution. These are distributional predictions that only PQR can test formally. Second, the empirical distribution of all key variables is heavily right-skewed (Table 3), a pattern that renders OLS inefficient and sensitive to leverage points.

3.2. Model Specification

The baseline panel quantile regression model takes the form:

$$Q\ln(STEXP_{it})(\tau \mid X_{it}) = \alpha(\tau) + \beta_1(\tau) \cdot \ln(STPROD_{it}) + \beta_2(\tau) \cdot \ln(GRENFIV_{it}) +$$

$$\beta_3(\tau) \cdot \ln(REER_{it}) + \beta_4(\tau) \cdot \ln(CRBIN_{it}) + \varepsilon_{it}(\tau) \quad (2)$$

where $STEXP_{it}$ denotes steel exports (thousands of USD); $\tau \in \{0.10, 0.25, 0.50, 0.75, 0.90\}$ is the quantile index; $STPROD_{it}$ is crude steel production (thousands of tonnes); $GRENFIV_{it}$ represents country-level green bond issuances (billion USD), the central variable of interest; $REER_{it}$ is the real effective exchange rate index (base 2010 = 100); and $CRBIN_{it}$ is carbon intensity (tCO₂ per tonne of steel). All variables enter in natural logarithms, so the estimated coefficients are interpreted directly as elasticities. Country fixed effects are absorbed into the quantile-specific intercept $\alpha(\tau)$.

3.3. Variable definitions and data sources

Steel exports ($STEXP$) are measured in thousands of USD (annual flows) sourced from the World Integrated Trade Solution (WITS). This measure aggregates across product categories within the steel sector and captures actual export revenues, providing a comprehensive summary of export performance. Country-level green bond issuances ($GRENFIV$) are sourced from the IMF Climate Finance Database and measured in billions of USD. We argue that this country-level measure appropriately captures green finance capacity for three reasons articulated in Section 2.5: sovereign green bonds signal government commitment to the ecological transition; corporate issuances reflect private sector appetite for green capital; and the cross-country variation is substantial (standard deviation of USD 14.79 billion against a mean of USD 9.22 billion, see table 3), reflecting genuine differences in green financial ecosystem development. We explicitly acknowledge that country-level issuances are not equivalent to steel-sector-specific capital formation.

Table 1. Variables of the study and sources

Variable	Code	Measurement	Source
Steel exports (dependent)	STEXP	Thousands of USD (annual)	World Integrated Trade Solution (WITS)
Steel production	STPROD	Thousands of tonnes (crude steel)	World Steel Association (WSA)
Green finance	GRENFIV	Green bond issuances (billion USD)	IMF Climate Finance Database
Real eff. exc. rate	REER	Index, 2010 = 100	World Bank
Carbon intensity	CRBIN	ETS emissions / crude steel output (tCO ₂ /t)	Tax Foundation Europe; WSA ; Vidovic et al. (2023)

Note: Sample: 17 European countries, 2015–2024 (N = 170, balanced panel). All variables enter in natural logarithms.

Carbon intensity ($CRBIN$) is computed as the ratio of ETS-verified sector emissions to crude steel output (tCO₂ per tonne), following the methodology of Vidovic, Marmier, Zore, and Moya (2023). This measure captures both the environmental performance of producers and their exposure to carbon compliance costs under the EU ETS and CBAM. The Real Effective Exchange Rate ($REER$, World Bank, base 2010 = 100) captures macroeconomic price competitiveness. Steel production ($STPROD$) proxies' productive capacity (World Steel Association), constituting the supply-side anchor of the model

motivated by the capacity-driven export hypothesis.

Table 2. Sample composition by export category

Large Exporters (High)	Medium Exporters	Small Exporters
Germany, Italy, France	Portugal, Poland, Hungary, Czech Republic, Netherlands, Austria, Belgium, Spain	Greece, Slovenia, Slovak Republic, Romania, Finland, Sweden

Note: Classification based on average crude steel output over the 2015–2024 sample period.

Table 3. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
STEXP (000 USD)	7075.33	13640.73	3.33	72694.78
STPROD (000 tonnes)	8430.40	9553.35	240.00	43400.00
GRENFIV (bn USD)	9.22	14.79	0.015	81.63
REER (index)	95.92	6.62	82.26	125.87
CRBIN (tCO ₂ /t)	0.85	1.23	0.06	15.69

Source: compiled by the author. Note: N = 170 (17 countries × 10 years). All variables exhibit right-skewed distributions, providing methodological justification for PQR over OLS.

4. Empirical results and discussion

4.1. Main quantile regression estimates

Table 4 presents the panel quantile regression results across five quantile levels ($\tau = 0.10, 0.25, 0.50, 0.75, 0.90$), with OLS and fixed-effects estimates provided for comparative reference. The overall pattern of results is strikingly consistent with the theoretical predictions developed in Section 2: a monotonically declining production elasticity, a stable near-zero coefficient for green finance across the entire distribution, a U-shaped carbon intensity effect with amplification at the extremes, and exchange rate sensitivity concentrated at the lower quantiles. The discussion proceeds variable by variable.

Table 4. Panel quantile regression results and mean-regression benchmarks

Variable	Q10	Q25	Q50	Q75	Q90	OLS	FE
ln(STPROD)	2.330*** (0.180)	1.939*** (0.196)	1.050*** (0.233)	1.060*** (0.146)	0.745*** (0.178)	−0.473* (0.285)	−0.473* (0.285)
ln(GRENFIV)	−0.004 (0.128)	0.018 (0.091)	0.083 (0.080)	−0.092 (0.108)	0.038 (0.063)	0.030 (0.056)	0.030 (0.056)
ln(REER)	8.863** (3.739)	5.786** (2.866)	1.693 (3.639)	−1.197 (2.243)	1.193 (1.648)	2.297* (1.334)	2.297 (1.334)
ln(CRBIN)	−1.545*** (0.262)	−1.306*** (0.218)	−0.750** (0.246)	−0.484** (0.155)	−4.069*** (0.238)	−0.508** (0.256)	−0.508** (0.256)
Constant	−24.212*** (7.671)	−16.295*** (5.967)	−4.094 (7.896)	−0.484 (0.155)	−1.346 (3.328)	0.254 (3.174)	0.254 (3.174)
N	170	170	170	170	170	170	170

Source: author's calculations. Notes: Bootstrapped standard errors (1,000 replications) in parentheses for Q10–Q90; robust standard errors for OLS/FE. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2. Green finance and export performance: Interpreting the structural temporal mismatch

The central empirical finding for GRENFIV is that green bond issuances are statistically

insignificant at all five quantile levels and in both mean-regression specifications. Point estimates fluctuate narrowly around zero across the distribution from -0.092 at Q75 to +0.083 at Q50; and no coefficient approaches conventional significance thresholds. This uniform insignificance across the full distribution, confirmed by the slope equality tests in Table 5 (all p-values > 0.46 for GRENIV across all quantile pairs), is itself a substantively important result that requires careful and theoretically grounded interpretation.

We advance three complementary interpretations. The primary interpretation invokes the temporal mismatch hypothesis developed in Section 2.5. The pathway from green bond issuance to steel export competitiveness involves at minimum: (i) allocation of bond proceeds to steel-sector eligible projects, a step that, as documented by the Climate Bonds Initiative (2022), occurs infrequently given the dominance of renewable energy, building efficiency, and transport in green bond proceeds allocation; (ii) procurement and installation of decarbonization capital equipment; (iii) operational stabilization of new production processes; and (iv) market recognition and pricing of enhanced environmental credentials by international buyers. This sequence unfolds over five to fifteen years in the steel industry (Johnson et al., 2025; IEA, 2020), far beyond the contemporaneous and one-period relationships that the current panel structure can capture.

The second interpretation concerns the sectoral allocation structure of European green bond markets during 2015–2024. Although aggregate issuances grew rapidly, from under USD 50 billion annually to over USD 300 billion by 2023, the allocation of proceeds to steel-sector industrial applications remained limited. The bulk of certified green bond financing in Europe flowed to renewable energy generation, building efficiency, sustainable transport, and water infrastructure. Proceeds earmarked specifically for industrial decarbonization, particularly for the high-cost, high-risk processes of hydrogen-based steelmaking, constituted a small fraction of the total. This structural gap in green finance architecture, documented by the OECD (2024) and the Climate Bonds Initiative (2022), implies that country-level green bond issuances constitute a noisy measure of steel-sector green capital formation, producing downward-biased estimates of the true (long-run) relationship.

The third interpretation concerns the signaling channel. For the signaling mechanism to generate near-term export gains, international buyers and supply chain partners must actively update their procurement preferences in response to a country's green bond market activity. This behavioral shift is contingent on the maturation of green procurement standards, most prominently the EU's Corporate Sustainability Reporting Directive (CSRD) and the Science Based Targets initiative (SBTi), that were still in early stages of market penetration during the sample period. As Hunjra (2025) notes, the effectiveness of the signaling channel depends on the quality of green bond certification standards and the sophistication of buyer screening frameworks, conditions that were not yet fully operative in European steel markets during 2015–2024.

In sum, the null result for green finance contains a precise and policy-actionable message: the current architecture of European green bond markets is insufficiently connected to steel-sector decarbonization investment to generate measurable near-term export benefits. This finding does not refute the potential for green finance to matter in the longer run; rather, it identifies a structural gap between green financial market activity and industrial transformation that policy design must urgently address. We confirm then our first hypothesis.

4.3. Production capacity and the capacity driven export hypothesis

Steel production capacity is the dominant and universally positive determinant of export performance across all five quantile levels, with the estimated production elasticity declining monotonically from 2.33 at Q10 to 0.75 at Q90 exactly consistent with the capacity driven export hypothesis and the diminishing marginal returns to scale predicted by New Trade Theory for countries approaching industrial maturity. The Wald equality test (Table 5) confirms that the slope difference between Q10 and Q90 is statistically significant at the 1% level ($Z = 6.298$, $p < 0.001$), validating the distributional pattern rather than attributing it to sampling variability.

For low-exporting countries at Q10, a one percent increase in crude steel production is associated with a 2.33-percent increase in exports, suggesting that productive capacity functions as a binding constraint: these economies export close to their feasible maximum given current production volumes, and any expansion of output directly translates into higher export flows. For top exporters at Q90, (Germany, Italy, France), the same production expansion generates a 0.75-percent export increase, reflecting the fact that large producers' export volumes are constrained primarily by demand-side factors, (global market saturation, long-term buyer contracts, product specialization in value-added steel grades), that cannot be relaxed by additional capacity alone. These findings closely align with Bassanini, Scarpetta and Hemmings (2015) and Martins and Yang (2009), who document stronger capacity effects for smaller and less-established exporters. The results confirm the second hypothesis.

The contrast with OLS and fixed-effects results is the most striking methodological finding of this study. Both mean-based estimators yield a negative and marginally significant coefficient for production (-0.473 , $p < 0.10$), reversing the sign of all quantile estimates. This sign reversal arises because OLS is sensitive to leverage effects generated by a small number of large, specialized exporters, for whom production volumes are partially supply-push (driven by excess capacity) rather than demand pull, creating a spurious negative association in the pooled regression. The panel quantile estimator, which is robust to such leverage effects, recovers the true positive relationship across the distribution. This sign reversal is not a minor statistical nuance: it implies that policymakers relying on OLS estimates would conclude, incorrectly, that capacity

expansion is detrimental to export performance, a potentially costly policy error with direct consequences for industrial and trade policy design.

4.4. Carbon intensity and environmental competitiveness

Carbon intensity is a consistent and statistically significant drag on steel export performance at all five quantile levels. The estimated elasticity exhibits a U-shaped pattern: large and negative at Q10 (-1.55) and Q25 (-1.31), moderating toward the center of the distribution (-0.75 at Q50, -0.48 at Q75), and then surging to -4.07 at Q90. The Wald tests confirm significant slope heterogeneity for carbon intensity between Q25 and Q75 ($p = 0.003$) and between Q10 and Q50 ($p = 0.028$), validating that this non-monotonic pattern is statistically robust.

For low-exporting countries at Q10-Q25, the negative effect of carbon intensity reflects direct cost and market access mechanisms: carbon-intensive production raises unit costs through EU ETS compliance obligations, reduces eligibility for green procurement programs, and limits access to European supply chains adopting scope-3 emissions standards. These mechanisms align with the empirical evidence of Costantini and Mazzanti (2012), who document that carbon-intensive EU producers face export competitiveness penalties in environmentally regulated markets.

For top exporters at Q90, the dramatically amplified coefficient (-4.07) reflects the premium that environmental performance commands in the most competitive tier of global steel markets. Europe's largest steel exporters operate primarily in high-value, differentiated steel markets where buyers pay a premium for environmental credentials and are willing to switch suppliers in response to carbon performance differences. This finding is consistent with the CBAM impact analysis of Shuai et al. (2024), who document that carbon compliance costs reshape competitive positions most acutely at the premium end of the global steel market, and with Nilsson et al. (2025), who show that environmental performance is becoming a decisive competitive factor as CBAM enforcement reshapes the cost arithmetic of European steel imports. The magnitude of the Q90 coefficient, while large, is theoretically coherent and directionally robust, though appropriate caution is warranted pending robustness analyses excluding specific high-carbon country-years. These findings confirm the third hypothesis.

4.5. Real effective exchange rate

The REER exerts a positive and statistically significant effect at Q10 (8.86) and Q25 (5.79), but is insignificant at Q50, Q75, and Q90. This pattern precisely confirms the Berman, Martin and Mayer (2012) theoretical prediction: exchange rate pass-through is highest for small, undiversified exporters and negligible for large producers that exercise pricing power in international markets. The large Q10 coefficient suggests that for the weakest steel exporters, (Greece, Slovenia, the Slovak Republic), real currency movements

constitute a dominant short-run competitive factor, underscoring their macroeconomic vulnerability relative to capacity and environmental constraints. For large exporters, exchange rate insensitivity reflects the market power embedded in specialized, differentiated product portfolios that command premium prices regardless of short-run currency movements.

4.6. Tests of quantile slope equality

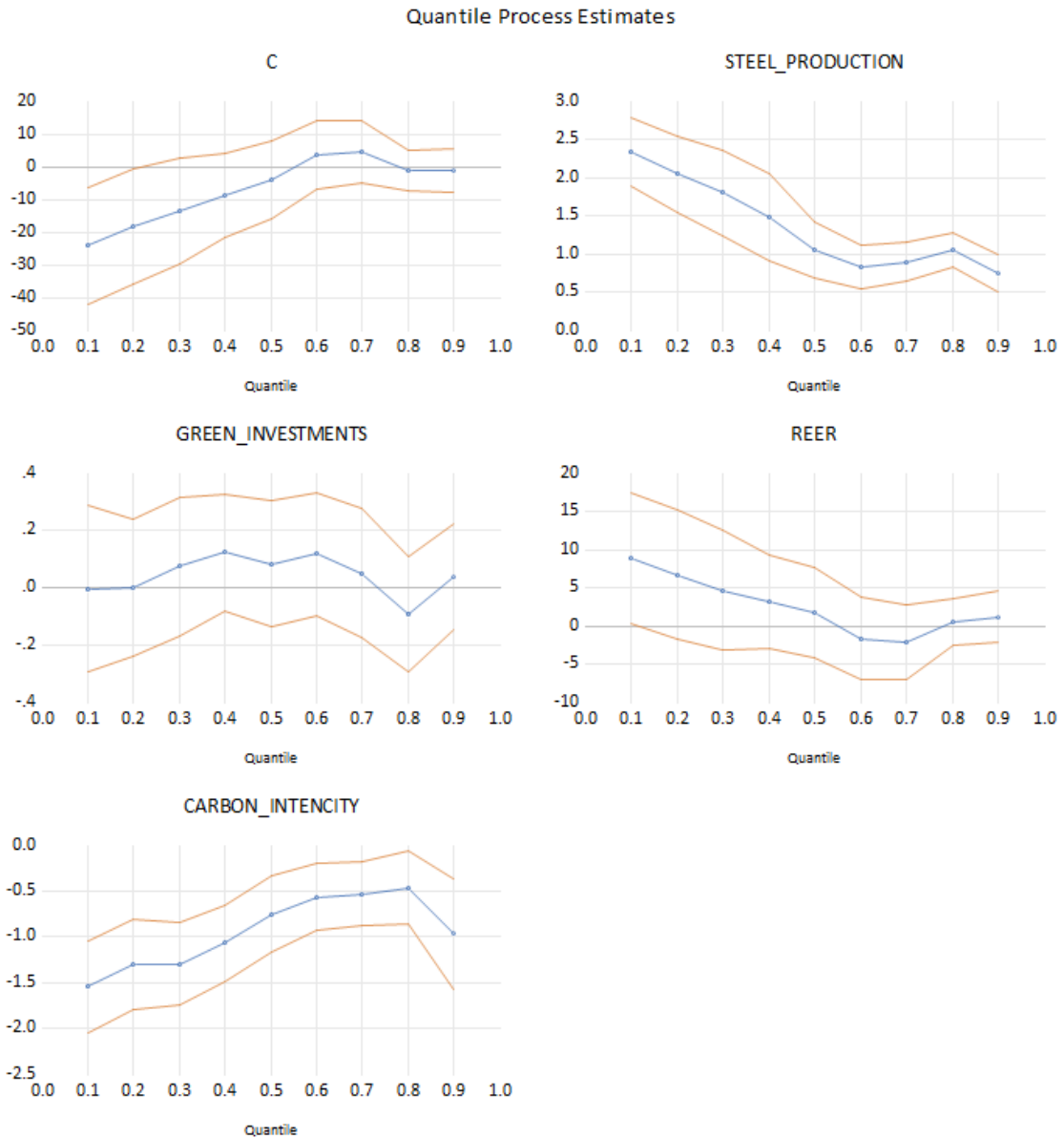
The Wald tests confirm statistically significant slope heterogeneity for production (Q10 vs Q90: $Z = 6.298$, $p < 0.001$) and carbon intensity (Q25 vs Q75: $p = 0.003$; Q10 vs Q50: $p = 0.028$). Green finance shows no significant slope differences across any quantile pair (all $p > 0.46$), confirming that the short-term null result is stable and homogeneous across the distribution, not merely an average of positive and negative effects that cancel out. This result strengthens the temporal mismatch interpretation: the absence of green finance effects is pervasive, not confined to specific segments of the export distribution, and is consistent with a structural and systematic feature of the green bond–steel sector relationship rather than a distributional artefact.

Table 5. Wald tests of slope equality across quantile pairs

Variable	Q10 vs Q90	p	Q25 vs Q75	p	Q10 vs Q50	p	Q50 vs Q90	p
ln(STPROD)	6.298	0.000***	3.383	0.001***	4.441	0.000***	1.063	0.288
ln(GRENFIV)	−0.289	0.773	0.726	0.468	−0.569	0.570	0.440	0.660
ln(REER)	1.748	0.080*	1.889	0.059*	1.351	0.177	0.132	0.895
ln(CRBIN)	−1.606	0.108	−2.996	0.003***	−2.203	0.028**	0.656	0.512

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Z-statistics based on bootstrapped (1,000 replications) standard errors. Source: author's calculations.

The Figure 1 represents the Quantile Process Estimates, displaying quantile-specific coefficient paths for $\ln(\text{STPROD})$, $\ln(\text{GRENFIV})$, $\ln(\text{REER})$, and $\ln(\text{CRBIN})$ across $\tau \in \{0.05, 0.10, \dots, 0.95\}$ with 90% bootstrap confidence bands and horizontal OLS/FE reference lines. Of particular interest is the flat near-zero path of $\ln(\text{GRENFIV})$ with narrow confidence bands, visually confirming the stable null result across the distribution, and the monotonically declining path of $\ln(\text{STPROD})$ confirming the capacity-driven export hypothesis.

Figure 1. Quantile process estimates.

Source: Compiled by the author

5. Policy Implications

The empirical findings of this study generate a differentiated set of policy implications, directed at distinct tiers of the European steel sector and at the design of green finance regulatory instruments. Three directions are identified.

First, sector-targeted green finance instruments are urgently needed. Generic sovereign or corporate green bonds whose proceeds flow primarily to renewable energy and building efficiency are structurally unlikely to accelerate steel decarbonization at the

pace and scale required. The EU's Innovation Fund and Just Transition Fund should expand eligibility criteria and co-financing structures to provide specific, competitive financing windows for large scale steel decarbonization projects, electric arc furnaces, hydrogen direct reduction units, and carbon capture utilization, and storage (CCUS) infrastructure. The European Investment Bank's industrial decarbonization lending facilities should be scaled up and made more accessible to mid-sized European producers, who may lack the balance sheet strength to access green bond markets at investment grade terms. The EU Green Bond Standard's taxonomy-linked thresholds for steel (primary steel below 0.4 tCO₂/tonne) should be accompanied by transition finance provisions that reward producers on a credible decarbonization pathway rather than only those who have already achieved best-available-technology performance.

Second, longer-horizon evaluation and incentive frameworks are required. The evidence that green finance effects in the steel sector materialize over five to fifteen years implies that incentive structures must be calibrated to this temporal profile. Investment tax credits, accelerated depreciation for green capital expenditures, performance linked green bonds with deferred coupon structures, and long duration contract for difference mechanisms for green hydrogen supply should be designed to reduce the effective cost of capital for investments whose competitive benefits will not appear in near-term balance sheets or contemporaneous panel datasets. Evaluation frameworks for the EU's Innovation Fund and CBAM revenues should incorporate appropriate temporal lags and counterfactual analysis before drawing conclusions about the effectiveness of green finance instruments.

Third, differentiated industrial and trade policies should reflect the quantile heterogeneity documented in this study. For small and medium exporters at Q10-Q25, concentrated among Central and Eastern European producers, capacity development programs, access to the EU Innovation Fund for initial decarbonization projects, and exchange rate stabilization through Currency Risk Management Guarantees from the European Fund for Strategic Investments deliver the largest marginal export returns per policy euro. For large exporters at Q90, environmental performance is the strategic imperative: accelerated CBAM enforcement with rising reference carbon prices, robust EU ETS pricing above €80/tonne, supply chain transparency requirements under the CSRD, and demand side premiums through public procurement criteria favoring verified low-carbon steel will strengthen the competitive position of Europe's decarbonization leaders and create the market signals necessary to justify long duration green bond issuances at industrial scale. A final policy consideration concerns the Brussels Effect (Bradford, 2020): by projecting EU carbon standards onto trading partners through CBAM, the European regulatory architecture creates incentives for third-country producers to align with EU environmental standards, an externality that, if realized, would ultimately expand the competitive space for European green steel producers in global markets.

6. Limitations and Future Research

This study is subject to several limitations that simultaneously define a productive and policy relevant research agenda. The most significant concerns endogeneity: steel exports and production are jointly determined; export success may attract green finance and facilitate decarbonization; and carbon intensity may be endogenous to export orientation and market positioning. Panel quantile regression assumes conditional exogeneity; the results should be interpreted as associations rather than causal effects. Future research should explore lag-structure specifications to capture the temporal mismatch mechanism directly, external instrumental variables exploiting variation in EU Taxonomy adoption timelines or CBAM certificate price shocks, and panel VAR frameworks accommodating feedback between exports, production, and environmental performance variables.

The proxy for green finance, country-level green bond issuances, captures aggregate financial market activity rather than steel-sector-specific capital formation. Future research with sector disaggregated green finance data-plant-level capital expenditure in decarbonization infrastructure drawn from EU ETS registry, CBAM declarant level data, and commercial databases such as Bloomberg NEF or the Climate Bonds Initiative's project database, would permit more targeted inference about the green finance, export competitiveness channel and would directly test the structural gap hypothesis advanced in Section 4.2. The increasing granularity of CBAM reporting requirements, which will generate novel plant-level emission intensity data for both EU and non-EU producers beginning in 2026, represents a potentially transformative data infrastructure for this research program.

The 2015-2024 sample encompasses three major structural disruptions, Brexit (2016-2020), the COVID-19 pandemic (2020-2021), and the 2022 Russia-Ukraine energy crisis, each of which generated idiosyncratic shocks to European steel production, energy costs, and trade flows. Sub-period robustness checks separating the pre-COVID (2015-2019) and post-COVID recovery and energy crisis (2020-2024) periods would clarify whether the estimated slopes are driven by specific episodes rather than structural relationships. Additionally, the country-level analysis aggregates over firms with heterogeneous technologies, product mixes, and export orientations: a firm or plant-level quantile analysis drawing on matched EU ETS registry, COMEXT trade, and financial data would reveal mechanisms invisible in country-level aggregates and represents the highest priority extension of this work. Wavelet coherence analysis, recently applied to fiscal policy and macroeconomic growth questions, offers a complementary time-frequency methodology suited to examining the dynamic co-movement between green bond market indicators and European steel export performance across multiple policy cycles.

6. Conclusion

This study investigates the heterogeneous effects of green finance on European steel export dynamics using Panel Quantile Regression across 17 countries and the period 2015–2024. By centering the analysis on green bond market activity operationalized as country-level green bond issuances, as the primary variable of interest, and embedding this within a comprehensive theoretical framework that integrates green bond market theory, New Trade Theory, Porter's innovation offset hypothesis, and the economics of EU carbon market architecture, the paper addresses a gap at the intersection of sustainable finance, trade economics, and industrial policy that the existing literature has left substantially unexplored.

The central finding: that green finance does not exhibit a statistically significant short-term effect on steel export performance at any quantile level, is interpreted not as evidence of green finance's irrelevance to industrial decarbonization, but as revealing a structural temporal mismatch between green capital market activity and real-sector industrial transformation. This mismatch operates through three channels: the long investment cycle of steel decarbonization (10–15 years, per Johnson et al., 2025); the structural misalignment between aggregate green bond proceeds allocation, dominated by renewable energy, building efficiency, and transport, and steel-sector capital requirements; and the early-stage maturation of green procurement standards that would allow the signaling channel to generate near term competitive returns. Together, these channels imply that the absence of a short-term effect is a structurally motivated, theoretically coherent finding that carries its own policy message.

Beyond the green finance result, the study produces three additional contributions. First, production capacity is the dominant export driver, with a monotonically declining elasticity from 2.33 at Q10 to 0.75 at Q90, confirming the capacity-driven export hypothesis and identifying diminishing marginal returns as the primary source of distributional heterogeneity in the panel. Second, mean-based OLS and fixed-effects estimators reverse the sign of the production–export relationship, providing direct methodological evidence that panel quantile regression is not merely a refinement but a necessity in panels with pronounced structural heterogeneity spanning countries as diverse as Germany and Slovenia. Third, carbon intensity consistently depresses exports across all quantiles, with a particularly powerful effect at the top of the distribution (−4.07 at Q90), consistent with the growing environmental compliance premium in global steel markets and the accelerating effect of CBAM enforcement.

The study's findings are timely: as CBAM entered its enforcement phase in January 2026 and EU ETS free allowances are progressively withdrawn, the green finance–competitiveness nexus documented here will become increasingly consequential

for European steel producers, their downstream buyers, and the industrial communities in which they operate. Understanding whether and how green financial markets can be made to effectively channel capital into the steel sector's decarbonization will be one of the defining empirical and policy questions of the coming decade.

Conflict of Interest

The author declares that there are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical Approval

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