Review

TRENDS IN CURRENT INTERFACES BETWEEN FINTECH, SUSTAINABLE DEVELOPMENT AND METHODS: A SCIENTIFIC REVIEW

Gintare Pauliukeviciene, and Jelena Stankeviciene

Abstract. This study aims to conduct a scientific review of the interfaces among fintech, sustainable development, and methods. It will also evaluate the trends of this interface in recent years to discover the most suitable methods for further research on the sustainable development of the fintech industry. A descriptive and evaluative analysis of the recent scientific literature in the Scopus and Web of Science (WoS) databases is carried out for this purpose via the keywords "FinTech," "Sustainable development," and "Method." The results of the scientific review indicate several main findings: (1) the first traces of the selected keywords interface began to appear in 2017-2018, which gained momentum in 2019-2021, and a growth spurt is visible in 2021-2024; (2) the top 20 countries with the most articles for the selected keywords interface in Scopus and WoS cover 5 continents out of 7, which demonstrates the relevance of the selected keywords interface in today's context on a global scale; (2) Asian countries are the most interested in research on the interface of selected keywords with China at the forefront; (3) EU countries are currently not very interested in research on the interface of selected keywords; (4) Ukraine pays special attention to the research of selected keywords, as it is second only to China in terms of productivity, and second only to the UK in scientific journals; and (5) an evaluative analysis of Scopus data has shown that the method of moments quantile regression (MMQR) is the most suitable for research on the interface between fintech and sustainable development. The results of this study refine the most appropriate methods for studying the sustainable development of the fintech industry, which, to date, has not been refined and clearly named. The results of the study can be used by parties interested in this topic as a guideline or basis for further research.

Keywords: FinTech; sustainable development; method; interface

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1. Introduction

Fintech and sustainability are both driving forces that are transforming the finance industry [1-10]. There is no financial institution that does not have a stake in it. No startup does not derive its existence from it. What is striking, however, is that these two are rarely found in combination.

In the 2020s, when the fintech sector began to grow rapidly during the COVID-19 pandemic, the potential of fintech to significantly contribute to sustainable development, mainly through the growth of financial inclusion, began to escalate at the political level on a global scale [11-17]. According to the UN Capital Development Fund, financial inclusion enables the achievement of the Sustainable Development Goals, also known as SDGs, which are targeted at 8 of the 17 goals [18]. Meanwhile, the rapid growth of fintech has facilitated the digitalisation of finance and thus of financial inclusion, which in turn has made it possible to contribute to the achievement of 13 of the 17 SDGs [19].

Sustainable development is a combination of the sustainable development of society, the economy and the environment [20]. The economic aspect is a vital component of the SDGs, as it intersects with several key areas, such as poverty eradication; decent work and economic growth; industry, innovation, and infrastructure; and reduced inequalities. UNs recognise that sustained, inclusive, and sustainable economic growth is an indispensable requirement for prosperity and quality of life [21]. However, it is often forgotten that sustainable economic development is impossible without sustainable development of its constituent parts—economic sectors or industries—including fintech. Therefore, it is essential to study the links between fintech and sustainable development not only through the prism of FT4SD, as fintech is for sustainable development but also from the point of view of the sustainable development of the fintech industry itself. At this point, a scientific problem is encountered—the sustainable development of the fintech industry has not been defined in the scientific literature to date. Sustainability, through its complex and disparate historical origins, remains both context specific and ontologically open; thus, any rigorous operationalisation requires an explicit description of how it is understood [20]. Accordingly, to define the sustainable development of the fintech industry, it is crucial to evaluate the links between fintech and sustainable development in the latest scientific literature and the methods used to explore their interlinkages, which has not been done to date. A scientific bibliometric analysis approach was employed (2022) to review 705 academic publications from WoS related to "FinTech" from 2006-2021, which indicated that the integrated application of FinTech in management, technology, and policy is coming [22]. A similar result was obtained (2022) through the scientific mapping of 574 articles published from 2011-2022 from Scopus, which identified six research themes associated with fintech research, such as economic development and financial inclusion [23,24]. A bibliometric analysis (2023) of 103 research documents published in Scopus from 1991-2022, using the keyword "Sustainability" in relation to financial services, revealed that the full sustainable transformation of the financial services sector is critical globally [25,26]. A bibliometric analysis (2023) of 695 research papers on the role of digital financial services in promoting financial access and economic development in Scopus from 2010-2023 according to the keywords "FinTech" and "Financial Inclusion" underscored the importance of interdisciplinary collaboration, global cooperation, and vigilance in addressing the challenges and opportunities presented by the rapid adoption of digital financial services in

promoting inclusive and sustainable economic development [27]. However, all these bibliometric analyses are focused on fintech analysis, and their relationship with the sustainability aspect is minimal. The only bibliometric analysis that has explored both aspects of fintech and sustainability was conducted by Ellili (2023), who highlighted the latest trends in the literature on the relationship between fintech and sustainability by applying a bibliometric review of 59 documents published in Scopus from 2015-2021. The findings of the search for the keywords "FinTech" or "Financial Technology" and "Sustainability" identified three major clusters (sustainability performance, blockchain technology, digital transformation) and highlighted the importance of FinTech in the development and execution of sustainability strategies and practices [28,29]. However, this analysis did not explore the relationship between fintech and sustainability to define the sustainable development of the fintech industry and discover the most appropriate methods for its assessment. Accordingly, this issue justifies the need for further research.

Therefore, the main aim of this article is to conduct a scientific review on the interface of fintech, sustainable development and methods, which has never been done before, and to evaluate the trends of this interface in recent years to discover the most suitable methods for further research on the sustainable development of the fintech industry, which has not been defined to date. For this purpose, descriptive and evaluative analysis of the recent scientific literature in Scopus and WoS is carried out via the keywords "FinTech," "Sustainable development," and "Method." This bibliometric analysis of the scientific literature revealed general global trends and methodological perspectives for further research, which contributes to the current theoretical and practical framework.

2. Methods

Systematic reviews play many critical roles, such as (i) providing syntheses of the state of knowledge in a field, from which future research priorities can be identified; (ii) addressing questions that otherwise could not be answered by individual studies; (iii) identifying problems in primary research that should be rectified in future studies; and (iv) generating or evaluating theories about how or why phenomena occur [30]. Therefore, to ensure that this review is valuable to users, the PRISMA 2020 statement recommendations were adapted in the process.

The search in Scopus was carried out on February 23, 2024, using the keywords "FinTech" and "Sustainable" and "Development" and "Method" in English language articles. It was conducted in two volumes of data—in all fields and within the article title, abstract and keywords. In both cases, the subject area was limited to "Economics, Econometrics and Finance," which amounts to 48% of all subject areas within the selected keywords. The oldest article was from 2017, so the search was not narrowed down to a shorter period to objectively assess the evolution of scientific literature on the chosen topic. The broad bibliographic search yielded 1270 results between 2017 and 2024, whereas the narrower search yielded 37 results between 2020 and 2024.

The search in the WoS Core Collection was carried out on the same date using the same keywords, languages and volumes of data. However, this time, the search area was limited to "Economics," "Business Finance," and "Social Sciences Mathematical Methods," which amounts to 29% of all subject areas within the selected keywords. The oldest article, in this

case, was from 2020. The broad bibliographic search yielded 21 results between 2020 and 2024, whereas the narrower search yielded 18 results between 2020 and 2024.

The research results were analysed in two steps—descriptive and evaluative analysis—where VOSviewer software was applied. To evaluate the co-occurrence of the selected keywords and the total link strength, keyword co-occurrence analysis was performed. First, the full texts of 1270 Scopus articles were downloaded and uploaded to VOSviewer, choosing the full counting method, meaning that each co-occurrence link has the same weight [31]. The selected threshold of the minimum number of keyword occurrences was 30. Therefore, of the 5109 keywords, 35 met the threshold. The total strength of the co-occurrence links with other keywords was calculated for each of these keywords. Therefore, 35 keywords with the greatest total link strength were selected. The same procedure was repeated with WoS data. However, its results are not included in the article because they do not reveal any new facts. Figure 1 shows the PRISMA flow diagram of the Scopus systematic review.
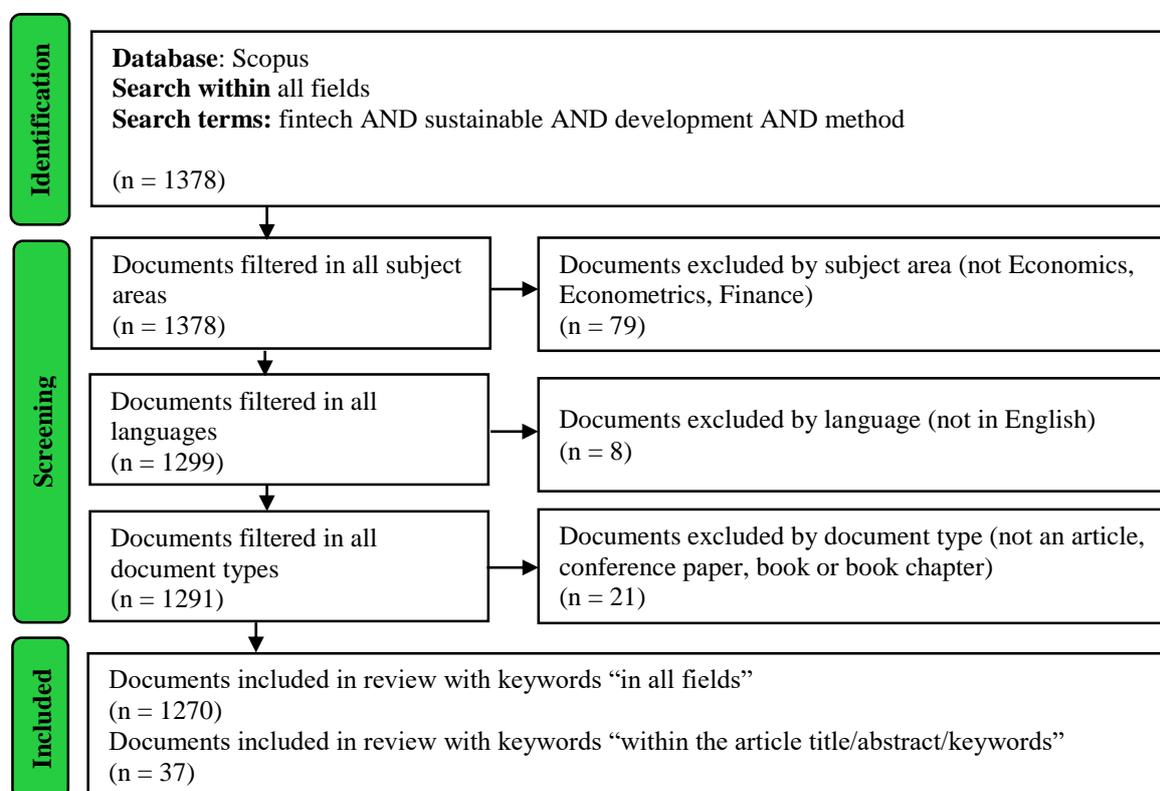
Figure 1. The adaptation of the PRISMA 2020 flow diagram for the scientific review of the Scopus database only

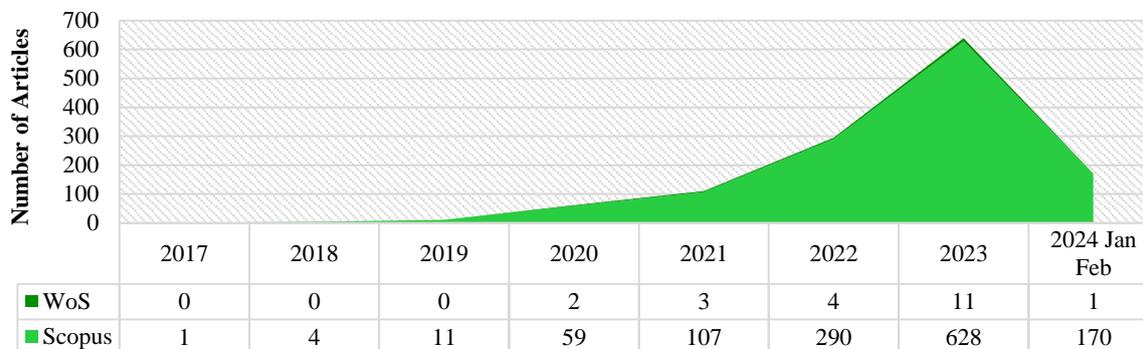Source*: Prepared by the authors according to the PRISMA 2020 recommendations, 2024 [30].*

3. Results
3.1. Descriptive analysis

Figure 2 shows the growth trend of scientific research based on selected keywords in Scopus and WoS when the search was carried out in all fields. This figure shows that the first traces of "FinTech," "Sustainable development," and "Method" interfaces began to appear in 2017-2018

and gained momentum in 2019-2021, and a clear growth spurt was visible in 2021-2024. In less than two months of the year 2024, the intermediate result of the years 2021-2022 was almost achieved, so the relevance of the topic seems to be unquestionable.

	2017	2018	2019	2020	2021	2022	2023	2024 Jan Feb
WoS	0	0	0	2	3	4	11	1
Scopus	1	4	11	59	107	290	628	170

Figure 2. The growth trend of scientific research on the basis of selected keywords in Scopus and WoS, all fields
Source*:* Prepared by the authors according to Scopus and WoS data, 2024.

Moreover, after conducting an identical search but searching for the keywords selected for the study only in the titles, abstracts and keywords of the articles, where only the most important keywords reflecting the essence of the articles are included, a slightly different, more modest trend can be seen, the beginning of which is 2020.

	2020	2021	2022	2023	2024 Jan Feb
Scopus	1	2	3	11	20
WoS	2	3	3	9	1

Figure 3. The growth trend of scientific research on the basis of selected keywords in Scopus and WoS within the article title, abstract and keywords
Source*:* Prepared by the authors according to Scopus and WoS data, 2024.

This growth trend is illustrated in Figure 3, where interest in the keyword interface has been growing steadily since the 2020s in both Scopus and WoS, with a clear growth spurt, visible in 2023, and more articles were written in Scopus from January–February 2024 alone than in the last four years combined [32–51]. This only justifies the importance of the "FinTech," "Sustainable development," and "Method" interfaces. On the basis of these research dissemination trends, the importance of the keyword interface began in 2017 but became evident in the 2020s during the COVID-19 pandemic, with the rapid growth of the e-commerce and fintech industries on a global scale. Therefore, this justifies the relevance of the chosen topic and keywords and the need for further research. Table 1 presents the results of the

countries with the most articles for the keywords FinTech, sustainable development and method in Scopus and WoS in total.

Table 1. Countries with the most articles for the keywords "FinTech," "Sustainable development," and "Method"

Rank	Countries	Scopus	WoS	Total	Rank	Countries	Scopus	WoS	Total
1	China	382	6	388	9-11	Turkey	52	0	52
2	Ukraine	154	3	157	12	Vietnam	45	0	45
3	Indonesia	98	2	100	13	UAE	44	0	44
4-5	India	96	0	96	14	Australia	43	0	43
	Malaysia	95	1	96	15	Italy	37	2	39
6	UK	70	0	70	16	Poland	36	2	38
7	US	65	0	65	17	Russia	37	0	37
8	Pakistan	59	2	61	18	Spain	36	0	36
9-11	Saudi Arabia	52	0	52	19-20	South Africa	34	0	34
	Taiwan	52	0	52		Germany	33	1	34

Source: Prepared by the authors according to Scopus and WoS data, 2024.

This table includes 20 countries rather than the usual 10 because it shows several interesting world trends worth noting:

- − The majority of the top 20 list (50%) is made up of Asian countries, with China at the forefront with 388 scientific articles, which amounts to 30% of all scientific research for selected keywords, which is partly unsurprising given the size of these countries' populations and the speed of fintech adaptation in recent years. In terms of achieving the SDGs, China currently ranks only 63rd in the world, and this problem may be one of the reasons for large-scale scientific research [52].
- − Not a single EU country made it in the top 10. These circumstances are worthy of deeper analysis, bearing in mind the advanced sustainable development of the EU and the increased attention of the EU to the regulation of the rapid development of the fintech industry.
- − Italy and Poland took the highest positions among the EU countries, which is also unexpected, considering that they are not the leaders of fintech development or sustainable development in the EU. With respect to achieving the SDGs, Italy currently ranks 24th globally, whereas Poland ranks 9th. In this case, it is worth mentioning that the first eight places are occupied exclusively by countries of the European continent [52]. However, similar to China, this problem may be one of the reasons for large-scale scientific research.
- − Ukraine took a high second place on the list. At the same time, Russia also entered the second top ten in 17th place, which is also surprising given the political unrest in these countries, which naturally affects all areas of the state. With respect to achieving the SDGs, Ukraine currently ranks 38th globally, whereas the Russian Federation is 49th [52].
- − The top 20 list covers five continents out of seven, with the US in 7th place, Australia in 14th place, and South Africa in 19th-20th place, excluding only South America and Antarctica, which demonstrates the grounded relevance of the selected keyword interface in today's context on a global scale.

In terms of global statistics, out of 195 countries recognised by the UN, 105 countries since 2017 have prepared at least one scientific article on the interface between FinTech, sustainable development and the method, accounting for 54% of the global total. A visual representation of these statistics is provided in Figure 4.
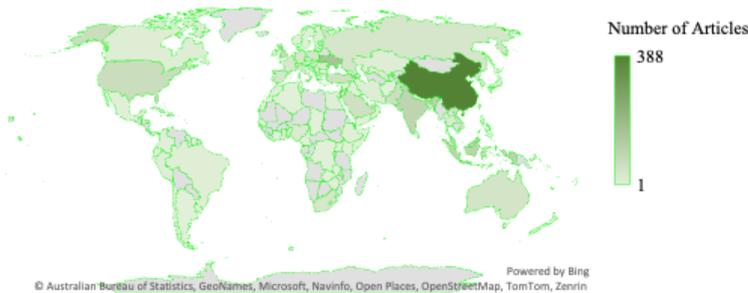
Figure 4. Distribution of scientific research based on selected keywords in the Scopus and WoS databases on a global scale
Source*:* Prepared by the authors according to Scopus and WoS data, 2024.

Speaking more broadly about the topic of the EU statistical data with the selected keyword interface, 25 of the 27 EU member states, which account for 93% of EU countries' involvement, have prepared at least one scientific article since 2017. A visual representation of these statistics is provided in Figure 4, which shows that only Estonia and Slovenia are not productive in this regard.

In summary, out of 1291 scientific articles in Scopus and WoS, 331 were prepared by EU countries, accounting for 26% of all scientific research. Accordingly, the EU examines the relationships of selected keywords less than China alone does. As shown in Figure 5, the relevance of the topic in the form of scientific research is more visible in Central-Southern Europe.

Figure 5. EU-level distribution of research in Scopus and WoS based on selected keywords
Source*:* Prepared by the authors according to Scopus and WoS data, 2024.

Table 2 presents the top ten scientific journals covering the most articles for selected keywords in Scopus. Two clearly leading journals stood out: the UK-based international journal "Resources Policy" devoted to economic and policy issues related to mineral and fossil fuel extraction, production and use, with 151 publications in total during the 2021-2024 period, of which 135 were published in 2023-2024; and the Ukraine-based international journal "Financial and Credit Activity Problems of Theory and Practice," devoted to studying problems of modern financial and credit systems and economies in general at the global, national and local levels, with 125 publications in total during the 2022-2023 period. The main difference between the volumes of these two journals is that during the months of January–February 2024, the first journal published 60 scientific articles, whereas the second journal published 0.

Table 2. Top 10 scientific journals with the most articles for the keywords "FinTech," "Sustainable development," and "Method" in Scopus

No.	Scientific Journal	H-Index	Country	Number of articles
1	Resources Policy	95	United Kingdom	151
2	Financial And Credit Activity Problems of Theory and Practice	N/A	Ukraine	125
3	Journal of Risk and Financial Management	7	Switzerland	46
4	Financial Innovation	36	Germany	38
5	Journal of Open Innovation Technology Market and Complexity	38	Switzerland	36
6	Energy Economics	187	Netherlands	33
7	Economic Research Ekonomska Istrazivanja	43	United Kingdom	29
8	Journal of The Knowledge Economy	38	Germany	26
9	Environment Development and Sustainability	72	Netherlands	24
10	Journal of Financial Services Marketing	25	United Kingdom	22

Source: Prepared by the authors according to Scopus and WoS data, 2024.

All the other eight leading journals maintain a stable, slowly growing annual volume of articles on the basis of selected keywords from 2019 or 2020. For example, the Germany-based journal "Financial Innovation" rose from 1 article in 2020 to 12 articles in 2023 and 13 articles during the first month of 2024. In summary, the general trends in scientific journals indicate a gradually increasing relevance of the topic internationally. Table 3 presents the relationships between the WoS bibliographic search results and the UN Sustainable Development Goals. The results obtained in the field of economic sciences that are most closely related to SDG "08 Decent Work and Economic Growth" are natural.

Table 3. Relation of WoS bibliographic search results to UN Sustainable Development Goals

Sustainable Development Goals	Number	Sustainable Development Goals	Number
08 Decent Work and Economic Growth	6	10 Reduced Inequality	2
01 No Poverty	5	04 Quality Education	1
09 Industry Innovation and Infrastructure	5		

Source: Prepared by the authors according to Scopus and WoS data, 2024.

However, the results obtained according to the selected keywords are related not only to the economy but also to society, since SDG 08, SDG 09, and SDG 10 in the scientific literature are attributed to the economy, and SDG 01 and SDG 04 are attributed to society [53-54].

3.2. Evaluative analysis

Figure 6 presents a network visualisation of the co-occurrence analysis of the keywords "FinTech," "Sustainable development," and "Method" in Scopus, prepared via VOSviewer software. Three clusters of keywords have been identified, the largest of which covers sustainable development with 26 keywords, the second smallest one covers the fintech industry and its connections with six keywords, and the smallest one covers financial markets and commerce with three keywords.

Figure 6. Network visualisation of co-occurrence analysis of keywords "FinTech," "Sustainable development," and "Method" in Scopus
Source*:* Prepared by the authors according to the Scopus data via VOSviewer software, 2024 [55].

Despite the difference in cluster sizes, the interrelationships between sustainable development and fintech are evident when the quantity of connections is assessed. Both "FinTech" and "sustainable development" are equally relevant keywords in the scientific literature, whereas "financial inclusion" and "economic growth" are the closest to them in terms of relevance. To identify the most suitable methods for analysing the links between fintech and sustainable development and defining the sustainable development of the fintech industry, five methods, most associated with fintech and sustainable development, have been identified with the help of this co-occurrence analysis, as shown in Figure 6 and Figure 7, and presented in detail in Table 4.

Table 4. Research methods were obtained via a Scopus bibliometric analysis with the keywords "FinTech," "Sustainable development," and "Method"

No.	Keyword (research method)	Occurrences	No.	Keyword (research method)	Total link strength
1	Regression analysis	44	1	Economic analysis	294
2	Economic analysis	38	2	Regression analysis	291
3	Quantile regression	36	3	Method of moments	252

No.	Keyword (research method)	Occurrences	No.	Keyword (research method)	Total link strength
4	Method of moments	35	4	Quantile regression	213
5.	Empirical analysis	31	5	Empirical analysis	177

Source: Prepared by the authors according to Scopus data via VOSviewer software, 2024 [55].

The most popular methods in the scientific literature are "Regression analysis" and "Economic analysis." However, it is important to evaluate the novelty factor at this point.
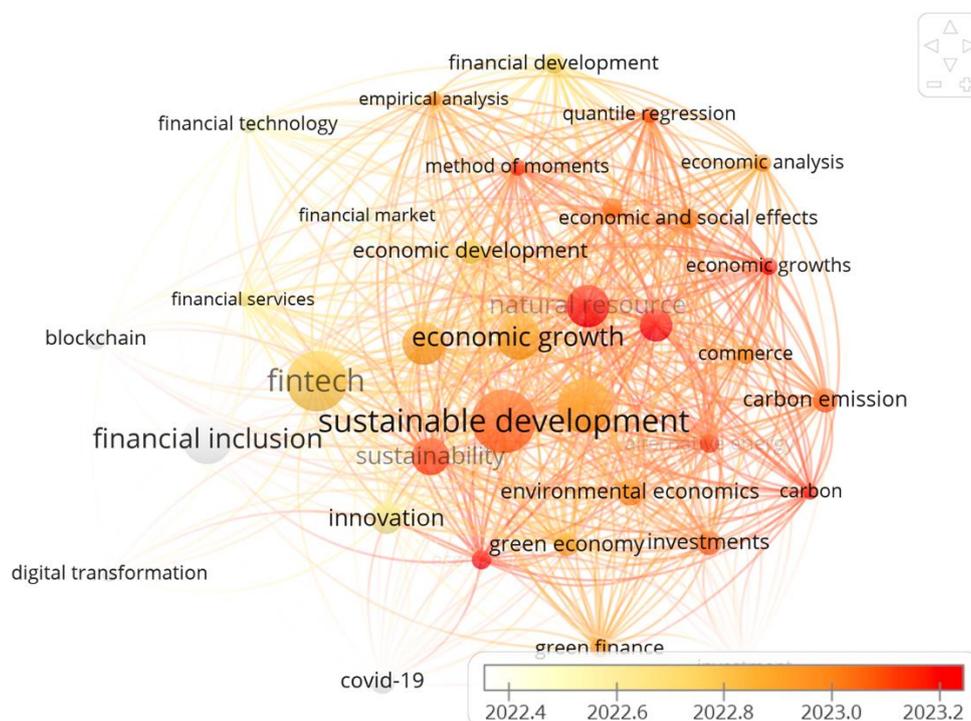
Figure 7. Overlay visualisation of co-occurrence analysis of keywords "FinTech," "Sustainable development," and "Method" by year in Scopus
Source*:* Prepared by the authors according to the Scopus data via VOSviewer software, 2024 [55].

Therefore, the overlay visualisation of the co-occurrence analysis of keywords "FinTech," "Sustainable development," and "Method" by year in Scopus was performed with the help of VOSviewer. As shown in Figure 7, the "method of moments" and "quantile regression" demonstrate the most significant novelty in the scientific literature. Therefore, we chose to conduct a more detailed analysis of these keywords as methods. For this purpose, the title, abstract and keyword data of 1270 Scopus articles selected according to the keywords "FinTech," "Sustainable development," and "Method" were filtered according to the keywords "Method of moments". The result of this search was 14 articles published from 2023-2024. An identical search using the keyword "Quantile regression" was then performed, resulting in 11 articles published from 2023-2024, 9 of which matched the first search results. These searches revealed that the "Method of moments" and "Quantile regression" methods are the same novel method called the method of moments quantile regression, also referred to as MMQR. The same search principle was applied to WoS, where three articles matched the search keywords but overlapped with those identified in the Scopus search, so the WoS search did not yield new

results. Table 5 presents the systematised results of this search, where only those methods used in the latest scientific literature at least two times are included.

Table 5. The most popular methods in the latest scientific articles are the keywords "FinTech," "Sustainable development," "Method," and "Method of moments," or "Quantile regression"

Method	Authors
Method of Moments Quantile regression (MMQR)	Lisha et al., 2023; Zhang, 2023; Chen & Liu, 2024; Lin et al., 2024; Lv et al., 2024; Ren, 2024; Wang et al., 2024; Xia & Liu, 2024; Zeng et al., 2024; Zhang & Cui, 2024 [56-59,47,60,41,48,42,51].
Generalised method of moments (GMM)	Kong & Xu, 2023; Taghizadeh-Hesary et al., 2023; Ullah et al., 2023; Zhang, 2023 [61-63,57]
Two-stage least squares (2SLS) regression	Ullah et al., 2023; Kashif et al., 2023 [63,64].

Source: Prepared by the authors according to Scopus and WoS data, 2024.

This table excludes the advanced econometric techniques applied only once, such as fully modified ordinary least squares (FM–OLS) regression, dynamic ordinary least squares (DOLS) estimation, fixed effect–OLS (FE–OLS), fixed effects (FE), feasible generalised least squares (FGLS), cross-quantile correlation, multivariate quantile–quantile regression or the sparse quantile model. However, on the basis of the data presented in Table 5, the method of moments quantile regression is the most suitable for research on the interface between fintech and sustainable development. MMQR was introduced to the scientific community in 2019 in the "Journal of Econometrics" by researchers Machado and Santos Silva, who investigated the conditions under which regression quantiles can be estimated by estimating conditional means. The advantage of this approach is that it allows the use of only valid methods in estimating conditional means while still providing information on how the regressors affect the entire conditional distribution [65]. Therefore, its applicability to the interface between fintech and sustainable development is worthy of further investigation, as provided in Table 6, where the application of MMQR to research is presented in detail.

Table 6. Application of the method of moment quantile regression to research the link between fintech and sustainable development

Year	Authors	Research Object	Research Sample	Scientific Journal
2024	Lin et al. [59]	*Interconnections* among natural resources, FinTech, green technologies and sustainable environment in E7 nations.	2000-2020	Resources Policy
2024	Ren [60]	*The role* of FinTech, Natural Resources, Green Growth and Economic Development in Environmental Sustainability.	N/A	Resources Policy
2024	Chen & Liu [58]	FinTech's *potential impacts* on consumption-based Material Footprint in BRICS nations.	2001-2021	Resources Policy
2024	Lv et al. [47]	*The role* of natural resources and green technologies on energy transition and CO2 emission (the key indicators of sustainable development) under the moderating effect of FinTech in resource-abundant countries.	2000-2021	Resources Policy
2024	Xia & Liu [48]	*The asymmetric impact* of FinTech, natural resources, and environmental regulations on ecological footprint in G7 countries.	2000-2020	Resources Policy
2024	Zhang & Cui [51]	*The asymmetric impact* of FinTech, business regulations, and urbanisation on natural resource rent in the G10 countries.	2001-2020	Resources Policy

Year	Authors	Research Object	Research Sample	Scientific Journal
2024	Wang et al. [41]	*The role* of FinTech and digital trade in shaping trade-adjusted resource consumption in E7 countries.	2005-2020	Resources Policy
2024	Zeng et al. [42]	*The effectiveness* of FinTech and sustainable financing in driving low-carbon energy transitions; *the relationship* between these mechanisms and the imperatives of biodiversity and sustainable natural resource utilisation in the context of BRICS economies.	2000-2021	Resources Policy
2023	Lisha et al. [56]	*The nexus* between sustainability, green innovations, FinTech, financial development, and natural resources for BRICS economies.	2000-2019	Resources Policy

Source: Prepared by the authors according to Scopus data, 2024.

Judging from the information in Table 6, several clear research trends emerge:
- Eight out of nine scientific articles applying MMQR were published in the first two months of 2024.
- All nine research articles applying MMQR were published by the UK-based "Resources Policy" journal, which, as shown in Table 2, is currently the world leader in research on the links between fintech, sustainable development and methods.
- Most of the authors of the articles applying MMQR are from China, or the articles were prepared in cooperation between China and researchers from other countries, such as the UK, France, Italy, Saudi Arabia, Malaysia, Peru, and Uzbekistan.
- All studies applying MMQR were conducted to determine the following: role, potential or asymmetric impact, effectiveness, and interconnections/nexus.
- The statistics of selected countries' indicators for 15-21 years were used to conduct all the research applying the MMQR.

In conclusion, recent scientific research on the interplay between fintech and sustainable development reveals discernible trends, platforms, and directions for implementing novel methods to delineate the sustainable evolution of the fintech industry.

4. Conclusions and Discussion

In this study, a bibliometric analysis of the relevant scientific literature under the selected keywords "FinTech," "Sustainable development," and "Methods" was carried out in two steps: descriptive and evaluative analyses. Therefore, the conclusions are presented in the following order. Descriptive analysis revealed a rapidly growing interest in selected keyword association research in Scopus and WoS, with the former starting in 2017-2018, accelerating in 2019-2021, and gaining momentum in 2021-2024. Keyword analysis by country revealed that since 2017, 54% of the world's countries have prepared at least one scientific article on this topic. Keyword analysis by country of productivity revealed that China has led in this field of scientific research due to its volume of scientific articles, accounting for 30% of all articles worldwide. In contrast, the EU as a whole, with 93% of countries' involvement in this scientific research, accounts for 26% of all global articles. The relevance of the topic in the EU is more visible in Central–Southern Europe. Keyword analysis according to scientific journals distinguished two undisputed leaders—the UK-based international journal "Resources Policy," with 151 publications in total during the 2021-2024 period, of which 135 were published in 2023-2024,

and the Ukraine-based international journal "Financial and Credit Activity Problems of Theory and Practice," with 125 publications in total during the 2022-2023 period. When the links of keywords with the SDGs were evaluated through research, the analysis revealed that they are most closely related to the SDGs, which are attributed to the economy or society.

The evaluative analysis revealed that "FinTech" and "Sustainable development" are equally relevant keywords in the scientific literature, whereas "Financial inclusion" and "Economic growth" are the closest to them in terms of relevance. Five methods, most associated with "FinTech" and "Sustainable development," of which the most popular are "Regression analysis" and "Economic analysis," are indicated. Moreover, the latest and most relevant methods are the "Method of moments" and "Quantile regression." A more detailed analysis revealed that the method of moments quantile regression is the most suitable for research on the interface between fintech and sustainable development.

A comparison of the results obtained in this paper with the results of previous studies presented in the first part of the paper reveals that the results obtained are new, original and easily applicable to future scientific research, both theoretically and in practice. The application of the method of moment quantile regression in research on the sustainable development of the fintech sector should be a direction for further research.

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References

1. Alhanatleh, H., Khaddam, A., Abudabaseh, F., Alghizzawi, M., & Alzghoul, A. (2024). Enhancing the public value of mobile fintech services. *Investment Management and Financial Innovations*, *21*(1), 417-430. https://doi.org/10.21511/imfi.21(1).2024.32.
2. Taneja, S., Siraj, A., Ali, L., Kumar, A., Luthra, S., & Zhu, Y. (2023). Is fintech implementation a strategic step for sustainability in today's changing landscape? An empirical investigation. *IEEE Transactions on Engineering Management*, *71*, 7553-7565. https://doi.org/10.1109/TEM.2023.3262742.
3. Hidayat-ur-Rehman, I., & Hossain, M. N. (2024). The impacts of Fintech adoption, green finance and competitiveness on banks' sustainable performance: Digital transformation as moderator. *Asia-Pacific Journal of Business Administration* (ahead-of-print). https://doi.org/10.1108/APJBA-10-2023-0497.
4. Aldaarmi, A. A. (2024). Fintech Service Quality of Saudi Banks: Digital Transformation and Awareness in Satisfaction, Re-Use Intentions, and the Sustainable Performance of Firms. *Sustainability*, *16*(6), Article 2261. https://doi.org/10.3390/su16062261.

5. Chen, Y. (2024). Cleaning Russian oil industry for energy resource exploration and industrial transformation towards zero carbon green recovery: Role of inclusive digital finance. *Resources Policy*, *88*, Article 104436. https://doi.org/10.1016/j.resourpol.2023.104436.

6. Puschmann, T., & Khmarskyi, V. (2024). Green fintech: Developing a research agenda. *Corporate Social Responsibility and Environmental Management*, *31*(4), 2823-2837. https://doi.org/10.1002/csr.2675.

7. Shi, C., & Lu, J. (2024). Unlocking Economic Resilience: A New Methodological Approach and Empirical Examination under Digital Transformation. *Land*, *13*(5), Article 621. https://doi.org/10.3390/land13050621.

8. Serdarušić, H., Pancić, M., & Zavišić, Ž. (2024). Green finance and Fintech adoption services among Croatian online users: how digital transformation and digital awareness increase banking sustainability. *Economies*, *12*(3), Article 54. https://doi.org/10.3390/economies12030054.

9. Zarifis, A. (2024). Leadership in Fintech Builds Trust and Reduces Vulnerability More When Combined with Leadership in Sustainability. *Sustainability, 16*(13), Article 5757. https://doi.org/10.3390/su16135757.

10. Maksymova, I., Kurilyak, V., Mietule, I., Arbidane, I., & Kurilyak, M. (2024). Digitally driven model of a climateneutral economy in terms of global financial capacity. *Financial & Credit Activity: Problems of Theory & Practice*, *3*(56), 334–349. https://doi.org/10.55643/fcaptp.3.56.2024.4399.

11. Demir, A., Pesqué-Cela, V., Altunbas, Y., & Murinde, V. (2022). Fintech, financial inclusion and income inequality: a quantile regression approach. *The European Journal of Finance*, *28*(1), 86-107. https://doi.org/10.1080/1351847X.2020.1772335.

12. Nugraha, D. P., Setiawan, B., Nathan, R. J., & Fekete-Farkas, M. (2022). FinTech adoption drivers for innovation for SMEs in Indonesia. *Journal of Open Innovation: Technology, Market, and Complexity*, *8*(4), Article 208. https://doi.org/10.3390/joitmc8040208.

13. Koomson, I., Martey, E., & Etwire, P. M. (2023). Mobile money and entrepreneurship in East Africa: The mediating roles of digital savings and access to digital credit. *Information Technology & People*, *36*(3), 996-1019. https://doi.org/10.1108/ITP-11-2021-0906.

14. Pandey, A., Kiran, R., & Sharma, R. K. (2022). Investigating the impact of financial inclusion drivers, financial literacy and financial initiatives in fostering sustainable growth in North India. *Sustainability*, *14*(17), Article 11061. https://doi.org/10.3390/su141711061.

15. Danladi, S., Prasad, M. S. V., Modibbo, U. M., Ahmadi, S. A., & Ghasemi, P. (2023). Attaining sustainable development goals through financial inclusion: exploring collaborative approaches to Fintech adoption in developing economies. *Sustainability*, *15*(17), Article 13039. https://doi.org/10.3390/su151713039.

16. Mhlanga, D. (2022). The role of financial inclusion and FinTech in addressing climate-related challenges in the industry 4.0: Lessons for sustainable development goals. *Frontiers in Climate*, *4*, Article 949178. https://doi.org/10.3389/fclim.2022.949178.

17. Rizwan, A., & Mustafa, F. (2022). Fintech attaining sustainable development: an investor perspective of crowdfunding platforms in a developing country. *Sustainability*, *14*(12), Article 7114. https://doi.org/10.3390/su14127114.

18. UN Capital Development Fund. (2022). *Financial inclusion and the SDGs*. https://www.uncdf.org/financial-inclusion-and-the-sdgs.

19. Tay, L. Y., Tai, H. T., & Tan, G. S. (2022). Digital financial inclusion: A gateway to sustainable development. *Heliyon*, *8*(6), Article e09766. https://doi.org/10.1016/j.heliyon.2022.e09766.

20. Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability science*, *14*, 681-695. https://doi.org/10.1007/s11625-018-0627-5.

21. SDG Resource Centre. (2024). *Economic Aspect*. https://sdgresources.relx.com/economic-aspect.

22. Wang, J., Zhao, C., Huang, L., Yang, S., & Wang, M. (2022). Uncovering research trends and opportunities on FinTech: A scientometric analysis. *Electronic Commerce Research*, 1-25. https://doi.org/10.1007/s10660-022-09554-8.

23. Tsouli, D. (2022). Financial Inclusion, Poverty, and Income Inequality: Evidence from European Countries, *Ekonomika*, *101*(1), 37–61. https://doi.org/10.15388/Ekon.2022.101.1.3.

24. Raval, A., & Desai, R. (2023). Reviews and directions of FinTech research: bibliometric–content analysis approach. *Journal of Financial Services Marketing*, 1-20. https://doi.org/10.1057/s41264-023-00262-4.

25. Tuyon, J., Onyia, O. P., Ahmi, A., & Huang, C. H. (2023). Sustainable financial services: reflection and future perspectives. *Journal of Financial Services Marketing*, *28*(4), 664-690. https://doi.org/10.1057/s41264-022-00187-4.

26. Streimikiene, D., Mikalauskiene, A., & Burbaite, G. (2023). The role of sustainable finance in achieving sustainable development goals. *Economics and Sociology*, *16*(1), 271-298. https://doi.org/10.14254/2071-789X.2023/16-1/17.

27. Afjal, M. (2023). Bridging the financial divide: a bibliometric analysis on the role of digital financial services within FinTech in enhancing financial inclusion and economic development. *Humanities and Social Sciences Communications*, *10*(1), 1-27. https://doi.org/10.1057/s41599-023-02086-y.

28. Ellili, N. O. D. (2023). Is there any association between FinTech and sustainability? Evidence from bibliometric review and content analysis. *Journal of Financial Services Marketing*, *28*(4), 748-762. https://doi.org/10.1057/s41264-022-00200-w.

29. Botoc, F. C., Khaled, M. D., Milos, L. R., & Bilti, R. S. (2023). The role of big data in the FinTech industry: a bibliometric analysis. *Transformations in Business & Economics*, *22*(3A(60A)), 853-868.

30. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*, Article n71. https://doi.org/10.1136/bmj.n71.

31. Van Eck, N. J., & Waltman, L. (2012). *VOSviewer manual. Manual for VOSviewer version*, *1*(0). https://www.vosviewer.com/documentation/Manual_VOSviewer_1.5.2.pdf.

32. Chinoda, T., & Mingiri Kapingura, F. (2024). Fintech-based financial inclusion and banks' risk-taking: the role of regulation in Sub-Saharan Africa. *Journal of Economic and Administrative Sciences*. https://doi.org/10.1108/JEAS-11-2023-0304.

33. Kishor, K., Bansal, S. K., & Kumar, R. (2024). The Role of Fintech in Promoting Financial Inclusion to Achieve Sustainable Development: An Integrated Bibliometric Analysis and Systematic Literature Review. *Journal of the Knowledge Economy*, 1-29. https://doi.org/10.1007/s13132-024-02168-5.

34. Iftikhar, H., Ullah, A., & Pinglu, C. (2024). From regional integrated development toward sustainable future: evaluating the Belt and Road Initiative's spillover impact between tourism, Fintech and inclusive green growth. *Clean Technologies and Environmental Policy*, 1-28. https://doi.org/10.1007/s10098-024-02890-3.

35. Pata, U. K., Si Mohammed, K., Nassani, A. A., & Ghosh, S. (2024). Discovering the sustainable development role of fintech credit and the pilot low carbon project on greenwashing in China. *Environment, Development and Sustainability*, 1-20. https://doi.org/10.1007/s10668-024-04919-5.

36. Thanh Ha, L. (2024). Gauging the dynamic interlinkage level between Fintech and the global blue economy performance. *Journal of Economic Studies*. https://doi.org/10.1108/JES-10-2023-0613.

37. Ersin, Ö. Ö., & Bildirici, M. E. (2024). Are cleaner energy and financial technologies needed? Contagion and causality evidence between global fintech markets, energy consumption, and environmental pollution. *Clean Technologies and Environmental Policy*, 1-15. https://doi.org/10.1007/s10098-024-02845-8.

38. Rahman, M. S., Moral, I. H., Kaium, M. A., Sarker, G. A., Zahan, I., Hossain, G. M. S., & Khan, M. A. M. (2024). FinTech in sustainable banking: An integrated systematic literature review and future research agenda with a TCCM framework. *Green Finance*, *6*(1), 92-116. https://doi.org/10.3934/GF.2024005.

39. Ayub, M., Khan, K., Khan, M., & Ismail, M. (2024). Waqf for accelerating socioeconomic development: a proposed model with focus on Pakistan. *Qualitative Research in Financial Markets*. https://doi.org/10.1108/QRFM-07-2023-0161.

40. Li, Y., Liu, C. Y. N., Lao, U., & Dang, J. (2024). Navigating the path to environmental sustainability: Exploring the role of fintech, natural resources and green energy in Belt and Road countries. *Resources Policy*, *88*, Article 104485. https://doi.org/10.1016/j.resourpol.2023.104485.

41. Wang, S., Li, J., & Zhao, E. (2024). Exploring the role of financial technologies and digital trade in shaping trade-adjusted resource consumption in E7 countries. *Resources Policy*, *88*, Article 104495. https://doi.org/10.1016/j.resourpol.2023.104495.

42. Zeng, L., Wong, W. K., Fu, H., Mahmoud, H. A., Cong, P. T., Thuy, D. T. T., & Bach, P. X. (2024). FinTech and sustainable financing for low carbon energy transitions: A biodiversity and natural resource perspective in BRICS economies. *Resources Policy*, *88*, Article 104486. https://doi.org/10.1016/j.resourpol.2023.104486.

43. Feng, S., Li, J., Nawi, H. M., Alhamdi, F. M., & Shamansurova, Z. (2024). Assessing the nexus between fintech, natural resources, government effectiveness, and environmental pollution in China: A QARDL study. *Resources Policy*, *88*, Article 104433. https://doi.org/10.1016/j.resourpol.2023.104433.

44. Murshed, M. (2024). The role of Fintech financing in correcting ecological problems caused by mineral resources: testing the novel ecological deficit hypothesis. *Resources Policy*, *88*, Article 104439. https://doi.org/10.1016/j.resourpol.2023.104439.

45. Jin, G., & Huang, Z. (2024). Resource curse or resource boon? Appraising the mediating role of fin-tech in realising natural resources-green growth nexus in MENA region. *Resources Policy*, *89*, Article 104590. https://doi.org/10.1016/j.resourpol.2023.104590.

46. Han, Z., & Heng, Y. (2024). Do fintech and trade diversification discard the natural resource dependency in MENA countries? *Resources Policy*, *89*, Article 104496. https://doi.org/10.1016/j.resourpol.2023.104496.

47. Lv, Z., Chen, L., Ali, S. A., Muda, I., Alromaihi, A., & Boltayev, J. Y. (2024). Financial technologies, green technologies and natural resource nexus with sustainable development goals: Evidence from resource abundant economies using MMQR estimation. *Resources Policy*, *89*, Article 104649. https://doi.org/10.1016/j.resourpol.2024.104649.

48. Xia, A., & Liu, Q. (2024). Modelling the asymmetric impact of fintech, natural resources, and environmental regulations on ecological footprint in G7 countries. *Resources Policy*, *89*, Article 104552. https://doi.org/10.1016/j.resourpol.2023.104552.

49. Yaqoob, T., & Maqsood, A. (2024). The potency of time series outliers in volatile models: An empirical analysis of fintech, and mineral resources. *Resources Policy*, *89*, Article 104666. https://doi.org/10.1016/j.resourpol.2024.104666.

50. Jian, P., & Zhengjie, S. (2024). Navigating the green future: Unravelling the role of fintech, decentralisation, natural resources, and monetary policy uncertainty in China. *Resources Policy*, *89*, Article 104573. https://doi.org/10.1016/j.resourpol.2023.104573.

51. Zhang, Y., & Cui, X. (2024). Fintech, business regulations, and urbanisation: Shaping the landscape of natural resource rent in G10 countries. *Resources Policy*, *89*, Article 104551. https://doi.org/10.1016/j.resourpol.2023.104551.

52. Sachs, J. D., Lafortune, G., Fuller, G., & Drumm, E. (2023). Sustainable development report 2023: implementing the SDG stimulus. https://doi.org/10.25546/102924.

53. Folke, C., Biggs, R., Norström, A. V., Reyers, B., & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecology and Society*, *21*(3), Article 41. http://dx.doi.org/10.5751/ES-08748-210341.

54. Schoenmaker, D., & Schramade, W. (2018). *Principles of sustainable finance*. Oxford University Press.

55. *VOSviewer* (Version 1.6.20). (n.d.). https://www.vosviewer.com.

56. Lisha, L., Mousa, S., Arnone, G., Muda, I., Huerta-Soto, R., & Shiming, Z. (2023). Natural resources, green innovation, fintech, and sustainability: A fresh insight from BRICS. *Resources Policy*, *80*, Article 103119. https://doi.org/10.1016/j.resourpol.2022.103119.

57. Zhang, Y. (2023). Impact of green finance and environmental protection on green economic recovery in South Asian economies: mediating role of FinTech. *Economic Change and Restructuring*, *56*(3), 2069-2086. https://doi.org/10.1007/s10644-023-09500-0.

58. Chen, X., & Liu, Z. (2024). Fintech and sustainable resources management: Role of trade openness and globalisation in BRICS countries. *Resources Policy*, *90*, Article 104700. https://doi.org/10.1016/j.resourpol.2024.104700.

59. Lin, H. H., Hsu, C. C., Wu, P. H., Shen, C. C., & Chen, G. H. (2024). Demystifying the interconnections among natural resources, fintech, green technologies, and sustainable environment in E-7 nations. *Resources Policy*, *90*, Article 104698. https://doi.org/10.1016/j.resourpol.2024.104698.

60. Ren, Y. (2024). Unlocking the green potential through Fintech-natural resources, and economic development in resource-rich countries-An MMQR study. *Resources Policy*, *90*, Article 104694. https://doi.org/10.1016/j.resourpol.2024.104694.

61. Kong, X., & Xu, T. How Fintech Affects Total Factor Energy Efficiency? – Evidence from Chinese Cities. *Frontiers in Energy Research*, *11*, 1296820. https://doi.org/10.3389/fenrg.2023.1296820.

62. Taghizadeh-Hesary, F., Dong, K., Zhao, C., & Phoumin, H. (2023). Can financial and economic means accelerate renewable energy growth in the climate change era? The case of China. *Economic Analysis and Policy*, *78*, 730-743. https://doi.org/10.1016/j.eap.2023.04.013.

63. Ullah, A., Ullah, S., Pinglu, C., & Khan, S. (2023). Impact of FinTech, governance and environmental taxes on energy transition: Pre-post COVID-19 analysis of Belt and Road initiative countries. *Resources Policy*, *85*, Article 103734. https://doi.org/10.1016/j.resourpol.2023.103734.

64. Kashif, M., Pinglu, C., Ullah, S., & Zaman, M. (2023). Evaluating the influence of financial technology (FinTech) on sustainable finance: a comprehensive global analysis. *Financial Markets and Portfolio Management*, *38*, 123–155. https://doi.org/10.1007/s11408-023-00439-w.

65. Machado, J. A., & Silva, J. S. (2019). Quantiles via moments. *Journal of Econometrics*, *213*(1), 145-173. https://doi.org/10.1016/j.jeconom.2019.04.009.