Performance of Green Bonds in Emerging Capital Markets: An Analysis of Academic Contributions

Ion Frecautan

PhD student, Department of Finance, National Research University Higher School of Economics, Moscow, Russia, ifrekaucan@hse.ru, ORCID

Abstract

The ongoing experience of the global transition from fossil fuel-based economies to renewable-fuel-based economies shows that sustainable finance is an important step that enables this transformation in developed and emerging capital markets. As such, understanding the performance drivers of green bonds becomes important for development of new corporate models based on sustainability goals.

Our research presents a systematic literature review on financial and non-financial drivers of performance of green bonds in the emerging capital markets. Using a unique hybrid technique for textual analysis of articles published between 2010 and 2022, we propose to identify the main research clusters (renewable energies, investments, climate change and sustainable development, green bonds, and green finance) and the most representative emerging capital markets to consider in terms of assessing new trends.

Future research directions may be devised based on the trends of the keywords which are created herein using information extracted from the 'Scopus' application, processed with 'VOSviewer', and structured using 'Online Analytical Processing' (OLAP) principles with the help of 'Visual Basic for Applications' (VBA) programming through spreadsheets.

Our results demonstrate that non-financial performance factors are more influential in emerging capital markets because of the early stage of development of green bonds issuance, and because of the reduced regulatory framework regarding green financing.

Keywords: green bonds, green finance, sustainable development, systematic literature review, green economy, socially responsible investment, emerging capital markets, non-financial drivers

1. Introduction

The contemporary global social and economic zeitgeist is intensively focused on the process of transformation towards sustainability goals and new corporate models in order to fulfil the requirements for the allocation of sustainable finance. The extent of sustainable finance and its direct connection with organizational ESG transformation is exemplified by the analysis of Rystad Energy[1]. This showed that the gap between global capital spending on renewables and oil-and-gas is narrowing at a minimum level, thus for 2021 approximately $311B was spent in terms of oil and gas capital and $243B in terms of wind and solar. Indeed, the issuance of corporate green bonds (to provide the funds for climate initiatives) instead of conventional bonds creates additional value for companies, not only by improving their environmental performance, but also by stimulating a positive stock market response to such sustainable finance corporate initiatives, thus lower operational risks [1]. The developed capital markets reacted to the global climate transformation immediately, allowing for the building of new financial system infrastructure, which became efficiently functional. Related innovations include technical platforms, digitalization, regulatory and legal frameworks etc.

Due to the less flexible character of emerging capital markets, their sustainable transformation development lags behind the global trends, which makes these countries lose competitiveness in attracting 'green' capital to cope with the new global sustainable development architecture. Generally, the economic and financial system of emerging countries is not fully calibrated to the fundamental principles of green financing, specifically in terms of green bonds. The financial systems of emerging capital markets still rely on foreign direct investment. Thus, there is a possibility of losing economic, financial, and political competitiveness at least in the medium term if these countries do not achieve their climate targets. Despite the external pressures of globalization processes in the medium and long term, the adherence of these countries to global climate initiatives and the likelihood of them achieving climate and CO_2 emissions targets become uncertain.

The development of the green bonds market and its performance is affected by different financial and non-financial factors. Most of the relevant academic research papers analyze these aspects of companies acting in developed capital markets, and there is limited academic evidence about performance of green bonds issued in emerging capital markets.

The performance of both green and conventional bonds is sensitive to macroeconomic factors: the uncertainty of economic policies, daily economic activity, oil price, changes in financial market returns [2], and individual countries' specific fiscal and monetary policies for sustainable development and the transition to a green economy [3]. Other academic papers have analyzed the relationship between green bonds issuance, stock market performance of these companies, and ESG profile – which ultimately improve the bond's liquidity. D.Y. Tang and Y. Zang [4] found that green bonds issuance brings performance through green premium, and stock markets performance (higher returns) for companies issuing green fixed-income instruments. In their research the authors analyzed issuances from 28 countries (both developed and emerging capital markets) in the period 2007–2017. They assess how country financial market regulations directly "dictate" the level of green bonds market development and its performance, and the evidence found for both developed (incl. OECD countries) and emerging capital markets [5; 6].

Our contribution is twofold. First, this paper provides an analytical summary of research findings on green bonds in emerging capital markets, including existing academic research clusters and empirical evidence about performance of green bonds and its influential factors. Second, our paper provides analysis and conclusions on the future trends of research in green bonds in the emerging capital markets.

The rest of the paper is structured in four sections. Section 2 presents our research methodology, section 3 shows the outcomes of our methodological application and presents the academic findings on the performance of green bonds in the emerging capital markets as compared to developed markets. Finally, we discuss the results and present our conclusions in the fourth section.

2. Methodology

To identify the academic contributions about green bonds markets in the developing countries, we apply VOSviewer[2] for text mining and data processing. Several steps were undertaken to achieve the scope of the paper. First, we define our specific research questions. Second, we examine 'Scopus' and 'Web of Science' using 6 relevant keywords through titles, abstract and keywords of the papers. The keywords were selected to refer to the full spectrum of the meaning of the green bonds: "green bond" or "green bonds" or "sustainable bond" or "sustainable bonds" or "climate bond" or "climate bonds". Third, we applied three criteria for filtering the database to get the batch of selected academic documents: period 2010–2022, only academic articles (including review articles), English language articles within all subject areas. Fourth, information retrieved from the Scopus was processed with the help of VOSviewer software to identify keywords clusters. For the purpose of our research, the system data analysis considered the following dimensions: title, abstract, and keywords of the articles.

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[1] URL: https://www.rystadenergy.com/newsevents/news/press-releases/renewables-spending-set-for-new-record-in-2021-luring-service-suppliers-as-oil-and-gas-gap-narrows/

[2] A bibliometric network can be identified and created using the following criteria: citation, bibliographic coupling, co-citation, or co-authorship relations. The system permits a user to run text mining based on different criteria, and also to construct and visualize a co-occurrence network of keywords (keywords clusters) extracted from different structures of scientific literature (in our case from title, abstract, and keywords of the articles).

Table 1. Generic green bonds market value chain

	Buyers of green bonds	Green bonds issuers	Supporters of GB issuance	Beneficiaries of the GB issuance
GB market participants	Investors and financial institutions	Corporations / Financial institutions	Governments, NGOs, stock exchanges, regulatory financial authorities, rating agencies etc.	Civil society, business community and environment
Strategies	Internalisation of sustainability	Internalisation of sustainability	Assurance of GB regulatory ecosystem	Monitor and challenge the GB market improvement
Performance and metrics of GB	Risk-adjusted returns, increased public reputation and image	Lower cost of capital, improved corporate performance	GB regulatory framework, GB standards, rating, indexes, etc.	Achievement of sustainability targets

Fifth, 'Online Analytical Processing' (OLAP) principles for data management were applied with the help of spreadsheets[3] to retrieve the most relevant research papers for our research scope. To increase the representativeness of the selected research papers, we combined citations index and the number of identified keywords per each cluster. The combination of these two factors reveals the most relevant papers for our research. Visual Basic for Applications (VBA) programming was used to retrieve the number of keywords with no restriction of text bodies (see Appendix 1).

Finally, at the sixth step the identified relevant articles were critically assessed to determine the academic contribution of the performance of green bonds in the emerging capital markets. To have a clearer view about green bonds market structure and dynamics, we redesigned the framework for sustainable finance and investment market proposed by F.A.F. De Souza Cunha et al. [7] and present it in Table 1.

The above framework describes the green bonds market from the perspective of market participants, their strategies in terms of green finance, and the performance metrics of green bonds of each type of the participants. We may postulate that investors which acquire green bonds will consider the internalisation of green bonds features into the corporate business model as a basic organisational commitment for sustainable development and climate change. In exchange, these companies will receive not only financial rewards (e.g. risk adjusted returns), but also non-financial benefits (e.g. better public reputation and image) and ultimately improved organisational ESG scores.

Organisations which issue these types of sustainable financial instruments will internalise sustainability ambitions into their operational business models, but in a different structural format. Thus, these companies will reshape the operational business model (including technological and human resources) towards sustainability and environmental protection, the implementation of CSR, and the imple-

mentation of sustainability policies. As a result, the impact of issuing green bonds will result in a lower cost of capital for the issuer and improved financial and operational performance.

Supporters of green bonds issuance also play a critical role in the efficiency of the green bonds market functioning. It is also possible that supporters can be issuers and buyers as well (e.g., governments, local authorities). The role of such supporters, from a strategic point of view, is to build and ensure the regulatory platform at all levels considering different structural components of green bonds market development (e.g., financial markets components, framework for sustainable development etc.) and indirectly, to cope and achieve the climate change targets. As a result, the performance of the green bonds market will be determined by (among other things) the existence and efficiency of the regulatory framework, standards and criteria, the functionality of the green bonds ratings, and indexes.

Beneficiaries of green bonds issuance are reaping the rewards, as are those that represent voices which positively appreciate the impact and the benefits of green bonds issuance. As such, strategically, they continuously challenge the other 3 categories of participants to make the green bonds market and the system functional and more efficient. As a result, they will assure the achievement of climate targets, climate protection, net-zero emissions, and positive social impacts which will in fact indirectly impact the performance of green bonds.

The fullest realisation of performance of the green bonds market will be achieved only when the benefits are shared directly and indirectly between all the parties to assure the mutual value growth. These mutual financial and non-financial benefits are the main motivational drivers for developing the green bonds market in any jurisdiction. The performance of green bonds, along with the proposed generic value chain, should also be considered in rela-

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[3] Microsoft Office.

tion to strategic timing, which is the key aspect of keeping all the parties satisfied *(e.g. civil society can benefit from green bonds issuance only after 2–3 years from the moment fixed-income instruments are put on the market).*

3. Research Questions

Social, environmental, regulatory, macroeconomic, and financial factors all influence the dynamics of the green bonds market. This is achieved through a combination of an investor's motivation, the characteristics of the particular bonds, the applicable risk profile, consideration of the strategic perspective, and the ambition of the ultimate outcome. The following sections present the answers to the main research questions of this paper. First, we will define and understand the concept of performance of green bonds.

In the academic and non-academic literature, the performance of green finance is presented in different ways, and as mentioned earlier, the concept generically called "performance" has different meanings for different stakeholders. This can be split into financial and non-financial performance. Most academic papers are focused on the traditional approach to the performance of green bonds, called "green premium" or "greenium". The International Capital Markets Association (ICMA) was among the first to conceptualise the nature of green bonds considering its role towards transition to a net-zero economy model. ICMA defines green bonds as: *"any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new or / and existing eligible green projects"* [8]. The key element in the definition is the use of financial funds, which according to the green bond principles should be utilised in the following areas: renewable energy, energy efficiency, pollution prevention and control, environmentally sustainable management of living natural resources and land use, clean transportation, etc.

'Green premium' is the main direct performance indicator which reflects the attractiveness of the green bonds for the investors' world and its success to mitigate climate change. The green bonds function similarly, with conventional non-green fixed-income securities to which it has assigned a "use of proceed" pledge towards environmental activities. The "green" characteristic of the security can bring additional value to it, but also additional risk (e.g. "green premium" vs "greenwashing").

Another approach to measure the performance of green bonds refers to subscription level (e.g. under-subscription vs over-subscription). According to a 'Climate Bonds Initiatives' report "Green bond pricing in the primary market H1 (Q1–Q2) 2020", in most of the cases the number of times of over-subscription of green bonds compared with 'vanilla' (i.e. non-green) bonds was much higher for both EUR and USD issues: for EUR bonds, the average over-subscription was 5.2x for green bonds, and 3.1x for vanilla equivalents. For USD bonds, the average oversubscription was 2.6x for green bonds and 2.3x for vanilla equivalents [9].

3.1. What are the most relevant (dynamic) emerging markets for green bonds financing?

The number of research topics about green bonds in developed countries is much higher compared to emerging markets considering both the number of publications issued by these countries and the volume/value of green bonds issued in the last 12 years. Moreover, emerging countries are still facing barriers for green bonds market development which contradict the interests of the market participants. In the literature the following type of barriers were identified: (1) institutional barriers, technical skills for monitoring and assessing, lack of knowledge, and inappropriate institutional arrangements, and (2) market barriers: the issue of minimum size, the currency of issuance, and high transaction costs associated with green bond issuance etc. [10; 11].
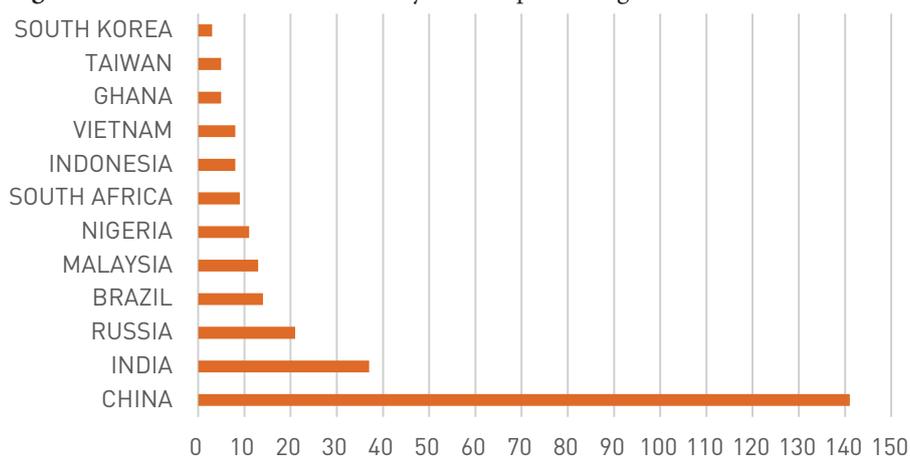
Figure 1. Number of articles per each country of publication
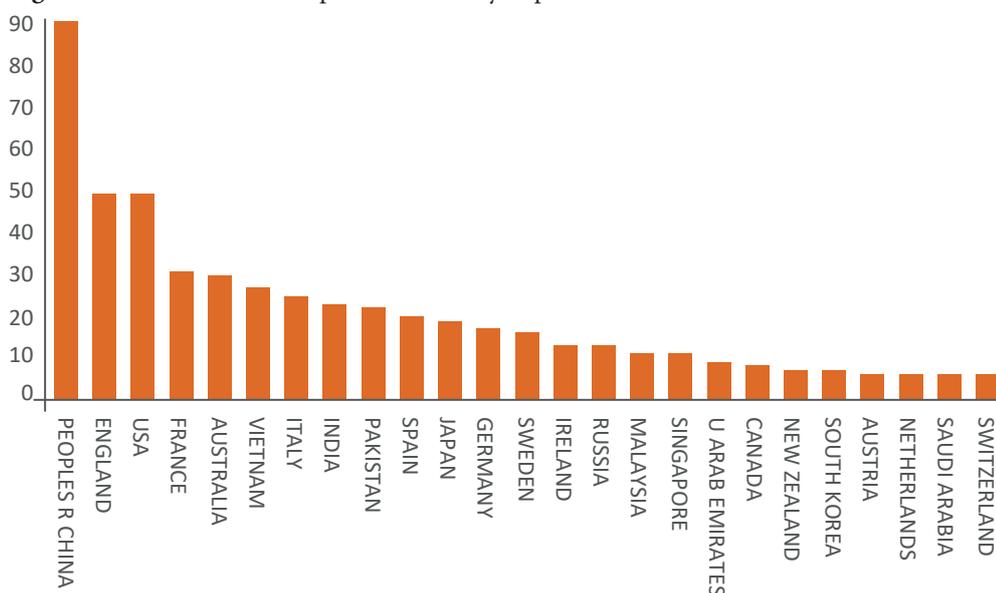
Source: Web of Science.

Figure 2. Value of GB issuance (2014–2020) – emerging countries except China
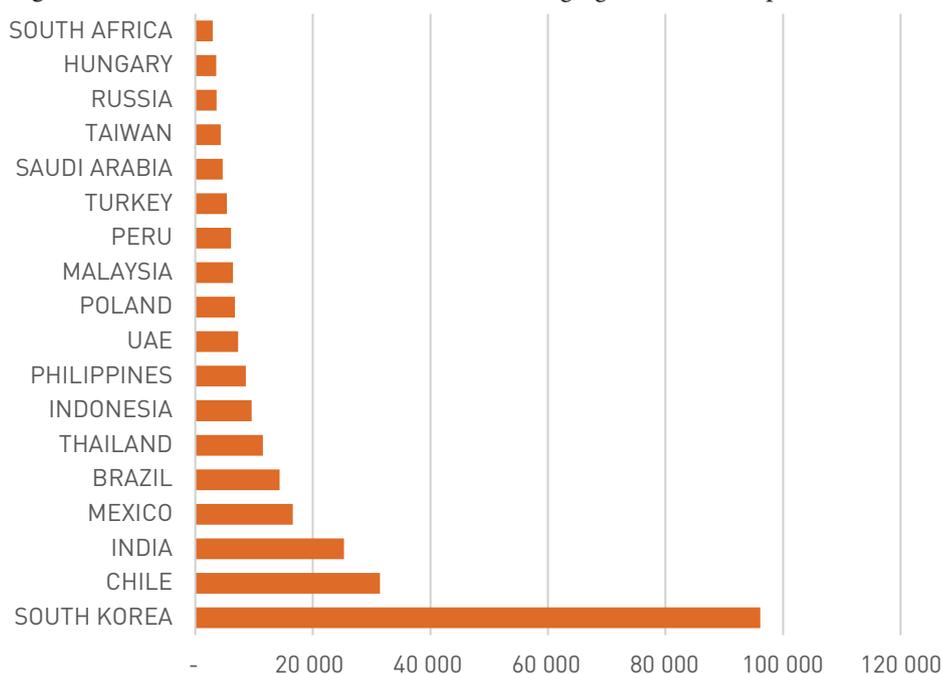
Source: Climate Bonds Initiatives; diagram made by the author.

Figure 3. The identified number of keywords representing the name of the countries mentioned in the articles'

Source: Scopus; diagram made by the author.

To identify the relevant emerging countries which are the subject of our research the information from two sources were combined. First, data extracted from Web of Science Core[4] collection was structured per country of publication and number of published articles (see Figure 1).

Except for China, Vietnam, India, and Pakistan, the top 10 countries which are publishing papers represent developed economies. Second, the information extracted from and provided by Climate Bond Initiatives[5] was structured in such a way so as to have the value and volumes of green bonds issuance only recorded from developing countries (see Figure 2).

By combining the list of emerging countries which publish papers about green bonds and countries which issued these instruments, the followings were identified for further analysis: India, Russia, Malaysia, Nigeria, Vietnam, Brazil, Indonesia, South Africa, Ghana, and South Korea. This is the only list of emerging countries whose names were mined and identified throughout the articles extracted from Scopus (see Figure 3).

The comparison of the three graphs shows that the trend of papers published by different countries do not follow the same trend of green bonds issuance for the same pe-

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[4] Data extracted as of 1st September 2022.

[5] Climate Bond Initiatives is an investor-focused not-for-profit organization which was among the first initiators of providing expertise for promoting and certifying green bonds, which ultimately is an active player for supporting a "transition to a low carbon and climate resilient economy". The activity of Climate Bonds Initiative is concentrated on three main workstreams: green bonds market intelligence; the development and monitoring of the Climate Bonds Standard and Certification Scheme; providing policy models and advice (URL: https://www.climatebonds.net/).

riod, therefore our approach was partially selective for choosing the relevant countries for the current analysis. The selected countries seem to be in a transition process of green bonds market development, where we consider the size of the country, the level of industrial and social development, and the value of the green bonds issued in USD equivalent.

3.2. The drivers of green bonds performance

As presented in Figure 4, a green premium is the central performance indicator for the green bonds. The motivation for understanding the factors affecting the performance of green bonds has arisen from both academic and professional bodies to reveal the efficiency and value growth impact of the new financial instruments used for climate change mitigation. C. Tolliver et al. [6] identified 3 categories of drivers: macroeconomic (size of the economy, stock market capitalisation and trade openness), institutional (capital account openness, rule of law, regulatory quality), and environmental, through 'Nationally Determined Commitments'. 'Social drivers' refers to a wider spectrum of data when it comes to the impact on the performance of green bonds. It can vary from the influence of social networking and social sentiments [12] on the performance of green bonds to the impact of corporate social responsibility (CSR) on it [13; 14].

Figure 4. Classification of the drivers of green bonds performance
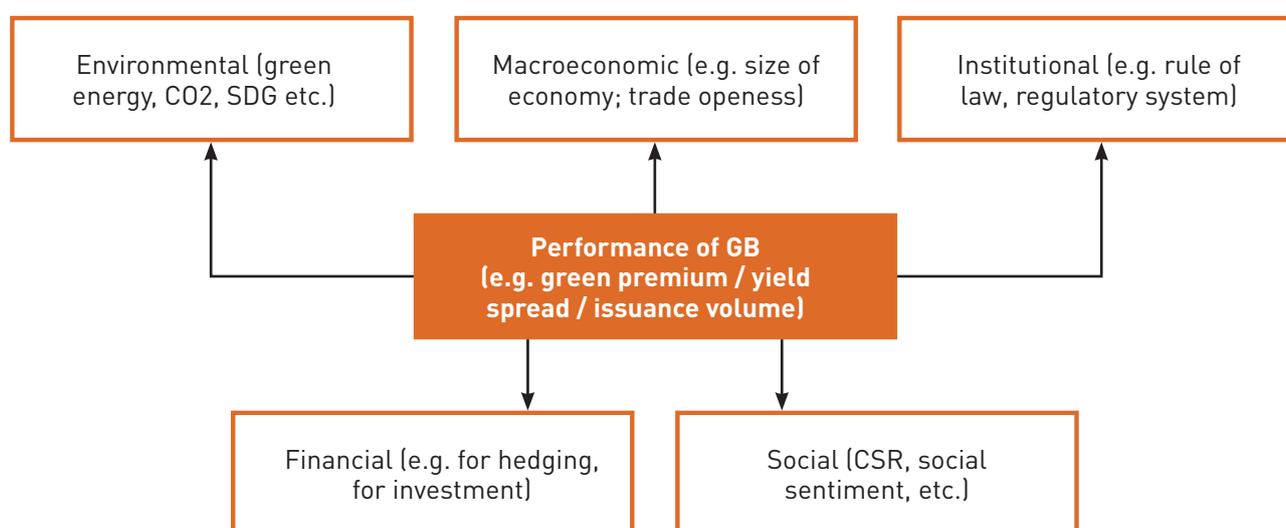
Source: diagram made by the author.

Environmental factors seem to be the central research pillar regarding the performance of green bonds with direct and indirect implications on sustainable development and mitigation of climate change. Specifically, increasing and promoting green energy production (in contrast to the reduction of CO_2 emissions) are among the core drivers for green bonds issuance and primary motivations to buy these instruments for both developed and emerging countries. I. Hanif et al. [15] is stressing the importance of issuing green bonds in upper-middle and lower-middle income economies from Asia as a core solution for reducing carbon emissions through building renewable energies production facilities. European countries also participate in this process, where asset managers invest in green bonds, and consider the use of proceeds for acquisition or exploitation of low-carbon assets [16]. Similarly, investment directions are undertaken by Nigerian central authorities who are interested in reducing CO_2 emissions and increasing the production of renewable energy through green bonds financing [17].

As alluded to previously, financial drivers are analysed in academic publications with a focus oriented more on developed capital markets. Possible reasons include the maturity of the market and data availability for the research. Two streams were identified in this "class of drivers": (1) green bonds as risk management instrument for hedging, and (2) green bonds as an investment class of assets for gaining access to green premiums. In the first stream, most of the authors concluded that green bonds become an important hedging instrument against climate risks, financial risks, as well as rare disasters, such as in the context of the recent pandemic [18–20]. This may be methodologically explained through asymmetric spillover effects between green bonds and other financial markets assets.

Literature research clusters

After filtering and interrogating data at the 3rd and 4th steps of the research methodologies, 328 articles[6] were identified. Then, at the 5th step data was processed through VOSviewer and 5 clusters were obtained shown on the map in Figure 5. In Appendix 2, we present details about keywords structures generated per each cluster.

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[6] Data extracted as of 1st September 2022.

Figure 5. Visualisation of key words clusters processed and retrieved through VOSviewer

Identified Clusters:

Cluster 1: Climate change.

Cluster 2: Investments.

Cluster 3: Green bonds.

Cluster 4: Renewable energies.

Cluster 5: Green finance.

Renewable Energies

To identify the relevant articles within the "renewable energies" cluster, we combined the most cited articles and the co-occurrences of the depicted keywords.

With the use of our selection criteria and data processing we have extracted those articles that study green bonds as instruments for financing renewable energy sector while reducing the CO_2 emissions. These papers analyse a wide spectrum of aspects about renewable energy and CO_2 reduction. The authors concluded that CO_2 reduction and an increase in renewable energy production capacities can be achieved through green bonds financing, as per the positive experience of developed countries. These aspects have two implications for developing economies: first, the level of green investments will trigger an increase in GDP (profit will reduce and wages earners receive higher share of GDP), and second, the CO_2 reduction through decrease in coal consumption (especially in China, India)

will trigger the increase of green energy production from 42% to 46% by 2030 [21; 15]. Moreover, it was found that to build an efficient green energy infrastructure in Asian emerging countries, an outstanding regulatory system for green bonds market development should be implemented [22; 23; 5].

The "renewable energies" cluster also refers to papers that analyse the impact of various non-financial drivers on development of the green bonds market: GDP per capital, CO_2 emissions and energy consumption in Nigeria [17]; economic infrastructure for public-private collaboration in the renewable energy sector [24]; macroeconomic, fiscal, and social-economic policies to change the flow of subsidies from fossil-fuel energy production to renewable ones [3]; and regulatory constraints about green energy and green finance [25].

To analyse the performance of green bonds in connection with the renewable energy sector, the empirical analysis in most of the articles use country-level data grouped as follow:

- specific developing countries (e.g. China, Indonesia, Malaysia and Singapore);

- mixed data about developed and developing countries without clearly specifying the names of the countries [26];

- mixed data about country specifics where research analysis is made at country level but still research conclusions are presented together [21; 27; 6].

In conclusion, the identified papers in the "Renewable energies" cluster do not explicitly present the quantified performance impact of using renewable energy production for reducing CO_2 emissions for green bonds issuing companies from different countries. Moreover, lack of this empirical analysis is not providing clear evidence about the impact on the performance of green bonds. Researchers share the same academic opinion that the poorly-designed regulatory framework for green finance ecosystem and renewable energy sectors will negatively influence the performance of green bonds market.

Investments

The "investments" cluster has a simple structure which mainly refers to research topics about the performance of green bonds in connection with other financial market drivers. We identified two research directions: (i) green bonds as hedging instruments and (ii) green bonds as investments assets (including portfolio management and design).

Most of the present authors were interested to find out the behaviour of green bonds compared to other financial assets / drivers from the capital markets. On the one hand, it was interesting to see the performance of green bonds correlated to conventional fixed income instruments (e.g., brown bonds, treasury bonds) and on the other hand, the behaviour of green bonds compared to other classes of assets (e.g., green equities, brown equities, price of CO_2, oil price etc.). Therefore, the spillover effect of different capital market assets is among important topics of the performance of green bonds. Most of the authors conclude that green bonds strongly co-move with corporate and treasury bond markets, and weakly co-move with stock and energy commodity markets [28]. The dynamic of the spillover effects is dependent also on different investment horizons. For example, J.C. Reboredo et al. [29] found that strong connectedness persists between GB (green bonds) and brown bonds in short and long periods. [30; 31] identified that spillover effects between green bonds and green equity is short-lived, and that connectedness decreases in the medium and long terms. X. Ren et al. [32] shares a different opinion about the level of relationship between carbon futures and green bonds. They found an asymmetric and strong influence of carbon futures in the medium to long term and an erratic performance in the short-term compared to the green bonds.

Green bonds as hedging instruments have been analysed by researchers for the nature of their connectedness with other capital markets assets, with special attention paid to time-variation and the nature of this relationship. T. Saeed et al. [33] found that clean energy stocks are more effective for hedging than green bonds, especially for crude oil, while W. Kuang [34] presents the different opinion that both green bonds and clean energy stocks provide equal risk diversification benefits for investors when compared

to dirty energy stocks. [35; 36] share a similar research opinion about the level of time-frequency connectedness across the global green bond market and other capital markets assets, meaning that a stronger relationship appears only at shorter time horizons. R. Ferrer et al. [35], in their paper state that GB "appears as a valuable tool to fight against climate change without having to sacrifice part of the return generated by traditional assets".

In conclusion, most of the studied authors agree that the dynamics of correlation and spillover effects are dependent on time-variation aspects, and have a negative relationship with specific market assets. This may be presented as follows:

- green bonds vs clean energy markets are asymmetric, and more pronounced during extreme financial markets' downward or upward movements, including COVID-19 pandemic [37; 38];
- green bonds and dirty energy assets (crude oil and energy ETF) with an "average level of return co-movements estimated at the mean/median is 29%, whereas it reaches 65% when estimated at the left and right tails" [33];
- the level of negative correlation (asymmetry) between green and conventional bonds was more pronounced during COVID-19 global pandemic. The authors concluded that "during a black swan event" green bonds have a potential to become an effective hedging instrument for investors in traditional assets [18; 39].

Both research directions (investments and hedging), still do not clearly present the level of relationship between performance of green bonds and other capital markets assets in emerging capital markets. Most of the papers utilise global or European indices datasets to describe the green bonds markets which comprise mixed information about developed and developing countries. Moreover, the structure of global/regional green bonds indices across time changes, which adds more bias to the understanding of the spillover effect on green bonds compared to other assets in emerging capital markets (including also hedging possibilities for these markets).

Green finance and green bonds cluster

Most of the articles within the "green finance" and "green bonds" clusters are focused on factors that affect the performance of the green bonds within different market contexts. Three categories of factors were identified: the characteristics of the green bonds, the corporate financial characteristics of issuer companies, and the macroeconomic factors which include also financial market specifics. M. Nanayakkara and S. Colombage [40] analyse all three factors that impact the performance of green bonds: (i) characteristics of the green bonds; (ii) currency of issuance; (iii) issuer specific characteristics; (iv) macroeconomic characteristics; and (v) capital market risk characteristics. M. Flaherty et al. [41] analyses the performance of green bonds from the perspective of the third category, which specifically refers

to the following: a 3-month treasury bill rate which is used as a proxy for short-term interest, inflation, Chicago Board Exchange market volatility index, long US dollar futures index, and an industrial production index. Z. Li et al. [42] research the performance of green bonds for Chinese companies by considering green bonds characteristics (labeled/non-labeled, rating, type, maturity) and characteristics of green bonds issuer (CSR performance, credit rating, return on equity, EBITDA/interest, and turnover of fixed assets). [43; 44] analyse the performance relationship between green bonds and CO_2 emissions per capita (as a macroeconomic driver) in the top ten economies that support green bonds market development. They conclude that green finance seems to be the most efficient financial strategy for climate change mitigation.

Ranking these factors, we preliminarily conclude that the characteristics of green bonds are the main influential drivers. Macroeconomic factors are the second most influential factors in terms of the performance of green bonds, and thirdly in terms of primacy come the financial characteristics of the issuer.

This conclusion is still preliminary, because it is not clear from the papers what is the magnitude of these factors when analysed separately for developed and developing countries, except for China. F. Taghizadeh-Hesary et al. [45], narrows this gap in their research because they analyse the performance of GB markets in 3 regions: US, Europe, and Asia-Pacific. Their paper is focused on the GB characteristics (rating, maturity, certification) and industry specifics (*Banking & Finance*, *Manufacturing*, *Power & Utilities*, and *Other*). Indeed, the granularity of this analysis is also much higher. The results show that overall risk-return profile of the green bonds in the Asia Pacific region is high when compared to Europe, which is low, and moderate for the US. The impact of sector is also interesting: in Asia-Pacific the banking and finance sector is dominant, while for the US and Europe the sectors of green bonds issuers are balanced.

In addition to the above, this cluster also explores the impact of social networks and investor sentiment on the performance of green bonds for corporate sustainable development. [12] use 'investors sentiment' as a research proxy – i.e. the information processed through Stanford CoreNLP software to measure the sentiment of each posted message. They found that a positive correlation between green bonds index and investors sentiment implies that messages posted in Twitter influence the performance of the index.

The complexity of drivers of green bonds performance are high, therefore the general conclusion is that the financial design of green bonds' issuance for a company should be carefully "projected". The behaviour of the green bond is not fully understood, as it internalises characteristics that include sustainability components. The identified academic papers from this cluster do not divide the countries be-

tween developing and developed, except some papers (e.g. [45; 10]) which still provide limited empirical evidence.

Climate change and Sustainable Development

The climate change cluster refers to the general scope and climate targets which were defined during Paris Agreement and later regulated through UN Sustainable Development Goals. These articles mostly refer to the identification and analysis of the green premium as one of the main performance thresholds for green bonds market. In most of the cases, authors identified negative premium when they compare green bonds and conventional bonds considering the same financial characteristics in the primary and secondary markets (e.g., bond type, risk, maturity etc.) [40; 46–49]. This means investors are ready to assume a lower return, and issuers are benefiting from a lower financing cost for sustainable development projects. Other researchers did not find a green premium for these types of fixed income instruments or show little evidence about green premium [4; 50; 51]. Still, the academic opinions did not reach a complete consensus about the existence or non-existence of "greenium".

Such green premium is calculated differently across research papers. For example, [46] has calculated the yield spread at issuance between matched green- and conventional bonds issued by the same company. [4] found a negligible negative premium in their research by calculating through yield spread at the issuance date. [52] calculated and identified a negative premium by using the matching process of daily 'i-spreads' of green-labeled and similar non-green labeled bonds. [53] have used propensity score-matching and average treatment effect to identify the existence of negative green premium on both primary and secondary markets bonds issuance. Generally, in the research about green premiums, authors use mixed information of green bonds market from developing and emerging capital markets e.g. [40]. Separate empirical evidence about the magnitude of green premium in emerging capital markets is limited, except in the case of China [47], which currently is the largest developing country that issues green bonds (approx. USD250 bn, as of 2022[7]).

Green premium is an indirect indicator that measures the risk of 'greenwashing'. Thus, [54] explore in their research the potential sources of greenwashing risk through green bonds issuance. Using propensity score matching (PSM) and a difference-indifference (DiD) regression model, they show how to identify greenwashing risk by analysing the impact of financial and non-financial drivers through performance of green bonds. The side effects of modeling the performance of green bonds can help companies to reduce investment risk in the sustainable projects and increase transparency, thus counteracting the agency conflicts between bondholders and shareholders.

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[7] Climate Bond Initiatives.

Table 2. Journals which published articles about performance of GB in the emerging capital markets (nr. of citations and nr. of keywords)

Journals	Citations	Nr. of KeyWords
Energy Economics	436	494
Finance Research Letters	416	286
Journal of Cleaner Production	404	478
Journal of Sustainable Finance and Investment	336	210
Energy Policy	285	314
Sustainability (Switzerland)	252	348
North American Journal of Economics and Finance	92	37
International Review of Financial Analysis	74	163
Pacific Basin Finance Journal	57	32
Environment and Planning A: Nature and Space	51	39
Resources Policy	47	163
Third World Quarterly	41	17
Science of the Total Environment	40	32
Energies	39	126
Asian Economic Policy Review	34	15
Development Southern Africa	27	47
Journal of Asian Finance, Economics and Business	27	68
Emerging Markets Finance and Trade	26	40

Besides the analysis of green premium, this literature cluster also approaches the influence of non-financial drivers on the performance of green bonds. [55] analyse and simulate the level of 'greenness' from the perspective of the following factors: effectiveness of green technology, level of sustainability advantage/disadvantage, level of corporate tax rate, level of assets volatility etc. [6] identify a diversified spectrum of factors that can affect the size of green bonds markets and its issuance volume. In their research, the authors analysed data from both developed and developing countries in accordance with the following variables: macroeconomic factors, institutional factors, the strength of nationally determined commitments. They found that these factors positively affect the level of green bonds issuance volume in both categories of countries.

S. MacAskill et al. [56] provides a systematic literature analysis wherein they identified and classified the factors of green premium according to 3 categories: environmental

factors, social factors, and economic factors. Additionally, they revealed that the green bonds characteristics (analysed by different authors) are important drivers of the level of greenness (e.g., bond governance[8], bond credit rating, bond type, study timeframe etc.).

In most of the papers from this cluster, the data used for the analysis is mixed, and refers to both developed and developing countries, without indicating separate performance dynamics of green bonds for a specific country, except in the cases of China or the US. This academic gap should be addressed in future research and a more detailed analysis is needed for specific countries.

Research themes about performance of Green Bonds in emerging capital markets

A methodological approach that combines machine-based content analysis and OLAP principles for data management assists us in the retrieval of relevant articles about

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[8] 'Bond governance' refers to those green bonds' characteristics, such as adherence to recognized GB certification standards (e.g. those outlined in accordance with the Climate Bonds Initiative), and the engagement of a third-party reviewer to validate and report on the use of proceeds and adherence to the green bonds principles [56].

green bonds market at country level. The following journals appeared to publish papers about green bonds and selected emerging capital markets considering the cumulative number of citations and the keywords (see Table 2).

Academic and financial market statistics are showing that China is the biggest country in terms of green bonds issuance in the Asian region and second overall worldwide. It is worth mentioning that the academic analysis about the Chinese green bonds market is advanced when compared with other emerging capital markets. From the Scopus database we identified about 36 academic research papers that refer to the Chinese sustainable finance system, representing about 10% of the total number of identified articles.

Reviewing the most cited articles from the data selection, the following research vectors were identified. First, a regulatory framework was used to represent the main driver that propels the performance and market development for green bonds (*especially in the case of Hong Kong as a Global Financial Centre of China (GFCC) in the overall process of institutional legitimacy for sustainability – and influenced by a national policy and financial market forces*) [23]. The next most cited topic refers to the identification and analysis of the green premium. The Chinese green bonds market has a more prominent green bonds pricing premium when compared to other financial systems because of the economic magnitude of the Chinese market [47]. The issuance of green bonds for companies can represent an important signal for stock markets that such companies embrace a sustainable development path, and therefore stocks can react positively. [13] explored this topic and found that Chinese companies issuing green bonds improve its stock prices, increase its corporate financial performance, and strengthen the corporate social responsibility (CSR) position.

Russia, Brazil, India

Academic contributions about the green bonds market in Brazil is limited: from the database only 4 articles were identified, focusing on the market analysis of macroeconomic drivers and regulatory forces. The Brazilian macroeconomic structure has two important industrial pillars: oil and gas and forestry. These sectors require the allocation of sustainable finance resources because of the impact on the social and environmental spheres. T. Ferrando et al. [57] concluded that bivalent dynamics (public-private) of the Brazilian regulatory system for the development of the green bonds market is important to mitigate the erosion of forestry resources. This was the motivation for the first attempts at green bonds issuance, which started with pulp industry. In the same vein [58; 59] are stressing the importance of the impact of macroeconomic context for green bonds market development. The authors identified structural barriers (e.g., unstable macroeconomic environment, inadequate legal protection system for investors, unstable political environment etc.) and market development obstacles (e.g., lower than expected risk-adjusted returns of low-carbon investments, the cost of meeting green bond requirements etc.). Still, empirical analysis in the identified papers is missing, therefore a case-effect of green bonds performance analysis is weak.

Almost all the research papers which refer to the Indian green bonds market were published in 2021, focusing on a wide variety of topics (e.g., performance, regulatory frameworks, etc.). P. Sarma and A. Roy [60] analysed the level of development of green finance market in India, and they found that Indian financial market implemented only 8 out of 18 green finance instruments: green indices, green venture capital, green bond, green loans, green insurance, guarantees, green banking, and risk-sharing tools). Moreover, L. Chakraborty [61] found that introducing sustainable fiscal and monetary policy initiatives in India in relation to green finance can help the country to easily recover after the covid-19 pandemic. R.K. Verma and R. Bansal [62] undertook the only research that empirically approaches the spillover effect of bonds issuance on the stock prices of issuer before and after the date of issue, and authors show positive impact.

Russia has the same pace of GB market development as was the case for India and Brazil. In Scopus, 9 articles were identified about green bonds market in Russia. Most of the papers are classified in the cluster referring to the climate change and sustainable development with the focus on the regulatory framework (4 articles) and general economic context (3 articles). The research direction refers more to the importance of implementation of the regulatory systems in the area of sustainable development, green finance, renewable energy etc. In this sense the Moscow Stock Exchange and the Russian Union of Industrialists and Entrepreneurs (RUIE) signed an agreement to design and compute a sustainable development index. In August 2019 the Moscow Stock Exchange launched the sustainable development sector on its platform [63], and the regulatory framework for disclosing non-financial information [64]. Still, empirical evidence is missing, as well as a separate analysis of the Russian green bonds market. This is a research gap which should be addressed in the future by academics in order to reveal the drivers of Russian GB market quantitatively.

Vietnam, Malaysia, Indonesia, South Korea

Asian countries other than China experienced a strong development of green bonds market comparing to other emerging countries. The leading country within this region is South Korea, which in the last 10 years issued about 27.7 billion USD[9] of green bonds. Nevertheless, the number of published papers about the performance of green bonds is low. Two articles were identified about the green bonds market in Korea: one referring to the growth duality of green innovation and green finance in Asia (including Korea) and the other referring to the relationship between cost of capital and climate risk (published in the Korean language). C. Tolliver et al. [65] found that green innova-

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[9] Climate Bonds Initiative.

tion and green finance (especially green bonds) in South Korea "go hand in hand" to ensure sustainable development of the country through competitiveness.

From the selected database we identified only 4 articles about the Indonesian green bonds market which were published in 2020. The research is focused on the general macroeconomic context of the country which should be reoriented towards sustainable development through green bonds market development. First, the use of proceeds from issuing green bonds should be addressed to increase green energy production capacities of the country and to invest in energy efficiency projects. Second, the authors found that to effectively implement the Paris agenda, a proper regulatory framework should be implemented in the country [66; 25; 22]. Moreover, [67] is showing that an enhanced regulatory system with regard to the transparency and to traceability of the funds used to finance green projects plays a key role in furthering green bonds market development in Indonesia.

The Malaysian green bonds market is better positioned in the region. This idea is supported also by the number of papers published, mainly in 2020 and 2021. Most of the research topics relate to the climate change and sustainable development cluster which specifically refers to the importance of setting an efficient regulatory framework for green *sukuk* market development. It was found that J.S. Keshminder and M.S. Abdullah are the authors with particularly high interest in working together on this research area, they published together 3 out of 7 identified articles.

[68; 69] stress that financial markets have limitations about the issuance and role of green sukuk to finance climate projects. Therefore, the greenwashing risk for international investors is still high. The big challenge is to integrate the green sukuk into the overall context and principles of Islamic finance, and in parallel to achieve the target and objectives of climate change in Malaysia. Furthermore, M.S. Abdullah and J.S. Keshminder [70] refer to the role of policymakers to explore the importance of green sukuk for country competitiveness, legitimation, and ecological responsibility. This aspect, in fact, will influence the performance of the Malaysian green sukuk and green bonds markets. N.H. Noordin et al. [71] analysed and compared the differences between the terms and conditions of green sukuk principles, and the information memorandum and principles of the International Capital Market Association's Green Bond Principles (GBP). They found that such differences are affecting the optimal functionality and overall performance of green bonds market in Malaysia.

The above aspects show that in the Asia region green bonds markets are still under-developed and where the focus is not on the financial performance of the green assets (empirical evidence is still missing) but on the efficiency of its functionality which in the end represents a research gap for the whole region.

Kenya, Ghana, Nigeria, South Africa

The green bonds market in Africa has the lowest level of development compared to the other regions because of the low level of economic development and low degree of in-dustrialization. Even though that is a challenging situation, the African financial community is currently discussing the importance of different forms of sustainable finance to cope with Paris agreement and to achieve sustainable development goals. This is because the pollution, the environmental damage, and global warming do not have any geographical borders.

As for other emerging countries, the use of proceeds (especially in relation to renewable energy projects) represents the scope and reason behind the issuance of green bonds in Ghana. [72; 73] interviewed CEOs, directors, managers, and financial analysts (which belong to financial institutions) in order to understand the motivation for issuing/buying green bonds. They found that "good credit ratings, provision of local guidelines, proper green qualifications criteria, and prioritizing viable projects" are the most important factors that affect green bonds market development. Similar factors were identified by [17] for the Nigerian market. The authors show that commitment to reduce CO_2 emissions assumed by the ministry of finance and the ministry of the environment is the main motivation to issue green bonds, and to finance renewable energy projects.

[74; 58; 45] showed that South Africa, together with Kenya and Nigeria (as economic hubs on the African continent) are among the initiators of issuing green bonds in the region. Thus, private-public partnership, integrated policies, and effective and optimal institutional frameworks will help these markets to develop and attract more green finances for their national and regional climate projects.

Empirical evidence about performance of green bonds in the emerging capital market is poorly developed, indeed the level of market development and financial trading dynamics are low, and therefore the quantitative analysis is limited. However, an empirical analysis of green bonds market performance can be undertaken for small geographical clusters (e.g. Asian developing countries, Eastern European countries, African countries etc.). This type of analysis can be relevant also because of the role of multilateral development banks (e.g., focused on the global south) which attempts to foster alternatives to the Bretton Woods institutions, for example the New Development Bank, the Asian Infrastructure Investment Bank etc. These types of financial institution are interested in stimulating these regions and capturing information about the green bonds market development especially in the emerging countries [58].

The future research trends of Green Bond's performance in the emerging capital markets

Machine-based content analysis is a complementary method to classical approach to literature review [75]. To identify the trends of the future research direction, an evolution of keywords was considered. Based on the data extracted from Scopus, which was processed through VOSviewer the obtained results were structured and organised using OLAP principles with the help of VBA programming through spreadsheets.

The results shown in Figure 6 conclude that sustainable finance, dominated by green fixed income bonds, are instruments designed for "investments", whose scope is for "financing" project to reduce the "carbon" emissions and to mitigate "climate change" in respect of "sustainable development".

Figure 6. Visualisation of key words trends extracted through OLAP principles from Scopus database and VOSviewer
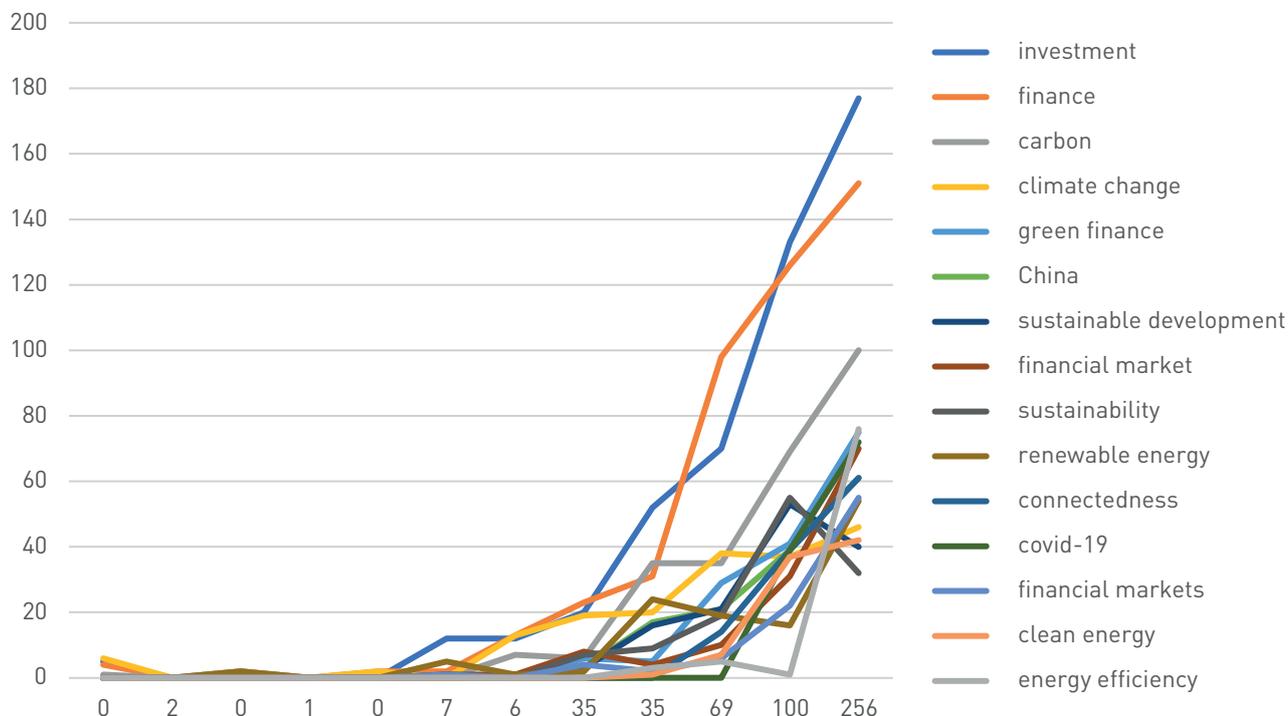
Source: Graph made by the author.

Future academic research will continue to develop in two directions: (1) investments direction (to buy/issue green bonds for investment purposes); (2) non-investment, to finance organisational sustainable development paths. The first conclusion that may be drawn is that investors are not keen to get immediate financial benefits by investing in green bonds, rather than participating and involving in the sustainable development, climate change and supporting transition to a net-zero economy. Due to this reason, the green premium is the financial measurement performance addressed towards medium- and long-term investments. It seems that this trend in the research will continue because of the high complexity of the green bonds market and low level of regulatory framework development, especially in emerging capital markets.

The second conclusion is that "China" and European countries will continue to develop the green bonds market more than other regions in terms of both corporate and government organisation. The main instrument for promoting and implementing the European "Green Deal" program are green finances. China is contrary to Europe, which is the one biggest consumer market in the world[10], in that China is one of the biggest manufacturing markets in the world[11]. This is one of the main reasons why China and EU countries will continue in the future to develop more green bonds markets in order to redesign both the macroeconomic processes towards sustainable development and net-zero economy.

The third conclusion is that sustainable bonds are still dominant when compared to financial "renewable energy" industries. This will also continue into the future and will act indirectly as a "CO$_2$ emission control" instrument. The identified research topics and future academic direction show that the empirical evidence about the performance of green bonds and its spillover effect is still limited, especially for the energy sector and for emerging capital markets. In fact, this represents a research gap which should be considered in future studies as the green bonds market in these regions is developing rapidly. The fourth conclusion refers to the role of the "COVID-19" pandemic in accelerating the development of the green bonds market and green finances towards mitigation of climate change vectors. The accelerated trend of the "covid-19" keyword in 2021 (and partially in 2022) in the context of green bonds academic literature analysis is evidence of this. The general keywords trend analysis is showing that the research direction is almost similar with the keywords trend of the selected emerging capital markets.

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[10] World Bank: Household final consumption expenditure.

[11] WEF: https://www.weforum.org/agenda/2020/02/countries-manufacturing-trade-exports-economics/

Conclusions and implications

The representation of the performance of green bonds in the academic literature research has different facets. The most common measurement is through "green premium" or *greenium*, always calculated in contrast with the conventional bonds or so-called brown bonds. Performance is represented also through the spillover effects in connection with other financial/capital markets instruments (e.g. oil price, green stocks, IT stocks, etc.). Some academic papers are analysing the green bonds performance in connection with economic, non-financial factors (e.g., FX rate, adherence of the country to OECD, level of development of regulatory system etc.). Thus, our first conclusion is that the performance of green bonds has a multifaceted character, and to reach a scientific consensus through the empirical analysis about it is difficult.

The analysis of the current academic contributions, focused mainly on emerging capital markets, presents the concern about the low level of regulatory framework in these countries. Indeed, ambiguous legal frameworks and lack of motivation from local or central authorities will increase the level of uncertainty about a country's sustainability policies and strategies (e.g., to meet 2030 climate targets, transition to net-zero economy, etc.). The second conclusion is that these market realities might have a double negative effect: high performance risk for green finances and barrier for the development of green bonds market.

'Performance' in the context of our research does not mean only the premium, coupon, or any other direct performance measurements. It also refers to those drivers which indirectly might affect its dynamics and further attractiveness to investors and willingness of issuers to attract green finances. We identified the following categories of drivers: macroeconomic, social, environmental, institutional (regulatory), and financial. Our third conclusion refers to the low predictability of green bonds performance in emerging capital markets. It is difficult to measure performance because it internalises the effects of all the stated drivers which are highly dynamic in developing countries (e.g., high inflation, low economic stability, high FX volatility, political instability etc.).

Emerging capital markets have a wide variety of social, financial, macro-economic, and political specifics that do not allow analytics and/or academia to identify a pattern of green bonds market development. Consider the economic contrast between Russia and Malaysia: these two countries have almost identical levels of green bonds issuance, but the nature of the instruments are completely different because of different financial principles of adherence (green bonds vs green sukuk). Additionally, we may exemplify the contrast of the green bonds market development between China and India. Different green bonds market dynamics, levels of instrument performance, and different levels of regulatory contexts of the sustainable finance markets make up the big difference between India and China, which are ranked among the global leaders in terms of bonds issuance. Due to these reasons the performance drivers and factors for green bonds markets are diversified and specific for each country. The fourth conclusion is that green bonds issued by organisations from "emerging capital markets" should not be analysed in a systematic manner from a geographical perspective. The analysis should be done for individual countries (e.g., China) or small cluster of countries (e.g., East European countries) depending on the macroeconomic characteristics and level of green bonds market development.

We finally conclude this academic review with the observation that non-financial factors mostly affect the performance of green bonds in emerging capital markets while the financial factors dominate the performance of green bonds in developed countries. Indeed, once the financial markets are mature, stable, and sufficiently regulated (included in terms of transparency) the flow and availability of capital is much higher. The competition between different types of capital is much higher in developed countries, therefore, the academic community is more concerned about the financial drivers affecting the performance of green bonds. The level of financial markets regulations and their transparency, the national regulatory framework for sustainable finance, macroeconomics drivers, and the existence of tax stimulus are among the factors international investors are looking at when deciding whether to invest in green bonds in emerging-market countries.

Limitations of this academic review include non-homogeneity of the data for empirical analysis (e.g. the sample size, timeframe, mixed financial data from developed and emerging capital markets etc.), and so the conclusion about influential non-financial factors should be addressed further. This will be possible only with the continuous growth of the green bonds market, which will bring more availability of robust data sets. Also, in this review we analysed only English language papers. In future research, this limitation might be addressed, especially those papers which refer to a country regulatory framework where the local language is needed for a better legal understanding.

In view of the methodology of the machine-based content analysis, it can be concluded in preliminary terms that future trends in the academia research will not be focused on the purely financial performance of the green bonds but on the role of such instruments in terms of sustainability. Following this logic, in the future we expect to see more issuance of green bonds in both developing and developed countries in order to achieve the climate targets set out in the Paris Agreement. The volume will increase as the formal "climate deadline" is getting closer (by 2030).

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Appendix 1 (VBA code for keywords data retrieve)

```
Function NrAparitii(ByVal FindText, ByVal InText)
vNrAparitii = 0
vInText = IIf(IsNull(InText), "", InText)
vFindText = IIf(IsNull(FindText), "", FindText)


lgInText = Len(vInText)
lgFindText = Len(vFindText)
If lgFindText <> 0 Then

  If lgFindText > lgInText Then
    vNrAparitii = 0
  Else
    PosInit = 1
    Pos = 1
    While Pos > 0
      Pos = InStr(PosInit, vInText, vFindText, vbTextCompare)
      If Pos > 0 Then
      vNrAparitii = vNrAparitii + 1
      PosInit = Pos + lgFindText
      End If
    Wend
  End If
Else
vNrAparitii = 0
End If
NrAparitii = vNrAparitii
End Function
```

Appendix 2

Green finance	Renewable energies	Investments	Green Bonds	Climate change and Sustainable development
Banking	alternative energy	clean energy	carbon dioxide	bond yield
capital flow	carbon	commerce	carbon emission	climate change
capital market	developing countries	costs	climate finance	climate change mitigation
Certification	economic analysis	crude oil	developing world	environmental protection
China	economic growth	energy market	environmental economics	green bond
climate bonds	economics	energy markets	environmental policy	green financing
conventional bonds	emission control	financial markets	finance	planning
corporate social responsibility	energy policy	green economy	financial services	risk assessment
covid-19	europe	investment	fintech	sustainability
credit rating	financing	investments	global warming	sustainable development
empirical analysis	fossil fuels	investor attention	governance approach	sustainable development goal
financial market	macroeconomics	market conditions	green bonds	sustainable development goals
financial system	renewable energies	power markets	innovation	sustainable finance
green bond premium	renewable energy	spillover effect	municipal bonds	sustainable investments
green finance	renewable energy projects	stock market		
panel data	renewable energy resources	united states		
performance assessment				
regression analysis				
research work				

Structure of the keyword's clusters generated by VOSviewer.