



INTERNALIZING EXTERNALITIES TOWARDS SUSTAINABLE ECONOMIC GROWTH: ENVIRONMENTAL REGULATIONS VS GREEN TECHNOLOGY ADOPTION

Shaffaq Shaffaq

Research Scholar, Government College University, Lahore, Pakistan,

Email: shaffaq112@outlook.com

Dr. Alvina Sabah Idrees

Assistant Professor, Government College University, Lahore, Pakistan,

Email: alvinasabah@gcu.edu.pk

Muhammad Khalid Rashid

Professor of Economics, Government Graduate College of Science, Lahore, Pakistan,

Email: krkhan55@gcslahore.edu.pk

Abstract

The interaction of economic growth and environmental sustainability has become a leading concern for policymakers, businesses, and societies worldwide in the 21st century. In this regard, it is pivotal to design effective policies by understanding the interaction between environmental regulation and green technology adoption. The present study undertakes environmental regulations such as environmentally adjusted multifactor productivity growth and environmental related tax revenue with green technology adoption factors such as patents for development of environmental related technologies, share of renewable energy in gross final energy consumption by sector to determine the environmentally adjusted multifactor productivity growth. This study is conducted for 18 selected European Union countries. Panel econometric techniques are applied to underscore the empirical analysis while using a macro-level data that based on 15 years (2004-2018). The econometric techniques Driscoll-kraay and Prais-Winsten robust to heteroscedasticity and serial correlation are applied. The empirical results of the data show that environmental policy stringency index, environmental taxes, patents and increasing share of renewable energy has positively increase the environmentally adjusted multifactor productivity growth. The study provides strong evidence that patents, renewable energy, environmental taxation, regulatory quality control, and good governance effectiveness are significant drivers of Environmentally Adjusted Multifactor Productivity Growth.

Keywords: *Environmentally adjusted multifactor productivity growth, Environmental policy stringency index, Environmental taxes, Patents*

1. Introduction

The coupling of economic growth and environmental sustainability has become a leading concern for policymakers, businesses, and societies worldwide in the 21st century. The internalization of environmental externalities costs or benefits emerging from economic activities is one of the most signifying challenges in this nation that are not mirrored in market prices and society does not tolerate them at large. The decision-making processes of businesses and governments must interfuse these externalities that are pivotal to boost sustainable economic growth. As stated by the Porter Hypothesis, High EPSI values create pressure for firms to invent and obey with regulatory standards more efficiently. Environmentally adjusted multifactor productivity increases by the innovation which often includes the adoption of new technologies and practices that meet environmental requirements (Rehman et al., 2020; Wang & Manopimoke, 2023; Marc et al., 2025; Ali et al., 2025; Naeem et al., 2025). For instance, Porter and van argued that technological advancements that improve both economic performance and



environmental outcomes could lead by stringent environmental regulations in 1995. Horbach (2008) also found that improving productivity performance leads to stringent environmental policies which in result motivate firms to adopt greener technologies.

Empirical research supports the positive impact of green technology adoption on productivity and sustainability. According to Jaffe and Palmer in 1997 revealed that to achieve higher productivity it will come up with increased research and development spending and technological advancements by fostering eco-innovation. While, according to Berman and Bui in 2001 found that to improve both environmental and economic performance, firms drive to invest in cleaner technologies by pollution taxes and associated incentives.

A thorough analysis of environmental regulation and green technology adoption includes appraising how both approaches influence EMPG and contribute to boost sustainable economic growth. In response to regulatory pressure environmental regulations make incentives for the firm so they can innovate, while energetically integrating sustainable practices are focused by green technology adoption (Singh & Kumar, 2023; Jamel & Zhang, 2024; Marc et al., 2025; Batool et al., 2025; Khalid & Abdul, 2025).

To boost sustainable economic growth, it is pivotal to design effective policies by understanding the interaction between environmental regulation and green technology adoption (Ali et al., 2025). Policymakers and businesses can attain significant refinement in Environmentally Adjusted Multifactor Productivity Growth (EMPG) by combining the principles of the hypothesis of Hypothesis, that demonstrate that environmental regulations can drive innovation and increase productivity, with the energetic adoption of green technologies. Economic efficiency and competitiveness and addressing environmental challenges are also promoted with this approach. For paving the way for a more sustainable and thriving future the intuition gained from this analysis can guide policy decisions and support efforts to balance environmental protection with economic development.

2. Literature Review

Wei Yang et al analyzed interaction of digitalization, technological innovation, and green economic development with Each Other, Towards Sustainable Development in 2022. For this purpose, a panel analysis is done using data from 30 provinces of China. To pragmatically test their alliance and degree of ascendancy they constructed the PVAR model. Their findings predict that there is an immobilized enlargement and self-bolstering appliance between the three variables. They assume a positive advertising effect of green economic development on digitalization while technological innovation had an insignificant impact on green economic development. In the short term the impression of economic development that is green on innovation in technology has a positive publicity effect, but in the long run this effect cautiously lessens and inclined to zero. Finally, a few pragmatic propositions are made based on the findings. Noordwijk et al examined five levels of internalizing environmental externalities basically it is a decision making root on influential and complementary values of nature in 2023. He found that certain values depending on the anticipated communal and environmental effects of actions are deemed significant and allow for consideration while others are not considered as decision externalities. He examined two different categories of decision externalities as unanticipated consequences and anticipated effects that go beyond the concern of group decision-makers. No data was used for this research. The study proclaims that none of the work disclosed in this publication may have been influenced by any known conflicting financial interests or personal ties.

Yu in 2023 examine the sequel of pressure on green technology innovation by economic growth. Also focuses on the view that ecological standards, public assistance, and monetary progress. He glanced at encouraging green growth and lowering negative externalities and how improving green technology is



essential for this purpose. It is important to find out how pressure of economic growth (EGP) affects green technological innovation (GTI) for aligned growth of economy and green transformation. Data had been taken from 285 Chinese cities for a time between 2006 and 2018. Germanized least squares (GLS) have been employed for analysis. According to the heterogeneity research, western China is particularly affected negatively by EGP when compared to the country's eastern and central areas. Moreover, to identify different indiscriminate die down effects between EGP and GTI we use a panel threshold model. EGP rising with a transpose U-shaped link between EGP and GTI.

Rodríguez et al, analyzed in 2018 the methodology for environmentally adjusted multifactor productivity and factual results specifically for OECD and G20 Countries. For environmental services he holds forth the inquisitive configuration for measuring multifactor productivity. The contributions for growth computing by labor, fabricate capital, and instinctive capital is broken down into pollution-adjusted measure of production growth. Using this technique, it is possible to more accurately evaluate the drivers of economic growth and its long-term. For this research the exploitation of subsurface natural resources, the outpouring of pollutants of air and greenhouse gases had been taken from OECD and G20 nations for the data of the years 1990–2013. The key conclusions indicate that while BRIICS nations to produce additional growth have mostly count

on higher use of factor inputs, OECD countries to generate growth have mostly count on productivity increases. Saudi Arabia, Chile, and Russia has resulted in a considerable increase in their natural capital by the extraction of subsurface resources. like. Throughout the past 20 years, most of the OECD nations have really lowered their emissions and because of their efforts to reduce pollution, which result in increase of their GDP growth rates, making it possible to for them to evaluate their economic success more accurately. The findings also show ecologically friendly industrial methods are now adopted by several nations.

OECD (2017) provides a detailed analysis of how eco-innovation affects productivity growth in member countries. According to the paper, both market forces and regulatory incentives can motivate investments in green technology that result in notable increases in productivity. The study highlights the importance of promoting sustained economic growth and how determining it is to combine eco-innovation outputs, like technical patents, and inputs, such R&D expenditure. The OECD paper shows that nations with robust eco-innovation policies typically have a higher level of productivity growth through cross-country data analysis, which is consistent with the more general idea of sustainable economic development.

Lanoie et al (2011) expand on the Porter Hypothesis by empirically examining the effects of environmental regulations on productivity across various industries. More eco-innovation and productivity gains are linked with stricter environmental regulations. According to the study, empowering by more regulations can lead to innovation and doing better financially businesses. If environmental laws are intended to boost innovation rather than merely impose compliance costs this bolsters the notion that they can increase production.

Costantini and Crespi (2008) explored the relationship between environmental taxes and eco-innovation, focusing on how fiscal instruments can influence green technological advancements. Their study finds that to boost green technology adoption environmental taxes and government funding must work together. Over time, this combination helps to increase production along with promotion of eco-innovation. Their study supports the idea that by emphasizing achieving sustainable economic growth they need to combine fiscal policies with innovation initiatives. well- designed environmental taxes may increase major improvements in green technology.

Gibbs (2020) investigates the role of environmental policy in shaping corporate strategies towards



sustainability and its subsequent impact on productivity. The study reveals that despite the early expense's firms are likely to implement sustainable practices who want to increase productivity over time and that are subject to stringent environmental restrictions. By examining data from several industries, Gibbs shows for increasing overall productivity and promoting long-term economic growth regulatory frameworks may encourage businesses to innovate and streamline the way they operate. This study emphasizes motivating businesses to match their operations with environmental objectives is crucial for policy making.

Popp (2006) examines how environmental regulations influence technological change and economic performance. According to the study, policies that support green technology bring a notable increase in productivity. This study supports the idea that environmental regulations may indicate technical advancement and, in turn, promote sustainable economic growth. Popp focuses more on the idea that more stringent environmental regulations in different areas help to examine data of patents and innovation output and also focuses on how innovation in technology helps more likely to use to foster.

Zhang and Zhou (2021) appraise the impact of regulations on the environment and eco-innovation on productivity in developing countries. According to their research, those that make eco-innovation investments enjoy notable increases in production, but it is difficult for poor countries to ensure strict environmental regulations. Zhang and Zhou examined data for developing countries and stated that even in less developed countries, focused environmental regulations and support for green technology may provide substantial economic benefits. This study finds to promote economic growth in a variety of contexts innovative and sustainable practices may be used by environmental policy.

3. Conceptual Framework

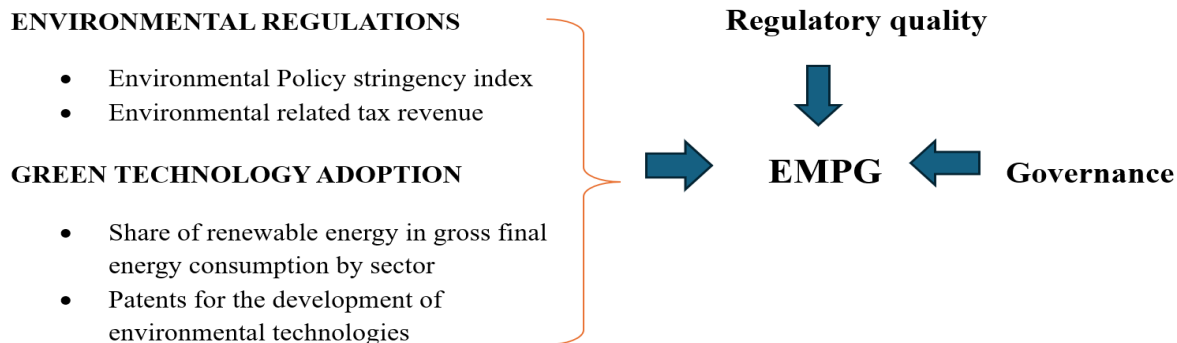
According to Porter's theory, financial savings, improved resource use, and competitive advantages businesses are the results of incumbents innovate by regulations frequently implementing green technology and fostering environmental efficiency. When environmental considerations are taken into discussion, the productivity of the economy or company boosts, resulting in higher Environmentally Adjusted Multifactor Productivity Growth (EMPG). This technique is supported by studies like Porter and van der Linde (1995), which mainly focus how environmental impact in the long run can be reduced by introducing different laws which may promote innovation.

According to the Porter Hypothesis (Porter & van der Linde, 1995), as is due crafted environmental laws can induce innovation and increase competitiveness. This theory holds that strict rules can encourage innovation by businesses, resulting in cleaner and more effective technologies that raise overall production.

In this circumstance of the Porter Hypothesis, the center of environmental regulation and productivity is eco-innovation. When we lower the environmental impact, it will increase productivity which helps in generating growth. In the research done by Acemoglu et al. in 2012 they argued that in order to attain economic persistence and sustainability in the long run the essential measure is investments in green technologies.

Research done by Jaffe et al in 2005 highlights that to alleviate the environmental impact patent activity is a responsible indicator of a country's duty to advance technologies. The degree of commitment to sustainable practices within an economy is reflected by the share of renewable energy in gross final energy consumption.

Figure 1: Schematic Representation of Theoretical framework



Source: Author’s own compilation based on the past literature (Albrizio et al., (2017); Berna et al., (2023); Hao et al. (2021); Ali et al., (2025); Ali et al., (2025))

4. Methodology and Data

It is a panel data analysis-based study, and the time span vary from 2004 to 2018. It is an analysis of internalizing externalities towards economic growth, and it involves a secondary data analysis. Furthermore, this study focuses on how environmental regulations and green technology adoption impact environmentally adjusted multifactor growth productivity. The variables for this study have been acquired from World Development Indicators, World Governance indicators, OECD statistics and European Commission.

Table 1: Variables and data sources

Variables	Source
Dependent Variable	
Environmentally adjusted multifactor growth productivity	OECD stat
Explanatory variables	
Environment related tax revenue	OECD stat
Environment policy stringency index	OECD stat
Patents for development of environment related technologies	OECD stat
Share of renewable energy in gross final energy consumption by sector	Eurostat
Control variables	
Governance effectiveness	World Governance Indicator (WGI)
Regulatory Quality	World Development Indicator (WDI)

The study look over the impact of internalizing externalities on environmentally regulated and green technology-adopted sustainable economic growth. The technique that follows explains the relationship between the variables for this purpose. This model explains the connection between the adoption of green technologies, environmental regulations, and environmentally adjusted multifactor productivity growth. This research is comprised of panel data analysis using pooled ordinary least square method and then tests for heteroscedasticity; Breusch pagan test, test of omitted variable bias and test to check multicollinearity are applied. After that, Panel fixed Effect Model (FEM) is applied to check variation in



variables from country-to-country. It primarily assumes that there is an unabsorbed effect where variables of country effect must not be correlated with each other and Panel Random Effect Model (REM) is applied to check all time-invariant variables related to independent variables. The independent variable is an uncorrelated error term, and the variation across the countries is supposed to be random. The Hausman test is utilized to opt among a fixed effect and a random effect model. The Modified Wald test is accustomed to expose categorical heteroskedasticity aimed the residuals of a fixed effect model. To deal with the matter of heteroskedasticity, auto-correlation, and cross-sectional subordination in a model is the use of Robust Driscoll-Kraay Standard Errors. In the provided data analysis, it has applied with a fixed effect and random effect model. Prevailing group-wise heteroskedasticity and the primary problem of cross-sectional dependency are considered in it. At last, PCSE (Panel Correlated Standard Errors) technique is applied problem of autocorrelation is tackled by this robust method. So, when they get their estimated results and find out that the data is correlated and heteroskedasticity is present in it the best solution is to apply PCSE to remove this issue.

Model

$$EMPG_{it} = \beta_0 + \beta_1 ERT_{it} + \beta_2 EPSI_{it} + \beta_3 PETS_{it} + \beta_4 SREGC_{it} + \beta_5 RRR_{it} + \beta_6 GE_{it} + \epsilon_{it}$$

Where,

EMPG= Environmentally adjusted multifactor growth productivity

ERT= Environmental related tax revenue

EPSI=Environmental policy stringency index

PETS=Patents for development of environmental related technologies

SREGC= Share of renewable energy in gross final energy consumption by sector

RQ = Regulatory quality

GE= Governance effectiveness

ϵ = Error Term, i = Country and t = Time

Here are the expected signs for the slope of the coefficient and models, $[\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6] > 0$

Table 1: Descriptive statistics of the variables

	Obs	Mean	Std.dev	Min	Max
EMPG	221	0.157	1.069	-5.830	2.914
ERT	270	0.976	0.281	0.448	3.258
EPSI	270	2.974	0.569	0.527	4.555
PETS	270	0.009	0.324	-2.407	0.722
SREGC	270	2.600	0.702	0.650	3.987
GE	270	1.247	0.547	0.125	2.347
RQ	270	1.245	0.416	0.135	2.039

Note: Computed from raw data collected from WDI, WGI, OECD stat, Euro stat: EMPG: environmentally adjusted multifactor productivity growth; ERT: Environment related tax revenue; EPSI: Environmental policy stringency index; PETS: Patents for development of environment related technologies; SREGC: Share of renewable energy in gross final energy consumption by sector; GE: Governance effectiveness; RQ: regulatory quality.

For the detection of presence of multicollinearity correlation matrix is used. Correlation matrix is also used to detect the correlation between any two variables of interest. So, when we need to move in econometric analysis it is usually in control. Therefore, its results are given in the below tables.

The calculation finds that none of the predictor variable is extremely correspond and there is no problem



of multicollinearity.

Table 2: Results of correlation matrix of the variables

	EMPG	ERT	EPSI	PETs	SREGC	GE	RQ
EMPG	1.0000						
ERT	0.0215	1.0000					
EPSI	0.2143	0.2350	1.0000				
PETs	0.1187	0.0079	0.1898	1.0000			
SREGC	0.0713	0.1354	0.3666	0.2223	1.0000		
GE	0.0991	0.0081	0.2959	0.0859	0.1969	1.0000	
RQ	-0.0795	-0.0784	0.3046	0.1275	0.0514	0.8648	1.0000

Table 3: Estimated results of the model

Independent variables	Pooled OLS	Random Effect	Driscoll Kraay	PCSE-Prais Winsten
ERT	0.42600 [0.31467] (0.077)	0.02364 [0.46669] (0.060)	0.42600 [0.29937] (0.073) *	0.38797 [0.38098] (0.009)***
EPSI	0.42677 [0.14102] (0.003)	0.38263 [0.16471] (0.020)	0.42672 [0.03867] (0.000)	1.41374 [0.14850] (0.005)***
PETS	0.28389 [0.22839] (0.015)	0.25313 [0.25266] (0.016)	0.28389 [0.14024] (0.059)**	0.29968 [0.25693] (0.043)**
SREGC	0.66704 [0.11354] (0.057)	0.08576 [0.16800] (0.010)	0.06670 [0.09159] (0.006)***	0.05377 [0.15936] (0.036)**
GE	0.31449 [0.27473] (0.054)	0.12421 [0.35224] (0.024)	0.31449 [0.26446] (0.051)**	0.35677 [0.34256] (0.098)*
RQ	0.35769 [0.36568] (0.129)	-0.19405 [0.44854] (0.165)	0.35769 [0.32996] (0.193)*	0.40928 [0.44977] (0.103)*
Constant	0.79477 [0.48787] 0.105	1.64552 [0.73053] (0.024)	0.79473 [0.56981] (0.181)*	0.81309 [0.60294] (0.177)*
Hausman Test	0.2273			
Hetero	Yes	Yes	Corrected	Corrected
Autocorrelation		Yes		Corrected

Note: Author’s own compilation. The standard error are given in [] and p-values are given in (). ***, ** and * indicate the level of significance at 1 percent, 5 percent and 10 percent, respectively.

As you can see the results of Driscoll-kraay test (robust standard estimator), the results show that, the sign of ERT is positive and has a positive and significant impact at 10 percent level of significance. It



shows that 1 unit increase in environmental related tax revenue brings 0.7% increase in the environmentally adjusted multifactor growth productivity. For the Environmental Policy Stringency Index (EPSI) indicates a statistically significant positive relationship with environmentally adjusted multifactor productivity growth. This means that 1 unit increase in EPSI bring increase in the environmentally adjusted multifactor growth productivity. The sign of PETS is positive and significant at level 5. It shows that 1 unit change increase in patents for development of environment technologies brings 0.5% increase in the environmentally adjusted multifactor growth productivity. A p-value of SREGC 0.006 with a positive sign suggests that there is a accurately significant, positive relationship between SREGC and the dependent variable. The sign of the control variables RQ and GE is positive. While 1 unit increase in governance effectiveness brings 0.5% increase at level 5 in the environmentally adjusted multifactor growth productivity. While regulatory quality has a positive sign and significant at level 10.

The results of the Prais-winsten test (PCSE), the results show that, the sign of ERT is positive and has a positive and significant impact at 1 percent level of significance. It shows that 1 unit increase in environmental related tax revenue brings 0.09% increase in the environmentally adjusted multifactor growth productivity. For the Environmental Policy Stringency Index (EPSI) indicates a statistically significant positive relationship with environmentally adjusted multifactor productivity growth. This means that 1 unit increase in EPSI bring 0.5% increase in the environmentally adjusted multifactor growth productivity. The sign of PETS is positive and significant at level 5. It shows that 1 unit change increase in patents for development of environment technologies brings 0.43% increase in the environmentally adjusted multifactor growth productivity. A p-value of SREGC 0.036 with a positive sign suggests that there is a accurately significant, positive relationship between SREGC and the dependent variable. The sign of the control variables RQ and GE is positive. While 1 unit increase in governance effectiveness brings 0.9% increase at level 10 in the environmentally adjusted multifactor growth productivity. While regulatory quality has a positive sign and significant at level 10.

5. Conclusion and policy

The influence of environmental-related tax revenue, the environmental policy stringency index, the share of renewable energy in gross final energy consumption, and patents for environmental technology development on environmentally adjusted multifactor productivity growth is highlighted in this paper. The sample dataset included the years 2004–2018 and 18 different nations. The association between variables was initially examined using a few preliminary experiments.

The results show that a strong framework for environmental rules promotes investment in cutting- edge technology as well as the use of renewable energy sources. To reduce the detrimental externalities linked to conventional economic activities, such pollution and resource depletion, this alignment is crucial. Policymakers may encourage businesses to adopt green technology by creating a favorable regulatory framework, which will increase production, boost competitiveness, and improve efficiency.

Based on the empirical findings, several policy proposals are made to improve environmentally adjusted multifactor productivity growth (EMPG) by implementing green technology and using environmental legislation effectively. First, governments must increase and implement environmental laws that encourage sustainable behavior. Creating stricter emissions regulations, encouraging the use of renewable energy sources, and providing incentives for businesses to switch to greener technology might be included in it. Regulatory frameworks should be designed to encourage companies to enforce environmental requirements while promoting innovation and investment in green technology. Second, to motivate businesses to invest in green technologies by implementing financial incentives such as tax



credits, grants, and subsidies. These incentives can make it more feasible for firms to transition toward sustainability by lowering the upfront costs of adopting renewable energy sources and environmentally friendly practices. Furthermore, government can provide grants for environmental technology research and development that can boost competitiveness and encourage innovation. Third, this involves evaluating how the ERT and EPSI affect environmental results, productivity, and creativity by putting in place systems for tracking and assessing how well environmental laws and campaigns to promote the use of green technologies are working. Frequent evaluations may help guide changes to policies and guarantee that tactics continue to be successful in fostering long-term economic growth. Fourth, governments can drive advancements in green technology that will benefit both the economy and the environment by supporting cutting-edge research. Fifth, facilitate international cooperation on environmental issues and green technology development. Sharing knowledge, best practices, and technologies across borders can hasten the adoption of sustainable practices and create a global marketplace for environmental technologies. By implementing these policy recommendations, governments can create a conducting environment for sustainable economic growth that effectively addresses externalities associated with environmental degradation. The integration of robust environmental regulations and proactive green technology adoption strategies will not only foster innovation and productivity but also contribute to a more sustainable and buoyant future.

References

- Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). The environment and directed technical change. *American economic review*, *102*(1), 131-166.
- Albrizio, S., Kozluk, T., & Zipperer, V. (2017). Environmental policies and productivity growth: Evidence across industries and firms. *Journal of Environmental Economics and Management*, *81*, 209-226.
- Ali, A., Abbas, N., & Ahmad, K. (2025). Technological Innovation and Green Finance: Catalysts for Sustainable Development in Developing Economies. *Qualitative Research Review Letter*, *3*(1), 46-82.
- Ali, A., Agha, S., & Audi, A. (2025). Green Finance and Environmental Outcomes: Evidence from EU Countries. *Journal of Business and Management Research*, *4*(3), 610-629.
- Ali, A., Azhar, B., & Alam, M. (2025). Determinants of Central Bank's Climate Integration Score: The Role of Legal Policy and Green Finance. *Journal for Current Sign*, *3*(3), 543-564.
- Ali, A., Khurram, M. H., & Alam, M. (2025). Green Finance and Sustainable Development Goals: Challenges and Opportunities in Developing Economies. *Policy Journal of Social Science Review*, *3*(8), 364-382.
- Ambec, S., & Lanoie, P. (2008). Does it pay to be green? A systematic overview. *The Academy of Management Perspectives*, 45-62.
- Batool, A., Ali, A., & Audi, M. (2025). Assessing the Impact of Sustainability Initiatives on Greenhouse Gas Emissions in Sweden and Finland. *Annual Methodological Archive Research Review*, *3*(6), 150-176.
- Berman, E., & Bui, L. T. (2001). Environmental regulation and labor demand: Evidence from the south coast air basin. *Journal of Public Economics*, *79*(2), 265-295.
- Berman, E., & Bui, L. T. (2001). Environmental regulation and productivity: evidence from oil refineries. *Review of economics and statistics*, *83*(3), 498-510.
- Fan, M., Yang, P., & Li, Q. (2022). Impact of environmental regulation on green total factor productivity:



- A new perspective of green technological innovation. *Environmental Science and Pollution Research*, 29(35), 53785-53800.
- Frondel, M., Horbach, J., & Rennings, K. (2008). What triggers environmental management and innovation? Empirical evidence for Germany. *Ecological Economics*, 66(1), 153-160.
- Horbach, J. (2008). Determinants of environmental innovation—New evidence from German panel data sources. *Research policy*, 37(1), 163-173.
- Jaffe, A. B., & Palmer, K. (1997). Environmental regulation and innovation: a panel data study. *Review of economics and statistics*, 79(4), 610-619.
- Jaffe, A. B., Newell, R. G., & Stavins, R. N. (2004). A tale of two market failures. *Technology and environmental policy RFF DP*, 04-38.
- Jaffe, A. B., Newell, R. G., & Stavins, R. N. (2005). A tale of two market failures: Technology and environmental policy. *Ecological economics*, 54(2-3), 164-174.
- Jamel, M., & Zhang, C. (2024). Green finance, financial technology, and environmental innovation impact on CO₂ emissions in developed countries. *Journal of Energy and Environmental Policy Options*, 7(3), 43-51.
- Johnstone, N., Haščič, I., & Popp, D. (2010). Renewable energy policies and technological innovation: evidence based on patent counts. *Environmental and resource economics*, 45, 133- 155.
- Khalid, M. A., & Abdul, M. (2025). Green Growth and Human Capital in Bangladesh: Evaluating the Roles of Financial Development and Foreign Direct Investment in Reducing Carbon Emissions. *Journal of Energy and Environmental Policy Options*, 8(1), 1-13.
- Kozlov, D. (2021). The strategies of internalizing the negative externalities in the company's sustainable development. *Virtual Economics*, 4(3), 7-19.
- Marc, A., Khalil, A., Poulin, M., & Ali, A. (2025). Different Dimensions of Globalization and CO₂ Emission Nexus: Application of Environmental Kuznets Curve for Worldwide Perspective. *International Journal of Energy Economics and Policy*, 15(3), 553.
- Marc, A., Poulin, M., Ahmad, K., & Ali, A. (2025). Modeling disaggregate globalization to carbon emissions in BRICS: A panel quantile regression analysis. *Sustainability*, 17(6), 2638.
- Naeem, H. Ali, A., & Audi, M. (2025). The Impact of Financial Stability on Environmental Degradation: Mediating Role of Green Investment and Moderating Role of Environmental Awareness. *Policy Journal of Social Science Review*, 3(1), 448–469.
- Porter, M. E., & Linde, C. V. D. (1995). Toward a new conception of the environment- competitiveness relationship. *Journal of economic perspectives*, 9(4), 97-118.
- Porter, M. E., & van der Linde, C. (2002). Toward a new conception of the environment- competitiveness relationship. *International Business: Critical Perspectives on Business and Management*, 4(4), 261.
- Rehman, A. U., & Malik, S. (2020). Environmental and Health Hazards of Pakistan's Leather Industry. *Journal of Energy and Environmental Policy Options*, 3(3), 96-103.
- Rodríguez, M. C., Haščič, I., & Souchier, M. (2018). Environmentally adjusted multifactor productivity: methodology and empirical results for OECD and G20 countries. *Ecological economics*, 153, 147-160.
- Serener, B., Kirikkaleli, D., & Addai, K. (2022). Patents on environmental technologies, financial development, and environmental degradation in Sweden: evidence from novel Fourier-based approaches. *Sustainability*, 15(1), 302.



- Singh, U., & Kumar, K. (2023). Exploring the interconnection between anthropogenic activities and greenhouse gas emissions: an empirical study. *Journal of Energy and Environmental Policy Options*, 6(4), 43-53.
- van Noordwijk, M., Leimona, B., Amaruzaman, S., Pascual, U., Minang, P. A., & Prabhu, R. (2023). Five levels of internalizing environmental externalities: decision-making based on instrumental and relational values of nature. *Current Opinion in Environmental Sustainability*, 63, 101299.
- Wang, J., & Li, J. (2024). Green Innovation and Economic Growth Balancing Development and Environmental Protection. *Journal of Energy and Environmental Policy Options*, 7(3), 1-13.
- Wang, Z., & Manopimoke, P. (2023). Exploring the Interplay Between Supply Chain Dynamics and Organizational Culture in Green Practices Adoption: A Study of Thailand's Hospitality Sector. *Journal of Energy and Environmental Policy Options*, 6(4), 21-32.
- Yu, H., Wang, J., Hou, J., Yu, B., & Pan, Y. (2023). The effect of economic growth pressure on green technology innovation: Do environmental regulation, government support, and financial development matter?. *Journal of Environmental Management*, 330, 117172.
- Zhang, W., Zhang, X., & Zhou, Q. (2023). How does knowledge seeking and knowledge generation promote green supply chain management? An empirical study from China. *International Journal of Logistics Research and Applications*, 26(1), 37-57.