Resources Policy 92 (2024) 104953

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Artificial intelligence, disruption of financial markets and natural resources economy in the digital era

1. Introduction

The emergence of Artificial Intelligence (AI) is revolutionizing several sectors and societies with remarkable speed, within the expansive realm of technical advancement. The convergence of AI, financial markets, and the natural resources economy is undergoing significant transformations. The advent of the digital era has brought forth an unprecedented level of connectedness, accessibility to information, and advanced computational capabilities, fundamentally transforming conventional processes and giving birth to innovative paradigms (Naudé, 2021) (Table 1).

The financial markets, which have traditionally been influenced by human expertise and market dynamics, are currently experiencing a significant transformation as AI algorithms and machine learning models take on crucial roles in decision-making processes. The convergence of AI and finance brings up new possibilities and difficulties, as it paves the way for progress in predictive analytics, risk management, and trading methods. At the same time, it prompts important inquiries on algorithmic bias, regulatory frameworks, and the ethical consequences of automated decision-making in the financial domain (Moch, 2018).

Outside the boundaries of financial markets, the influence of AI extends to the natural resources economy, impacting various industries such as agriculture, energy, mining, and environmental conservation. The incorporation of AI technology in various industries holds the potential for enhanced effectiveness, optimal utilization of resources, and the adoption of sustainable methodologies. Nevertheless, it also poses difficulties in job displacement, ethical concerns in resource extraction, and the overall environmental impact of AI-driven processes (Goralski and Tan, 2020).

This special issue explores the various aspects of how AI impacts financial markets and the thoroughly analyze the consequences, tackle ethical issues, and investigate ways to employ AI responsibly. By employing this approach, we may effectively utilize the capabilities of AI to facilitate beneficial changes while minimizing the potential risks associated with its disruptive nature. We bring together a variety of viewpoints and examine key aspects of this overall issue, providing valuable perspectives, evaluations, and conversations that enhance our shared comprehension of the complex interaction between AI, financial markets, and the natural resources economy in the digital age.

2. Contribution of the special issue

In recent years, scholarly research has made significant strides in exploring the complex interplay between artificial intelligence, financial markets and digitalization of natural resourece economy. A comprehensive review of various studies reveals a diverse range of investigations into critical topics such as carbon emissions, natural resource management, energy efficiency, and the impact of artificial intelligence (AI) on both economic and environmental dimensions. These studies collectively shed light on the environmental implications of economic growth, the role of renewable energy, the influence of Industry 4.0 technologies, the impact of AI on various sectors, and the dynamic connections between decentralized finance and natural resource assets. Through rigorous empirical analyses, these studies provide nuanced perspectives and policy implications, addressing crucial challenges and offering potential solutions for achieving sustainable development goals and mitigating environmental risks.

Balsalobre-Lorente et al. (2023) examine the correlation between per capita carbon dioxide emissions, the economic complexity index, renewable energy, and inbound foreign direct investment. They utilize panel data for the BRICS countries from 1995 to 2020. Empirical evidence provided by them validates the fulfillment of the environmental Kuznets curve, wherein economic progress has a positive impact on environmental degradation, albeit with a diminishing effect. This implies that it is possible to attain a state of neutrality in CO2 emissions in the long run. Furthermore, the findings substantiate the Pollution Haven Hypothesis in this scenario, indicating that the BRICS economies choose regulatory measures that disregard environmental concerns. Other econometric research has corroborated this study's findings, indicating the presence of long-term cointegration. The unit root tests indicate stationarity at the first difference, whereas the variance inflation test indicates a lack of multicollinearity. This study uses a new methodology to estimate the influence of Industry 4.0 technologies on carbon emissions due to the lack of existing research. Their findings suggest that these technologies have little effect on environmental degradation. Furthermore, the findings indicate that over time, these technologies have the potential to aid in the attainment of emission neutrality.

Yan et al. (2023) determine the characteristics that can assist developing countries in managing their emissions of carbon dioxide into the atmosphere. Through a meticulous econometric analysis, using data from specific low- and middle-income countries, it has been determined that the efficient utilization of energy and the increase in the proportion of renewable energy in a nation's energy consumption can lead to a reduction in carbon emissions. In contrast, urbanization has a significant impact on increasing emissions, but the effects of financial development and international trade on emissions are uncertain. In addition, the analysis that focuses on certain income groups shows varied results, as it is observed that improvements in energy productivity only led to

https://doi.org/10.1016/j.resourpol.2024.104953

Available online 11 April 2024

Table 1
Studies in the special issue.

Authors	Research question	SDGs addressed	Data and sample	Analytical method	Findings and conclusions
Balsalobre-Lorente et al. (2023)	Q1. What is the influence of economic complexity processes and renewable energy on CO2 emissions of BRICS? Q2. What is the role of Industry 4.0 in this context?	SDG 13: Climate Action	Data from BRICS countries	Panel data analysis	Economic complexity processes and renewable energy have a significant impact on reducing CO2 emissions in BRICS countries. Industry 4.0 can play a crucial role in facilitating the transition towards a low-carbon economy.
Yan et al. (2023)	Q1. What are the characteristics that can assist developing countries in managing their emissions of carbon dioxide into the atmosphere? Q2. What is the impact of energy utilization, renewable energy, urbanization, financial development, and international trade on carbon emissions in developing countries?	SDG 13: Climate Action	Data from specific low- and middle-income countries	Meticulous econometric analysis	Efficient energy utilization and an increase in the proportion of renewable energy can lead to a reduction in carbon emissions. Urbanization has a significant impact on increasing emissions, while the effects of financial development and international trade on emissions are uncertain. The impact of these factors varies across different income groups and countries
Li et al. (2023)	Q1. What are the factors influencing the pricing of lithium mineral resources in China? Q2. Can the pricing of lithium mineral resources be predicted using specific methodologies?	SDG 7: Affordable and Clean Energy	Daily historical data from 5 November 2018 to 1 November 2022	Fb-P and ANN methodologies for predicting lithium prices	The pricing of lithium mineral resources exhibits exceptional precision and possesses significant long-term memory. The market is expected to experience a dramatic spike in the next six months. This has implications for the affordability and availability of clean energy sources.
4 Chen et al. (2023)	Q1. How can machine learning and Artificial Neural Networks (ANN) be utilized to forecast mineral resources based on economic development, pricing, environmental policy, and the adoption of greener energy in China?	SDG 12: Responsible Consumption and Production	Economic development, producer price index, market pricing, environmental policy stringency index, and adoption of greener energy in China	Utilization of machine learning (ML) and artificial neural networks (ANN)	ML and ANN demonstrated high sensitivity to changes in economic performance and the use of renewable energy. Effective utilization of natural resources is crucial for sustainable and responsible consumption and production.
6 Pan et al. (2023)	Q1. What is the influence and mechanism of Internet evolution on urban carbon emissions in China? Q2. How can the Internet facilitate the low-carbon growth of cities that rely on natural resources?	SDG 13: Climate Action	Panel data from 283 cities in China	Two-way fixed effects model, instrumental variables approach, substituting explanatory factors, and multi-period difference-in-difference (DID) model	The Internet plays a significant role in efficiently facilitating the transition towards a low-carbon urban environment. The development of the Internet diminishes urban CO2 emissions through the enhancement of industrial structure, the encouragement of green innovation, and the reinforcement of environmental regulation. The Internet has the potential to facilitate the low-carbon growth of cities that rely on natural resources.
Peng et al. (2023)	Q1. What is the correlation between AI-driven Facility Management (FM) and Maintenance and Repair Management (MRM) in the United States of America? Q2. How can AI-based financial systems enhance worker safety and efficiency in the mining industry?	SDG 9: Industry, Innovation, and Infrastructure	Economic conditions of the United States of America from 1980 to 2020	Non-linear autoregressive distributed lag (NARDL) methodology	The beneficial impact of AI-driven Facility Management is inversely correlated with mineral resource rent (MRR), indicating the potential for enhanced worker safety and efficiency in the mining industry.
Li et al. (2023)	Q1. What is the impact of financial technology, digitalization, institutional	SDG 8: Decent Work and Economic Growth	Selected OECD economies from 2002 to 2020	Method of moments quantile regression (MMQR), fully modified ordinary least	Financial technologies and digitalization decrease reliance on natural resources,

(*continued on next page*)

Table 1 (*continued*)

Authors	Research question	SDGs addressed	Data and sample	Analytical method	Findings and conclusions
	quality, and human capital on natural resources rent in selected OECD economies? Q2. How do these factors influence reliance on natural resources?			squares (FM-OLS), fixed effects OLS, and dynamic ordinary least squares (OLS) regression	while the growth of human capital and institutional quality also result in reduced reliance on natural resources. The impact of these factors varies across different quantiles, indicating the complex nature of their influence.
Li (2023)	Q1. What is the influence of extenics, measured by artificial intelligence (AI), and spatial factors, measured by geopolitical risk (GPR), on the natural resources market (NRM) in China from 1985 to 2022?	Sustainable Development Goal (SDG) 12: Responsible Consumption and Production	The study employs Chinese economic data from 1985 to 2022	The NARDL analysis demonstrates an unequal relationship between AI, GPR, and NRM in both the short-term and long-term timeframes	The study reveals that the utilization of extenics, as exemplified by AI, and geographical variables, as exemplified by GPR, exert a substantial influence on the natural resources market in China. The NARDL model uncovers asymmetrical correlations that demonstrate how variations in AI and GPR impact the natural resource market, affecting both positive and negative outcomes such as natural resource rent and revenue generation. The findings indicate that the Chinese government should prioritize improving its strategies for managing the effects on space and maximizing the market for natural resources. Additionally, the government should utilize extenics applications to accomplish these goals.
Ye and Lin (2023)	Q1. What is the influence of aggregate natural resources, financial risk, technological innovation, and investment on the economic expansion of the United States? Q2. What is the relationship between the overall amount of natural resources and the growth of the economy in the upcoming year?	SDG 8: Decent Work and Economic Growth	Data from the United States from 1988 to 2020	Quantile regression (QR) technique and FMOLS technique	Total natural resources have a substantial positive impact on GDP across all three quantiles, indicating a positive relationship between the overall amount of natural resources and the growth of the economy in the upcoming year. The econometric techniques of quantile regression and FMOLS yield equivalent outcomes.
Li et al. (2023)	Q1. What is the impact of artificial intelligence (AI) on the efficiency of business innovation? Q2. What is the moderating impact of increasing competition and streamlining the internal organizational structure?	SDG 9: Industry, Innovation, and Infrastructure	Panel data from 3185 publicly traded companies from 2008 to 2020	Instrumental variables and propensity score matching (PSM) techniques	The implementation of AI technology greatly enhances the efficiency of corporate innovation. Increasing competition in the external market and streamlining the internal organizational structure have a moderating impact. The influence of AI on the efficiency of business innovation is significant in larger companies with limited managerial authority. The greater the degree of AI advancement in the industry and geographical area where the company operates, the more profound the influence of AI on the efficiency of corporate innovation.
Li et al. (2024)	Q1. What are the effects of implementing artificial intelligence in the labor force on household energy usage in China? Q2. How can artificial intelligence impact household	SDG 7: Affordable and Clean Energy	Data from the China General Social Survey (CGSS)	Mechanical analysis	The study aims to thoroughly examine the effects of implementing artificial intelligence in the labor force on household energy usage in China. It provides insights into the impacts of artificial intelligence on household

(*continued on next page*)

Table 1 (*continued*)

Authors	Research question	SDGs addressed	Data and sample	Analytical method	Findings and conclusions
	energy usage from a demand-based perspective?				energy usage from a demand-based perspective, contributing to the goal of providing inexpensive energy to everyone as outlined in the 17 Sustainable Development Goals.
Cevik et al. (2022)	Q1. What is the impact of digital finance on the natural resource market? Q2. How does this impact vary across different natural resources such as DeFi, oil, and gold?	SDG 12: Responsible Consumption and Production	Data from DeFi, oil, and gold markets	Vector autoregression (VAR) model	Digital finance has a significant impact on the natural resource market, with varying effects across different resources. The impact of digital finance on DeFi is positive, while its impact on oil and gold is negative. The findings suggest the need for responsible consumption and production practices in the natural resource market.
Kolte et al. (2023)	How does the incorporation of a suitable Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) framework facilitate the evaluation of market uncertainty across stock return indexes in the European Union, Pacific, South America, Latin America, East Asia, West Asia, and South Asia?	SDG 8: Decent work and economic growth SDG 9: Industry, Innovation, and Infrastructure	Appropriate Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) is used to capture volatility dynamics of the European Union, the Pacific, South America, Latin America, East Asia, West Asia, and South Asia stock return indices.	Excel with STATA functions	The findings show considerable differences in equity return uncertainty across global capital markets, which has far-reaching consequences for portfolio diversification strategies and the decisions of both international and local institutional investors.
Singh et al. (2023)	What are the key factors influencing Natural Gas Consumption (NGC) and how do they contribute to the prediction of yearly NGC in the United States?	SDG 7: Affordable and clean energy	Annual statistics from 1980 to 2020 on NGC predictive factors and USA influencing variables (GDP, population, urbanization, carbon dioxide emissions, and energy consumption).	Multiple linear regression (MLR), Support Vector Machine regression (SVM), and Artificial Neural Network (ANN)	The findings show a substantial relationship between NGC and other contributing factors. GDP, population, and urbanization rate all showed the largest and most significant positive link with natural gas consumption, while carbon dioxide emissions showed a modest but significant correlation.
Sood et al. (2023)	RQ1: What are the main risk categories and their classification allied with the adoption of stablecoins as a mainstream means of payment? RQ2: How can the overall importance of identified risk categories and their classification allied with stablecoin adoption as a mainstream means of payment be assessed and a priority of focus established for the current theme? An	SDG 8: Decent work and economic growth SDG 9: Industry, Innovation, and Infrastructure	For literature review Scopus, Web of Science and Google scholar were used to collect the database. Purposive sampling was used to identify 15 industry and academic experts for interview.	The study employs SLR to identify relevant literature, PF-Delphi, and PF-AHP to validate and prioritize various risks associated with stablecoin adoption, and PF-CoCoSo to classify the various sub-criteria. Nevertheless	Findings reveals that the most influential criterion was technological risks, which are the most significant hurdle to the broad adoption of stablecoins as a method of payment, followed by macroeconomic risks and legal and regulatory concerns. User-centric risks were discovered to be the least significant criterion.
Bansal et al. (2022)	RQ1: How can digital technologies be effectively utilized to manage natural resources? RQ2: How innovation, digitization, and technology transfer and dissemination contribute to resource management and sustainable usage, ultimately leading to the achievement of the SDGs?	SDG 7: Affordable and clean energy SDG 9: Industry, Innovation, and Infrastructure SDG12: Responsible consumption and production SDG 13: Climate action SDG 14: Life below water SDG 15: Life on land	143 publications from the Scopus database (1974–2022).	The study adopts a two-tiered analytical strategy that involves bibliometric analysis as well as an integrated literature review (mechanical analysis and manual interpretation).	Revolutionizing our environmental destiny requires an energetic symphony: a fusion of astute energy policies, relentless innovation, digital finesse, and widespread tech adoption. This dynamic quartet is the catalyst for impeccable resource management and the sustainable harnessing of nature's bounty. In this high-stakes game against environmental degradation, these strategic moves not only fortify our defenses but also pave the way for achieving

(*continued on next page*)

Table 1 (*continued*)

Authors	Research question	SDGs addressed	Data and sample	Analytical method	Findings and conclusions
					the ambitious Sustainable Development Goals (SDGs). It's a roadmap where smart policies, inventive thinking, digital prowess, and cutting-edge technology harmonize to create a thriving and resilient future for our planet.
Wang et al. (2023)	How can recommendation systems be effectively applied to optimize decision-making and resource allocation for entrepreneurial projects within the complex landscape of cultural and creative industry (CCI) enterprises?	SDG 9: Industry, Innovation, and Infrastructure	CCI-related entrepreneurial projects (300)	The neural network algorithm (NNA) is adopted to model project features, user's behavioral and content features.	The results show that as the training period lengthens, the model's recognition accuracy increases to 81.64%. Furthermore, the entrepreneurial project recommendation and resource optimization model can significantly improve recognition accuracy and reduce prediction errors, providing experimental references and contributing to the subsequent long-term development of the social economy and entrepreneurial resource optimization.
Ha (2023)	RQ1: what is the importance of digitalization in promoting the sustainability of the agriculture sector? RQ2: What are the policies to promote the digital transformation process that help countries pursue smart and sustainable agriculture? We	SDG 8: Decent work and economic growth	24 European Union countries between 2011 and 2019.	Panel-corrected standard errors (PCSE) model, feasible generalized least squares (FGLS) estimation, and two-step generalized method of moment (two-step GMM) model.	It is the first to demonstrate a nonlinear relationship between digitization and sustainable agriculture. The findings emphasize the significance of digitization in increasing agricultural productivity, export activity, employment, and environmental sustainability. The study also suggests that positive effects manifest only when digitalization development exceeds a specific threshold.
Alan and Köker (2023)	RQ1: What agricultural wastes can be the subject of recycling work and business? RQ2: How have the agricultural wastes in question changed over time? RQ3: What are the most commonly used topics or terms in agricultural waste recycling? RQ4: What are the new trends in recycling for the circular economy?	SDG 2: Zero hunger SDG 8: Decent work and economic growth	69945 articles from Web of Science database (2000–2022).	Integrative review, bibliometric analysis.	Composting, lignocellulosic biomass, biodiesel and biodiesel production, biogas and biogas production, biohydrogen production, and methane production were found to be increasingly important in the processing and recycling of these wastes, with agro-industrial wastes (fruit, vegetable, and plant wastes) standing out.
Ding et al. (2023)	RQ1: What is the impact of AI development on carbon emissions in China? RQ2: How does the spatial spillover effect of AI contribute to carbon emissions reduction? RQ3: What are the specific AI techniques and structures that are effective in reducing carbon emissions? RQ4: What are the limitations and challenges associated with implementing AI technology for carbon emissions reduction in China?	SDG 8: Decent work and economic growth SDG 9: Industry, Innovation, and Infrastructure SDG 17:	Balanced panel dataset of 30 Chinese provinces from 2006 to 2019. The carbon emissions data for each province comes from the Carbon Emission Accounts & Datasets database, while the National Bureau of Statistics provides data on population, total foreign-invested industry investment, and GDP. The energy consumption data comes from the EPS database.	Spatial Durbin model (SDM)	Findings reveal that AI development efficiently helps to carbon emission reduction, and the decrease effect is consistent across different spatial weights. In addition, the study identifies two key AI mediation impacts on carbon emissions reduction, namely technique and structural effects. According to the heterogeneity study, AI reduces carbon emissions via a spatial spillover effect, with the effect being larger in central and western China.
Shahzad et al. (2023)	What is the impact of the COVID-19 crisis on the adoption of artificial intelligence solutions in the basic materials industry and the oil and gas industry, and how has this adoption	SDG 9: Industry, Innovation, and Infrastructure SDG 13: Climate action	Global X Artificial Intelligence & Technology ETF as a proxy for the AI industry and sub-indices of the Dow Jones Global Index, namely the Basic Materials and Oil & Gas sectors, as well as their Islamic markets, i.e., Dow Jones Islamic Market	Quantile Vector Autoregression, QVAR(p)	Findings reveal that in the network of AI-based investments and companies related to basic materials and the oil and gas industries, AI is a net recipient of shocks both before and during the COVID-19 era, with a higher intensity

(*continued on next page*)

Table 1 (*continued*)

Authors	Research question	SDGs addressed	Data and sample	Analytical method	Findings and conclusions
	influenced economic activity in these essential sectors?		Basic Materials, and Dow Jones Islamic Market, for two periods: May 18, 2018–March 10, 2020 (pre-COVID-19 period) and March 11, 2020–June 01, 2022 (COVID-19 period)		of shock-receiving in the normal market and during the COVID-19-affected period than in the upper and lower tails and prior to the COVID-19 period.
Kahia et al. (2022)	Could the recent transition toward renewable energy sources improve the environmental quality in Saudi Arabia?	SDG 13: Climate action	Renewable energy use, oil use, gas usage, coal use, economic growth, and environmental degradation from 1980 to 2020.	Bayesian networks (BN) machine learning, Machine learning regression application.	The study discovers that lowering CO2 emissions in Saudi Arabia requires a complete transition from fossil to renewable resources, as well as a more viable path to sustainability. According to ML-based regression and prediction, CO2 emissions will continue to rise until 2024. Beginning in 2025 and beyond, the reduction in emissions (i.e., CO2 emissions) must be supported by an increase in the use of renewable energies to ensure stable economic growth.
Aldieri et al. (2022)	How do spillovers from enterprises within the same technical field, defined as 'intra-industry,' influence the interaction between climate change and the technology diffusion process?	SDG 13: SDG 9: Industry, Innovation, and Infrastructure	Innovation variables in three economic zones (Europe, Japan, and the United States) from 2002 to 2017: total company R&D investments and knowledge innovation spillovers in the energy field.	GMM estimation	The findings show that the overall R&D process is harmful to climate change variables, while the knowledge dissemination process of energy breakthroughs is beneficial to climate change mitigation.
Hao et al. (2023)	Focusing on green development and digital transformation, can the digital economy improve EE? What is the potential mechanism? Is there a spatial effect? Are there regional heterogeneities?	SDG 9: Industry, Innovation, and Infrastructure	The panel data of 30 provinces from 2011 to 2018 were collected from the databases including, the China Industrial Economic Statistical Yearbook, China Statistical Yearbook, China Energy Statistical Yearbook, China Environmental Statistical Year-book, China Science and Technology Statistical Yearbook, regional statis- tical yearbooks, the National Bureau of Statistics database, and EPS database	Spatial panel regression, spatial heterogeneity, geographically and temporally weighted regression model	The key findings of the study: (i) EE showed a steady but moderate rise and obvious regional agglomeration with spatial differentiation in regions. (ii) DIGE may greatly increase EE, and there was a discernible "spatial synergistic effect," exhibited as a spatial spillover effect of "1 + 1>2." (iii) The mediating effect of TFP growth rate demonstrated that technical advancement might work in tandem with DIGE to achieve EE augmentation. (iv) The geographically and temporally weighted regression (GTWR) model revealed that spatial heterogeneity from east to west exhibited a "band-like increase" characteristic.
Liang et al. (2023)	How can a novel deep reinforcement learning algorithm be developed for multi-step ahead crude oil price forecasting in three major commodity exchanges?	SDG 9: Industry, Innovation, and Infrastructure SDG 7: Affordable and clean energy	Crude oil close prices of the trading day in WTI, Brent, and Oman exchanges.	Reinforcement learning, Dynamic noisy proximal policy algorithm, Dynamic noise exploration mechanism, Dynamic approximation optimization mechanism	The key findings of the study: (i) DRL's forecasting capacity is developed using crude oil price forecasting and may be expanded to other natural resource price forecasting. (ii) The suggested technique is very applicable to the data of the world's three major crude oil price benchmarks. (iii) The suggested algorithm's accuracy decreases indistinctly when the forecasting step is increased; nonetheless, it accurately reflects the real price and fluctuation.

decarbonization in certain middle-income countries. Regardless of the socioeconomic group classification of emerging nations, the deployment of renewable energy has a decarbonizing impact. Conversely, the progress of financial development obstructs and advances the goals of reducing carbon emissions in lower-middle-income and upper-middle-income countries, correspondingly. Furthermore, increased exports contribute to the elevated emissions statistics of low-income nations, specifically. In addition, urbanization is recognized as a factor that limits the reduction of carbon emissions in developing countries, regardless of their income group categorizations. However, their results from the regional and country-specific analysis also show significant variation in most aspects. Based on these significant discoveries, various decarbonization solutions are advised by authors.

Li et al. (2023) study the prediction of the pricing of lithium mineral resources in China. They have employed the Fb-P and ANN methodologies to predict lithium prices by analyzing daily historical data from 5 November 2018 to 1 November 2022. By utilizing empirical estimates, one can make predictions about future prices up until 20 April 2023. Their results of the Facebook Prophet technique indicate that lithium mineral pricing exhibits exceptional precision and possesses a significant long-term memory, particularly at varying intervals of days. It is worth noting that the market is expected to have a dramatic spike in the next six months, surpassing 800,000 yuan/tonne, in contrast to the present price of 572,500 yuan/tonne.

Chen et al. (2023) study the utilization of machine learning (ML) and Artificial Neural Networks (ANN) to forecast mineral resources based on economic development, the producer price index, market pricing, the environmental policy stringency index (EPSI), and the adoption of greener energy in China. The outputs of machine learning (ML) and artificial neural networks (ANN) demonstrated the high sensitivity of quarterly minerals resource rent fluctuations to changes in economic performance and the use of renewable energy. The superior prediction accuracy of ML experiments compared to ANN trials is emphasized by data from metrics such as mean absolute percentage error, mean square error, root mean square error, root mean absolute error, and coefficient of determination. China possesses ample natural resources; yet, it is imperative to utilize these resources effectively in order to attain sustainable and environmentally favorable outcomes in the long run. Their study not only compared the outcomes of machine learning (ML) and artificial neural networks (ANN), but also drew causal inferences and identified policy implications.

Pan et al. (2023) analyze the influence and mechanism of Internet evolution on urban carbon emissions using panel data from 283 cities in China. This study utilizes a two-way fixed effects model to examine the influence of the Internet on urban carbon emissions. The empirical findings demonstrate that the Internet plays a significant role in efficiently facilitating the transition towards a low-carbon urban environment. Subsequently, we employed a set of rigorous tests, such as implementing the instrumental variables approach, substituting the explanatory factors, and utilizing a multi-period difference-in-difference (DID) model, to establish the soundness of the fundamental conclusion. The examination of the mechanism demonstrates that the development of the Internet diminishes urban CO2 emissions through the enhancement of industrial structure, the encouragement of green innovation, and the reinforcement of environmental regulation. Furthermore, the Internet has the potential to facilitate the low-carbon growth of cities that rely on natural resources. This study offers a crucial theoretical foundation for efficiently advancing the low-carbon transformation and development in metropolitan areas of China, focusing on the perspective of Internet development.

Peng et al. (2023) investigate the correlation between AI-driven Facility Management (FM) and Maintenance and Repair Management (MRM). A comprehensive analysis has been conducted on the economic conditions of the United States of America (USA) spanning the period from 1980 to 2020.The variables' stationarity is assessed using the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests. Their results confirm the existence of nonlinearity. Subsequently, the non-linear autoregressive distributed lag (NARDL) methodology is employed to ascertain the asymmetrical impact of FM on mineral resource rent (MRR). The data demonstrate an unequal association between FM and MRR. The beneficial impact of FM is inversely correlated with MRR, but a negative impact is directly correlated with MRR. Their findings indicate that the USA economy should revamp its mineral resource strategy by using AI-based financial systems. This will enhance worker safety and efficiency in the mining industry, leading to sustained growth in the long run.

Li et al. (2023) examine the impact of financial technology, digitalization, institutional quality, and human capital on natural resources rent in selected OECD economies from 2002 to 2020. The study employs the method of moments quantile regression (MMQR) to analyze the effects of selected explanatory variables at three different quantiles (lower, middle, and higher). Additionally, it uses fully modified ordinary least squares (FM-OLS), fixed effects OLS, and dynamic ordinary least squares (OLS) regression to estimate the long-run coefficients. The preliminary findings suggest the presence of cross-sectional dependency, heterogeneity in the slope coefficients, panel cointegration, and stationarity in the data. Their findings indicate that the implementation of financial technologies and digitalization decreases reliance on natural resources. Similarly, the growth of human beings and the quality of institutions result in reduced reliance on natural resources. However, the extent of their influence differs among various quantiles. Their findings indicate that the impact of financial technologies and digitalization is more pronounced at higher quantiles. Similarly, the impact of digitalization on the income derived from natural resources is extremely considerable and has a negative effect at the greatest level of measurement.

Li (2023) examines the impact of extenics, as quantified by artificial intelligence (AI), and spatial factors, as quantified by geopolitical risk (GPR), on the natural resources market (NRM). He analysis the Chinese economic data spanning from 1985 to 2022. The empirical evaluation is conducted through the utilization of unit root tests, specifically the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests, as well as the non-linearity test known as the BDS test. Additionally, the non-linear autoregressive distributed lag (NARDL) model is employed. The NARDL analysis reveals an asymmetrical correlation between AI, GPR, and NRM in both the short-term (SR) and long-term (LR) periods. Their findings indicate that an increase (down) in AI has a favorable effect on the natural resource market by reducing (increasing) natural resource rent. Likewise, a favorable (unfavorable) impact on the GPR raises (lowers) the income generated from natural resources and enables the utilization of the natural resource market. Their results proposes that the Chinese government should enhance and revamp its tactics for regulating spatial impacts to optimize its natural resource market, while also focusing on extenics applications.

Ye and Lin (2023) investigate the influence of aggregate natural resources, financial risk, technological innovation, and investment on the economic expansion of the United States from 1988 to 2020. To estimate the model over a continuous time period, they employ the quantile regression (QR) technique. It is determined that total natural resources have a substantial positive impact on GDP across all three quantiles. Consequently, it may be inferred that there is a positive relationship between the overall amount of natural resources and the growth of the economy in the upcoming year, regardless of the specific levels of measurement. Furthermore, their study employs the FMOLS technique to conduct a rigorous validation. When compared, the econometric techniques of quantile regression and FMOLS yield equivalent outcomes.

Li et al. (2023) examine the impact of artificial intelligence (AI) on the efficiency of business innovation by using panel data from 3185 publicly traded companies spanning the years 2008–2020. Their findings demonstrate that the implementation of AI technology greatly enhances the efficiency of corporate innovation. To address potential

endogeneity issues, they employ instrumental variables and propensity score matching (PSM) techniques to evaluate and derive reliable findings. Additionally, they observe that increasing competition in the external market and streamlining the internal organizational structure, which are significant economic methods of reallocating innovative resources, have a moderating impact. Moreover, the influence of AI on the efficiency of business innovation is significant in larger companies with limited managerial authority. Moreover, the greater the degree of AI advancement in the industry and geographical area where the company operates, the more profound the influence of AI on the efficiency of corporate innovation. Their results present empirical evidence that demonstrates the impact of artificial intelligence on innovation.

Li et al. (2024) examine the goal of providing inexpensive energy to everyone is as outlined in the 17 Sustainable Development Goals. To thoroughly examine the effects of implementing artificial intelligence in the labor force on household energy usage in China, a comprehensive study is carried out utilizing data from the China General Social Survey (CGSS) collected between May and September 2022. Their results show that AI greatly decreases the amount of energy used in households. Assuming all other parameters remain same, a one-standard-deviation increase in the influence of AI results in an average decrease of 10.751% in household energy use. The conclusion is confirmed through rigorous testing of robustness and endogeneity, which includes addressing missing data, utilizing several energy consumption and AI indicators, and employing advanced statistical techniques such as instrumental variable approach, placebo test, and penalized regressions. Mechanism analysis reveals that AI decreases energy use by reducing household income and augmenting their financial vulnerability. The primary consequences are predominantly seen in the substantial decrease in power and gas usage. Moreover, it heightens the likelihood of utilizing solid fuels such as honeycomb coal, coal lumps, conventional biomass, and other similar resources. This, in turn, amplifies the dependence on low-quality energy sources and elevates the vulnerability to energy poverty. AI disproportionately impacts individuals lacking access to energy subsidies, as well as households experiencing poor energy security and stability, lower income, and inadequate social security. In addition, its effects are more noticeable in locations with higher levels of technical advancement. Viable strategies to alleviate the negative consequences of AI are examined. Enhancing labor protection has been discovered to mitigate the negative effects on energy usage. Their paper presents empirical evidence on the effects of technology disruption from a demand-oriented standpoint. The statement underscores the necessity for enhanced policies on energy, social security, income distribution, and labor protection to mitigate the impact of AI on home energy usage and avert the risk of energy poverty.

Cevik et al. (2022) investigate the relationship between decentralized finance (DeFi) and natural resource assets in terms of the transmission of returns and volatility, as well as the effectiveness of hedging. To achieve this, we will employ the time and frequency domain causality test and the cross-quantilogram approach. In order to achieve this objective, we consider the prices of ChainLink (LINK) and Maker (MKR) in the DeFi market, while utilizing crude oil (WTI) and gold prices as substitutes for the natural resources market. They assess the effects of portfolio diversification during the Covid-19 outbreak, we analyze the daily period from March 14, 2018, to August 15, 2022. The results of the causality test conducted in the temporal and frequency domains indicate that digital financial instruments have a significant impact on the price and risk structure of natural resources, including crude oil and gold, especially in times of crisis. Furthermore, their findings from the cross-quantile analysis suggest that there are notable negative cross-correlations between DeFi tokens and natural resource markets in bearish market conditions. Consequently, DeFi tokens can serve as effective hedging instruments for investors in gold and crude oil.

Kolte et al. (2023) explore the major impact of volatile resource prices and equities volatility on advanced and emerging countries. The study analyzes the impact using an econometric and machine learning technique, which is especially significant in the context of the oil market and its consequences on emerging countries. The study's major objective is to incorporate a suitable Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) framework to evaluate market uncertainty across stock return indexes in the European Union, Pacific, South America, Latin America, East Asia, West Asia, and South Asia. The study also looks at how information updates from the United States affect the global returns of the S&P 500 and other regional indices. The findings show considerable differences in equity return uncertainty across global capital markets, which has far-reaching consequences for portfolio diversification strategies and the decisions of both international and local institutional investors. As a result, the study is important for these stakeholders since it sheds insight into the influence of foreign institutional investments on the rise of equity market returns within the designated regions.

Singh et al. (2023) examine the factors influencing Natural Gas Consumption (NGC) and their impact in predicting yearly NGC in the United States. Annual data for the selected influence factors and NGC for the period 1980–2020 is collected for prediction. The three chosen modeling techniques - MLR, ANN, and SVM - are used to accurately predict Natural Gas Consumption. The findings show a substantial relationship between NGC and other contributing factors. GDP, population, and urbanization rate all showed the largest and most significant positive link with natural gas consumption, while carbon dioxide emissions showed a modest but significant correlation. Based on the predictions, the government can make more changes to develop regulations that will help to use natural gas resources wisely, allowing the problem of global warming, air pollution, and acid rain to be controlled by controlling the influence factors.

The study by Sood et al. (2023) identifies and prioritizes many primary risk categories (Macroeconomic Risks, Legal and Regulatory Risks, Technical Risks, and User-Centric Risks) as well as the classifications of these risk categories, that hinder stablecoins from becoming widespread payment instruments. Through a thorough literature analysis, the first step identified four risk categories and their classifications. The study then employed Pythagorean fuzzy delphi to validate the established risk groups. In the last stage, the authors used a Pythagorean fuzzy analytical hierarchy and a combined complete solution strategy to prioritize these hazards. According to the findings of this study, the most influential criterion was technological risks, which are the most significant hurdle to the broad adoption of stablecoins as a method of payment, followed by macroeconomic risks and legal and regulatory concerns. User-centric risks were discovered to be the least significant criterion. In terms of sub-criterion ranking, the leading risks are monetary stability risks, relative price stability risks, concentration risks, money laundering (ML)/terrorist financing (TF) and other illicit activities, oracle risks, smart contract failures, operational failures, privacy risks, and consumer protection risks.

Bansal et al. (2022) perform a thorough analysis of the available literature to investigate how digital technologies are used to efficiently utilize natural resources. The study adopts a two-tiered analytical strategy that involves bibliometric analysis as well as an integrated literature review that includes mechanical analysis and manual interpretation of 143 publications from the Scopus database. The findings identify the most influential articles and sources on the subject based on their publication, citation, and importance to the intellectual network; additionally, the study sheds light on the field's intellectual structure (thematic analysis), which is supported by seven major clusters focusing on 'water resource management,' 'environmental impact,' 'economic and social impact,' 'technological innovation and digitalization,' 'circular economy,' and 'alternative energy.' The authors also used keyword co-occurrence and thematic analysis to build aggregate dimensions from the study's major issues and themes, which resulted in a conceptual framework for combining natural resource usage and SDGs. The conceptual framework outlines how innovation, digitization, and technology transfer and dissemination contribute to resource

management and sustainable usage, ultimately leading to the achievement of the SDGs.

A Recommendation method is used by Wang et al. (2023) to make decisions and optimize resources for entrepreneurial projects in the current condition of complex entrepreneurial enterprises in the cultural and creative industry (CCI). To model project attributes, user behavioral, and content features, the neural network algorithm (NNA) is used. Finally, for CCI-related entrepreneurial initiatives, a suggestion and resource optimization model based on NNA is built, and the model is reviewed and analyzed. The results show that as the training period lengthens, the model's recognition accuracy increases to 81.64%. Furthermore, when the word vector length is 200 and the number of implied features is 200, the recommender system's prediction error is minimized. As a result, the entrepreneurial project recommendation and resource optimization model can significantly improve recognition accuracy and reduce prediction errors, providing experimental references and contributing to the subsequent long-term development of the social economy and entrepreneurial resource optimization.

Ha (2023) presents a theoretical framework to give a comprehensive examination of the relationship between the digital transformation process in the commercial and governmental sectors and agricultural sector sustainability. The economic issue of sustainability is captured by productivity growth and export value growth, the social issue is captured by employment growth, and the environmental issue is captured by the sustainable nitrogen management index. Four e-Commerce aspects (e-Commerce sales, e-Commerce web sales, e-Commerce turnover, and online selling) and two e-Business estimations (Cloud utilization and customer relation management (CRM) usage) capture digital enterprises. User-centricity, business mobility, and key enablers are characteristics of digital public services. It is the first to demonstrate a nonlinear relationship between digitization and sustainable agriculture. The findings emphasize the significance of digitization in increasing agricultural productivity, export activity, employment, and environmental sustainability. The study also suggests that positive effects manifest only when digitalization development exceeds a specific threshold.

By analyzing agricultural waste and trash recycling, Alan and Köker (2023) intend to shed new light on problems that have received little attention in the literature. The dataset gathered from the literature was thoroughly and comprehensively studied for this purpose utilizing the bibliometric text mining technique. This study also demonstrates which agricultural wastes are the focus of recycling effort and entrepreneurship, as well as changes in research and studies on agricultural wastes during the last twenty years. The purpose of this study is to raise the importance and knowledge of the most widely used issues or terminology in trash recycling, the role of the circular economy, and agricultural waste recycling. Composting, lignocellulosic biomass, biodiesel and biodiesel production, biogas and biogas production, biohydrogen production, and methane production were found to be increasingly important in the processing and recycling of these wastes, with agro-industrial wastes (fruit, vegetable, and plant wastes) standing out.

Ding et al. (2023) explore the impact of artificial intelligence (AI) development on China's carbon emission reduction. The study examines the impact of AI development on carbon emissions using a balanced panel dataset of 30 Chinese provinces from 2006 to 2019 and the spatial Durbin model (SDM). According to the study, AI development efficiently helps to carbon emission reduction, and the decrease effect is consistent across different spatial weights. In addition, the study identifies two key AI mediation impacts on carbon emissions reduction, namely technique and structural effects. According to the heterogeneity study, AI reduces carbon emissions via a spatial spillover effect, with the effect being larger in central and western China. The paper makes recommendations to encourage AI development in China and reduce carbon emissions. Overall, the study adds to the existing literature by investigating the impact of AI development level on carbon emissions and per capita carbon emissions, as well as developing an index system that employs the panel entropy approach to measure the index of AI development in various Chinese provinces.

Shahzad et al. (2023) investigate the quantiles-based connectedness and non-linear causality-in-quantiles relationship of AI corporations with basic materials and oil and gas companies, as well as their Islamic marketplaces. Further the study examines two perspectives: before and after the COVID-19 pandemic (for the period May 18, 2018–June 1, 2022). It has been discovered that in the network of AI-based investments and companies related to basic materials and the oil and gas industries, AI is a net recipient of shocks both before and during the COVID-19 era, with a higher intensity of shock-receiving in the normal market and during the COVID-19-affected period than in the upper and lower tails and prior to the COVID-19 period. On the other hand, in the middle quantiles of the COVID-19 circumstance, both the Islamic and traditional basic materials and oil & gas industries appear to be a non-linear cause-in-variance of the AI technology.

Using machine learning (ML) techniques, Kahia et al. (2022) attempt to extend prior environmental economics literature by investigating the relationship between disaggregated energy use, economic growth, and environmental quality in Saudi Arabia. Using data from 1980 to 2020, the study discovers that lowering CO2 emissions in Saudi Arabia requires a complete transition from fossil to renewable resources, as well as a more viable path to sustainability. According to ML-based regression and prediction, CO2 emissions will continue to rise until 2024. Beginning in 2025 and beyond, the reduction in emissions (i.e., CO2 emissions) must be supported by an increase in the use of renewable energies to ensure stable economic growth.

Aldieri et al. (2022) aim to explore the interaction between climate change and the technology diffusion process by exploring the spillovers deriving from enterprises from the same technical field, defined as "intra-industry". This article investigates the impact of climate change on two major innovation variables in three economic zones (Europe, Japan, and the United States) from 2002 to 2017: total company R&D investments and knowledge innovation spillovers in the energy field. The data show that the overall R&D process is harmful to climate change variables, while the knowledge dissemination process of energy breakthroughs is beneficial to climate change mitigation. The findings reveal that the firm's investments in R&D have a positive impact on CO2, as stated in hypothesis 1. Conversely, the negative relationship formulated in hypothesis 2, arises when considering the knowledge spillovers among firms in energy innovations.

Using panel data from 2011 to 2018, Hao et al. (2023) calculate the digital economy level (DIGE) and quantifies environmental efficiency (EE) using the SBM-DEA model. The study then empirically analyzes the spatial effect of DIGE on EE and the probable impact mechanism using four distinct spatial models and the mediation model. The following are the key study findings: (i) EE showed a steady but moderate rise and obvious regional agglomeration with spatial differentiation in regions. (ii) DIGE may greatly increase EE, and there was a discernible "spatial synergistic effect," exhibited as a spatial spillover effect of "$1 + 1 > 2$." (iii) The mediating effect of TFP growth rate demonstrated that technical advancement might work in tandem with DIGE to achieve EE augmentation. (iv) The geographically and temporally weighted regression (GTWR) model revealed that spatial heterogeneity from east to west exhibited a "band-like increase" characteristic.

Liang et al. (2023) create a revolutionary deep reinforcement learning (DRL) system for multi-step crude oil price forecasting in three main commodity exchanges. The suggested algorithm incorporates two major enhancements: (a) For accuracy and generalization, a dynamic action exploration mechanism based on stochastic processes conforming to commodity price variations is devised. (b) To increase the network's learning efficiency, a dynamic update policy of network parameters based on approximate optimization theory is created. The effectiveness of the method is experimentally validated and compared to five state-of-the-art algorithms. The following are the key findings. (a) DRL's forecasting capacity is developed using crude oil price forecasting and

may be expanded to other natural resource price forecasting. (b) The suggested technique is very applicable to the data of the world's three major crude oil price benchmarks. (c) The suggested algorithm's accuracy decreases indistinctly when the forecasting step is increased; nonetheless, it accurately reflects the real price and fluctuation.

2.1. Coverage and expansions of the special issue

To better understand the current state of literature on the topics addressed in this special issue, we conduct a thematic analysis using the keywords used by the papers featured in this SI. The thematic map that emerges from this study (Fig. 1) directs us to the current state of knowledge in this field. The map categorizes the topics based on centrality and density (Cobo, M.J., Martınez, M.A., Gutierrez-Salcedo, M., Fujita, H. and Herrera-Viedma, 2015). The degree of connection between the themes is denoted by centrality, while the intensity of internal linkages within a topic is measured by density (Aparicio et al., 2019). The strategic diagram is divided into four quadrants that represent four types of themes: the motor theme, the peripheral/niche theme, the emerging or declining theme, and the basic theme (Sharma et al., 2022).

The basic themes quadrant is dedicated to a number of the articles included in this SI. The basic quadrant is comprised of three themes, which are listed in descending order of bubble size: development (which pertains to the digitalization era, sustainable development, and financial development), economic development (which includes digital economy, volatility, and the circular economy, economic growth), and resources (which includes natural resources, the SDGs, and climate change). These themes are particularly important to this field, meaning that they may be less relevant, yet they have evolved significantly throughout the years. The use of AI to the efficient use of natural resources is the primary emphasis of studies falling under these areas (Chengmin X. Li et al., 2023). Another work by Alan and Köker (2023) addresses the issue of agricultural waste recycling by building a circular economy that employs novel technology. To make the most of our natural resources in this digital age, we need to improve and expand the existing body of literature on energy policy and planning. There is a lot of room for growth in the economy and resources subthemes. There is a dearth of literature, for example, concerning the connection between ecology, life cycle assessment, and e-waste. In the future, scholars and practitioners may examine these specific concerns and work together to conduct significant studies to achieve sustainability.

The motor quadrant contains themes with high centrality and density, such as *Artificial intelligence* (AI, digital currencies, stablecoins), *CO2 emission* (Carbon emission, risk, renewable, decarbonization), and *Impact* (Growth, financial development, governance, environmental impact). These are the most extensively investigated topics in the discipline. The majority of the work in these areas is quantitative research that sheds light on the dynamic interaction between CO2 emissions, energy depletion, renewable energy development, and economic growth (Hossain et al., 2023). Yan et al. (2023) seeks to uncover elements that can assist developing nations in lowering their carbon dioxide emissions by demonstrating that using energy productively and increasing the amount of renewable energy in national energy consumption profiles can reduce carbon emissions. The usage of renewable energy and its effects on the environment, climate, ecology, health, and the economy are all interconnected topics that could use more investigation from future scholars.

In the top-left quadrant of the thematic map, which indicates the niche/peripheral theme, there is only one theme, *Utilization*, (which is related to Adoption, identification, and best usage). Publications investigating the optimal use of digital technology about natural resources and how this utilization might contribute to the attainment of sustainable development goals are concentrated within this theme (Bansal et al., 2022).

The following terms are located in the emerging quadrant: *environmental policy* (renewable energy, framework, energy policy, clean energy), *innovation* (innovation efficiencies, technologies, digital disruption), and *price* (machine learning pricing, crude oil price,

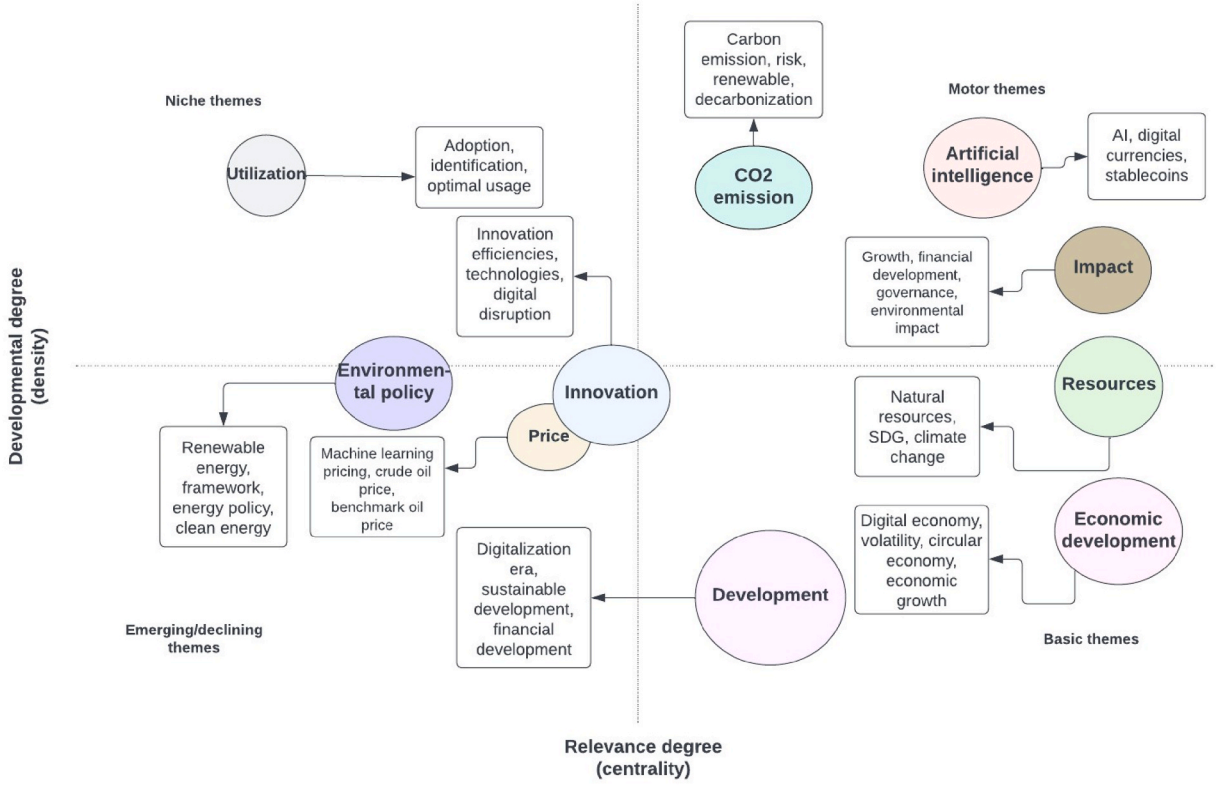

Fig. 1. Thematic map of the scholarship in the related areas.

benchmark oil price). This suggests that there is room for further research in this area. As this area of study develops, environmental policy and innovation may shift its focus to the basic or motor quadrant. Among the many topics covered by the studies housed in this quadrant are investigations into the effects of artificial intelligence on the effectiveness of corporate innovation strategies (Aldieri et al., 2022) and the relationship between R&D investments and knowledge innovation and climate change (Chengming Li et al., 2023; Ye and Lin, 2023).

Motivated by the papers in this SI, we identify many research opportunities and approaches in a new and fast-developing field, that can be investigated further. These include:

1 To use natural resources efficiently in the digital era by integrating AI into energy policy and planning. This can involve the development of AI-based models that can optimize energy usage, resource allocation, and sustainable energy planning.
2 To investigate using AI and new technologies to create circular economies, particularly in agricultural waste recycling. This research can build AI-driven waste management and resource utilization solutions for sustainable agriculture and natural resource conservation.
3 To advance digital energy policy and planning literature. Future studies can examine how AI and digital technology affect energy policy, resource allocation, and sustainable energy development. AI may be used to optimize energy systems, improve efficiency, and encourage sustainable energy practices.
4 Future studies can fill the gap in ecology, life cycle assessment, and e-waste literature. Scholars and practitioners can work together to study how AI can improve life cycle evaluations, reduce e-waste, and promote ecological sustainability.
5 Research can examine AI's changing role in environmental policy and innovation. This may involve studying how AI affects business innovation strategy, R&D funding, and climate change knowledge innovation. AI may progress environmental policy and promote sustainability innovation in future research.
6 Given the interdependence of renewable energy, ecology, climate, and economy, AI's effects on renewable energy development need additional study. Future research can use AI to optimize renewable energy systems, assess environmental implications, and promote sustainable energy transitions.

The future research directions indicated in this editorial offer a thorough roadmap for integrating AI into numerous facets of sustainable development, particularly natural resource management and energy policy. Scholars and practitioners may contribute to effective and sustainable resource consumption by incorporating AI into energy policy and planning, optimizing resource allocation, and supporting circular economies. The appeal to enhance digital energy policy and planning literature emphasizes the significance of using AI to optimize energy systems and encourage sustainable habits. In research, the main goals are to use AI to close ecological gaps, plan energy efficiently, and support circular economies. On the policy front, there is a push to develop AI-integrated plans for energy planning, waste management, and environmental legislation. In practice, stakeholders are advised to use AI in areas such as energy efficiency, waste management, and sustainable development methods.

The SI comprises a wide range of research approaches, viewpoints, and directions that transcend national and international research boundaries. It was our deliberate intention to include conceptual, empirical, analytical, and review articles to increase the diversity of methodological approaches. Our goal is that the issue will contribute to the fast-paced advancement of this field of academic study and assist policymakers, companies, and individual stakeholders in making better decisions as we all work together to create a more just and sustainable society.

References

Alan, H., Köker, A.R., 2023. Analyzing and mapping agricultural waste recycling research: an integrative review for conceptual framework and future directions. Resour. Pol. 85 (August 2022) https://doi.org/10.1016/j.resourpol.2023.103987.

Aldieri, L., Bruno, B., Lorente, D.B., Paolo Vinci, C., 2022. Environmental innovation, climate change and knowledge diffusion process: how can spillovers play a role in the goal of sustainable economic performance? Resour. Pol. 79 (September), 103021 https://doi.org/10.1016/j.resourpol.2022.103021.

Aparicio, G., Iturralde, T., Maseda, A., 2019. Conceptual structure and perspectives on entrepreneurship education research: a bibliometric review. European Research on Management and Business Economics 25 (3), 105–113. https://doi.org/10.1016/j.iedeen.2019.04.003.

Balsalobre-Lorente, D., Contente dos Santos Parente, C., Leitão, N.C., Cantos-Cantos, J. M., 2023. The influence of economic complexity processes and renewable energy on CO2 emissions of BRICS. What about industry 4.0? Resour. Pol. 82, 103547 https://doi.org/10.1016/j.resourpol.2023.103547.

Bansal, S., Singh, S., Nangia, P., 2022. Assessing the role of natural resource utilization in attaining select sustainable development goals in the era of digitalization. Resour. Pol. 79, 103040 https://doi.org/10.1016/j.resourpol.2022.103040.

Cevik, E.I., Gunay, S., Zafar, M.W., Destek, M.A., Bugan, M.F., Tuna, F., 2022. The impact of digital finance on the natural resource market: evidence from DeFi, oil, and gold. Resour. Pol. 79, 103081 https://doi.org/10.1016/j.resourpol.2022.103081.

Chen, F., Tiwari, S., Mohammed, K.S., Huo, W., Jamróz, P., 2023. Minerals resource rent responses to economic performance, greener energy, and environmental policy in China: Combination of ML and ANN outputs. Resour. Pol. 81, 103307 https://doi.org/10.1016/j.resourpol.2023.103307.

Cobo, M.J., Martınez, M.A., Gutierrez-Salcedo, M., Fujita, H., Herrera-Viedma, E., 2015. 25 years at Knowledge-based systems: a bibliometric analysis. Knowl. Base Syst. 80, 3–13.

Ding, T., Li, J., Shi, X., Li, X., Chen, Y., 2023. Is artificial intelligence associated with carbon emissions reduction? Case of China. Resour. Pol. 85 (PB), 103892 https://doi.org/10.1016/j.resourpol.2023.103892.

Goralski, M.A., Tan, T.K., 2020. Artificial intelligence and sustainable development. Int. J. Manag. Educ. 18 (1), 100330 https://doi.org/10.1016/j.ijme.2019.100330.

Ha, L.T., 2023. An investigation of digital integration's importance on smart and sustainable agriculture in the European region. Resour. Pol. 86 (PA), 104158 https://doi.org/10.1016/j.resourpol.2023.104158.

Hao, X., Wen, S., Xue, Y., Wu, H., Hao, Y., 2023. How to improve environment, resources and economic efficiency in the digital era? Resour. Pol. 80 (December 2022), 103198 https://doi.org/10.1016/j.resourpol.2022.103198.

Hossain, M.R., Singh, S., Sharma, G.D., Apostu, S.-A., Bansal, P., 2023. Overcoming the shock of energy depletion for energy policy? Tracing the missing link between energy depletion, renewable energy development and decarbonization in the USA. Energy Pol. 174, 113469 https://doi.org/10.1016/j.enpol.2023.113469.

Kahia, M., Moulahi, T., Mahfoudhi, S., Boubaker, S., Omri, A., 2022. A machine learning process for examining the linkage among disaggregated energy consumption, economic growth, and environmental degradation. Resour. Pol. 79 (June), 103104 https://doi.org/10.1016/j.resourpol.2022.103104.

Kolte, A., Roy, J.K., Vasa, L., 2023. The impact of unpredictable resource prices and equity volatility in advanced and emerging economies: an econometric and machine learning approach. Resour. Pol. 80 (December 2022) https://doi.org/10.1016/j.resourpol.2022.103216.

Li, A., 2023. An application of extenics, spatial factors, and natural resource market in China: the role of artificial intelligence and geopolitical risk. Resour. Pol. 81, 103289 https://doi.org/10.1016/j.resourpol.2022.103289.

Li, ChangZheng, Razzaq, A., Ozturk, I., Sharif, A., 2023. Natural resources, financial technologies, and digitalization: the role of institutional quality and human capital in selected OECD economies. Resour. Pol. 81, 103362 https://doi.org/10.1016/j.resourpol.2023.103362.

Li, Chao, Zhang, Y., Li, X., Hao, Y., 2024. Artificial intelligence, household financial fragility and energy resources consumption: impacts of digital disruption from a demand-based perspective. Resour. Pol. 88, 104469 https://doi.org/10.1016/j.resourpol.2023.104469.

Li, Chengming, Xu, Y., Zheng, H., Wang, Z., Han, H., Zeng, L., 2023. Artificial intelligence, resource reallocation, and corporate innovation efficiency: evidence from China's listed companies. Resour. Pol. 81, 103324 https://doi.org/10.1016/j.resourpol.2023.103324.

Li, X., Sengupta, T., Si Mohammed, K., Jamaani, F., 2023. Forecasting the lithium mineral resources prices in China: evidence with Facebook Prophet (Fb-P) and artificial neural networks (ANN) methods. Resour. Pol. 82, 103580 https://doi.org/10.1016/j.resourpol.2023.103580.

Liang, X., Luo, P., Li, X., Wang, X., Shu, L., 2023. Crude oil price prediction using deep reinforcement learning. Resour. Pol. 81 (June 2022), 103363 https://doi.org/10.1016/j.resourpol.2023.103363.

Moch, E., 2018. The Industrial Revolution of Artificial Intelligence : A New Era of Automation and Innovation.

Naudé, W., 2021. Artificial intelligence: neither Utopian nor apocalyptic impacts soon. Econ. Innovat. N. Technol. 30 (1), 1–23. https://doi.org/10.1080/10438599.2020.1839173.

Pan, M., Zhao, X., lv, K., Rosak-Szyrocka, J., Mentel, G., Truskolaski, T., 2023. Internet development and carbon emission-reduction in the era of digitalization: where will resource-based cities go? Resour. Pol. 81, 103345 https://doi.org/10.1016/j.resourpol.2023.103345.

Peng, X., Mousa, S., Sarfraz, M., Abdelmohsen A, N., Haffar, M., 2023. Improving mineral resource management by accurate financial management: studying through artificial

intelligence tools. Resour. Pol. 81, 103323 https://doi.org/10.1016/j.resourpol.2023.103323.
Shahzad, U., Ghaemi Asl, M., Panait, M., Sarker, T., Apostu, S.A., 2023. Emerging interaction of artificial intelligence with basic materials and oil & gas companies: a comparative look at the Islamic vs. conventional markets. Resour. Pol. 80 (December 2022), 103197 https://doi.org/10.1016/j.resourpol.2022.103197.
Sharma, G.D., Kraus, S., Liguori, E., Bamel, U.K., Chopra, R., 2022. Entrepreneurial challenges of COVID-19: Re-thinking entrepreneurship after the crisis. J. Small Bus. Manag. 00 (00), 1–23. https://doi.org/10.1080/00472778.2022.2089676.
Singh, S., Bansal, P., Hosen, M., Bansal, S.K., 2023. Forecasting annual natural gas consumption in USA: application of machine learning techniques- ANN and SVM. Resour. Pol. 80 (December 2022), 103159 https://doi.org/10.1016/j.resourpol.2022.103159.
Sood, K., Singh, S., Behl, A., Sindhwani, R., Kaur, S., Pereira, V., 2023. Identification and prioritization of the risks in the mass adoption of artificial intelligence-driven stable coins: the quest for optimal resource utilization. Resour. Pol. 81 (December 2022), 103235 https://doi.org/10.1016/j.resourpol.2022.103235.
Wang, Z., Deng, Y., Zhou, S., Wu, Z., 2023. Achieving sustainable development goal 9: a study of enterprise resource optimization based on artificial intelligence algorithms. Resour. Pol. 80 (December 2022), 103212 https://doi.org/10.1016/j.resourpol.2022.103212.
Yan, C., Murshed, M., Ozturk, I., Siddik, A.B., Ghardallou, W., Khudoykulov, K., 2023. Decarbonization blueprints for developing countries: the role of energy productivity, renewable energy, and financial development in environmental improvement. Resour. Pol. 83, 103674 https://doi.org/10.1016/j.resourpol.2023.103674.
Ye, X., Lin, R., 2023. Financial market risk and innovation nexus with growth: channelizing the role of natural resources volatility for United States. Resour. Pol. 81, 103267 https://doi.org/10.1016/j.resourpol.2022.103267.

Ayfer Gedikli
Düzce University, Düzce, Turkey

Gagan Deep Sharma *
Széchenyi István University of Győr, Győr, Hungary
University School of Management Studies, Guru Gobind Singh Indraprastha University, New Delhi, India
Lebanese American University, Beirut, Lebanon

Seyfettin Erdoğan
Istanbul Medeniyet University, Turkey

Shawkat Hammoudeh
University of Kansas, USA

* Corresponding author.
E-mail address: angrishgagan@gmail.com (G.D. Sharma).