ROLE OF GREEN FINANCE IN GREENING THE ECONOMY: CONCEPTUAL APPROACH

Aleknevičienė, V., Bendoraitytė, A.

Vilija Aleknevičienė / Vytautas Magnus University, Faculty of Bioeconomy Development, Department of Applied Economics, Finance and Accounting, Universiteto 10, Akademija, Kaunas district, Lithuania. Email: vilija.alekneviciene@vdu.lt

Asta Bendoraitytė / Vytautas Magnus University, Faculty of Bioeconomy Development, Department of Applied Economics, Finance and Accounting, Universiteto 10, Akademija, Kaunas district, Lithuania. Email: asta.bendoraityte@vdu.lt

Abstract

Currently, economic development of countries and regions is not possible without the implementation of the European Green Deal. A set of policy initiatives by the European Commission is closely related to concepts such as greening the economy, green finance, climate finance, climate change adaptation and mitigation, environmental protection and others. This research is dedicated to highlighting the role of green finance in environmental protection and development of the financial sector. Green finance connects the worlds of finance and business with environmentally friendly behaviour. In principle, all strategic decisions made by business organisations must take into account the potential impact on the environment, which means that value creation in the long term is integral to the well-being of current and future generations. The novelty of the research lies in the developed conceptual framework of the role of green finance in greening the economy. The conceptual framework covers three main elements of green economy: real green economy, green finance and providers of green finance – the green financial sector and public funds. It is developed by applying the methods of content analysis and synthesis, comparison and logical modelling, the model as a research design proposed by Jaakkola (2020), a system test proposed by Arnold and Wade (2015) and the main features of the conceptual framework presented by Jabareen (2009).

Implications for Central European audience: The main "green" economic and financial concepts are described and their interconnectedness is revealed in this study. This is important in the phase of greening the economy when various actors – users of information and decision-makers – interpret the concepts differently. Different understanding and thinking slow down the development of green economy. The developed conceptual framework provides a clear understanding of how business and public organisations, as well as individuals, can change their behaviour to environmentally friendly by investing in real investment projects or financial assets. Finally, the main research challenges and directions related to green real and financial investments are revealed.

Keywords: Green finance; green economy; environmental protection; green financial sector; green public funds
JEL Classification: Q50, Q56

Introduction

Green finance, as the object of research, is receiving more and more attention. The focus of researchers on green finance is varied, but the research history is not yet rich. Some research is conducted in an attempt to describe the concepts of green finance (Höhne et al., 2012; Lindenberg, 2014; Zadek & Flynn, 2013), green economy (Loiseau et al., 2016), and green investment (Eyraud et al., 2011; Golub et al., 2011). Green finance covers a lot of different financial instruments and tools, such as green bonds and stocks, green loans and mortgages, weather derivatives and green venture capital, government subsidies such as grants, loans, compensations, guarantees, feed-in tariffs, carbon taxes, pollution permits, tax credits, green public procurement, etc. It is therefore not surprising that researchers pay attention to one or more financial instruments or tools and focus on particular issues related to them.

Green bonds, as the main financial market instrument, have been analysed from different perspectives: pricing, premium, transparency, shareholder benefits, spillover effects, investors' behaviour, etc. Despite various issues, researchers have mainly concentrated on the impact of green bonds on greening the economy (Bongaerts & Schoenmaker, 2019; Flammer, 2019; Tolliver et al., 2019) and the existence, scale and effects of green bond yield premiums (Baker et al., 2018; Fatica et al., 2021; Hachenberg & Schiereck, 2018; Nanayakkara & Colombage, 2019; Zerbib, 2019). Green stocks have received significantly less attention from scientists than green bonds. The main focus has been on the impact of environmental performance on the cost of equity (Feldman et al., 1997; Heinkel et al., 2001) and the relationship between a company's green score and its stock price (Meric et al., 2012). Peculiarities of green venture capital have been analysed by Criscuolo and Menon (2015), Cumming et al. (2016), Gu et al. (2018) and Randjelovic et al. (2003). Weather derivatives have received attention from Bressan and Romagnoli (2021) and Brockett et al. (2005). Green loans and mortgages and their markets have been analysed by Gilchrist et al. (2021) and Weber (2005). The structure and types of green subsidies have been presented by Charnovitz (2014) and Fischer (2016), focusing on direct transfer of funds, fiscal incentives and purchase of goods and services.

In addition to fragmented and highly targeted research into green finance, some studies have been designed using a systemic approach. Dziwok and Jäger (2021) presented neoliberal and reformist forms of green finance and monetary policy, and progressive forms of green finance. Moon and Bace (2020) presented ways to define greening, green industrial areas and the circular economy model of green finance. Hafner et al. (2020) developed a simplified representation of the green finance gap, which includes the space of actors and the space of green finance barriers, and recommended this gap as an important question for future research. Sarumathi (2014) developed a conceptual framework for factors influencing green purchase behaviour of consumers.

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

Our research focuses on the role of green finance in greening the economy, as well as on the interconnectedness of different "green" economic and financial concepts. Such a systemic approach is valuable in providing a clear understanding of how business and public organisations, as well as individuals, can change their behaviour to environmentally friendly by investing in real investment projects or financial assets.

The main object of the research is green finance and green financial instruments and tools. The aim of the research is to describe the main "green" economic and financial concepts, to reveal their interconnectedness, to disclose the role of green finance in greening the economy and to indicate the main directions for future research.

The research paper is structured as follows: the first chapter is dedicated to research methods, the second chapter to research results and discussions, and the paper ends with conclusions.

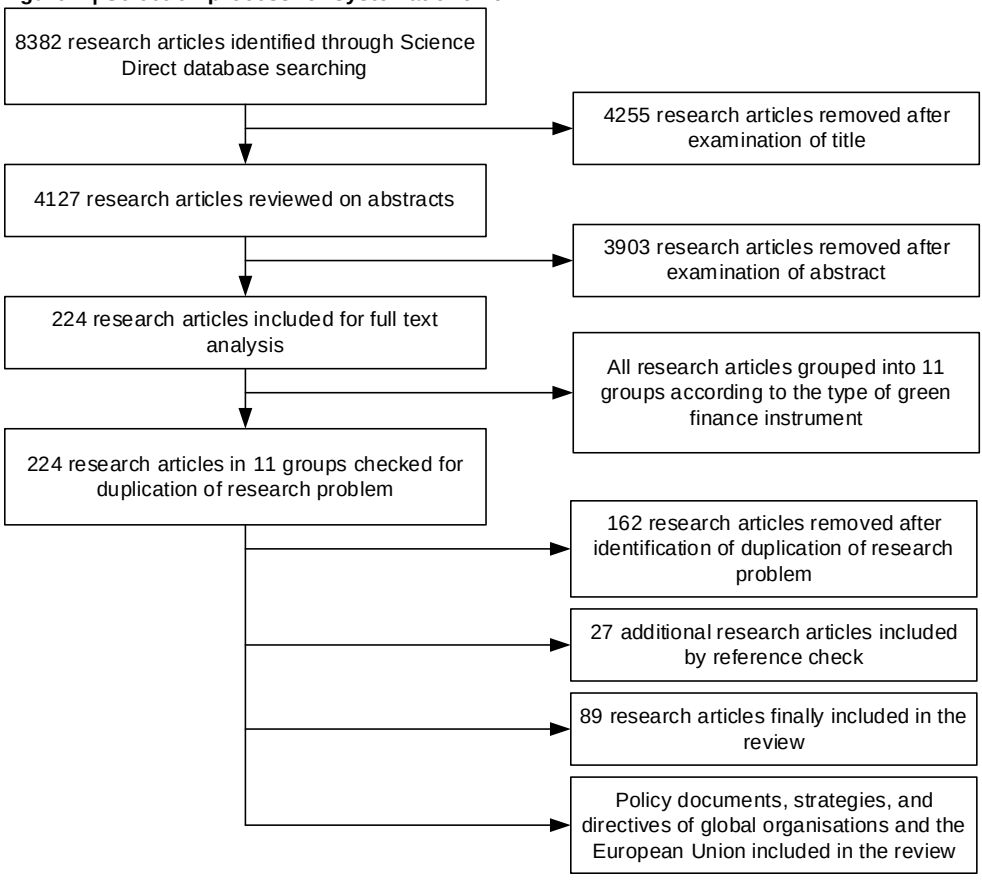
1 Research Methods

The research review was implemented using a systematic and analytical approach. The systematic approach was used to identify research articles according to predefined criteria. When relevant research articles were found, they were grouped, analysed and included in the research review. This is a qualitative approach that is widely used in the academic literature for conceptual articles. According to Jaakkola (2020), there are four common types of research design in conceptual papers: theory synthesis, theory adaptation, typology and model. The model was chosen as the research design, i.e., building a theoretical framework that predicts relationships between constructs. In order to build the relationships, the following steps are important: (1) identifying the scope of constructs, (2) setting up novel connections between constructs, (3) developing theoretical propositions that introduce new constructs and relationships between constructs, and (4) explaining why a sequence of events leads to an outcome.

The starting point of the research is identifying the scope of constructs. For this purpose, the process of researching and selecting scientific articles was carried out, as shown in Figure 1. Research articles for review and screening were selected from the Science Direct database. First, relevant search terms were created using the keywords "green finance" and "instruments". The search field was narrowed down by selecting research articles belonging to the categories "Social Sciences" and "Economics, Econometrics and Finance". According to the mentioned criteria, 8382 research articles were identified, then 4255 of them were removed after examination of the title and 3903 after examination of the abstract. After the elimination procedure, 224 research articles covering at least one type of green finance instrument were included for full-text analysis. The selected research articles were grouped according to the type of green finance instrument. The grouping allowed identifying the scope of constructs. Then 162 research articles were removed after identification of duplication of the research problem, and 27 additional research articles were included by a reference check. The final procedure is done in order to identify articles that summarise the instruments of green finance, describe the main features of these instruments, and/or present the role of green finance in greening the economy. Finally, 89 articles are included in the review. In addition, policy documents, strategies, and directives of global organisations and the

European Union related to green finance are surveyed. This procedure allows us to set up novel connections between constructs and to develop theoretical propositions that introduce new constructs and relationships between constructs.

Figure 1 | Selection process for systematic review



Source: authors

This review allowed us to explain a sequence of events and develop the main outcome of the research article: the conceptual framework of the role of green finance in greening the economy. The construction of a conceptual framework is based on logical modelling, a system test proposed by Arnold and Wade (2015), and conceptual framework features presented by Jabareen (2009). The system test (Arnold & Wade, 2015) is a requirement for systems thinking definition. It consists of three kinds of things: purpose, elements and interconnections. According to the aforementioned authors, purpose, function or goal should describe the purpose of systems thinking in a way that can be clearly understood and relates to everyday life. Elements will manifest as characteristics of systems thinking. Interconnections are the way the elements or characteristics feed into each other and are interconnected. The development of the conceptual framework follows the main features

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

presented by Jabareen (2009). According to the researcher, the conceptual framework has the following features: each concept should play an integral role in it; it should provide an interpretative approach to social reality; it should provide understanding; it should provide a "soft interpretation of intentions"; it should be non-deterministic in nature and therefore unpredictable; it can be developed and constructed through a process of qualitative analysis; data sources consist of many discipline-oriented theories in it, and seek to generate new interpretations that are agreed upon in a particular field of study.

2 Research Results and Discussion

Green finance is a new concept, so its description is under development. One aspect on which scientists generally agree is that green finance is used to fund activities related to achievement of environmental protection goals. The concept of "green finance" is closely related to the concepts of "climate finance" and "sustainable finance". Green finance is used to fund activities related to climate change mitigation, adaptation to climate change and other environmental protection goals such as water management, biodiversity, landscape protection, etc. Climate finance is a part of green finance. It is a source of funding used to finance projects and actions aimed at climate change mitigation and adaptation. Sustainable finance is the broadest concept that encompasses activities to be funded that ensure sustainable pursuit of environmental, social and economic goals. The history of the concept of "green finance" is associated with policy documents, strategies and directives of global organisations and the European Union. The first researchers to define this concept were Höhne et al. (2012), Lindenberg (2014) and Zadek and Flynn (2013).

Another concept related to green finance is green economy. It is defined as an economy that aims to reduce environmental risks and ecological scarcities and which pursues sustainable development without adversely affecting the environment. According to Loiseau et al. (2016), the concept of "green economy" is usually associated with the specific keywords "sustainable development" or "sustainability", i.e., the three dimensions of sustainability: environmental, economic and social. It means that we cannot reduce environmental risks and ecological scarcities at the expense of social and economic welfare. According to the aforementioned authors, green economy can be linked to theories of both environmental economics and ecological economics.

As mentioned earlier, green real economy covers green investment and public policies on greening economies. Green investment is investment in activities related to achievement of environmental protection goals. The history of this concept is associated with environment policy documents, strategies and directives of global organisations and the European Union (EU). The first researchers to describe this concept were Eyraud et al. (2011). They described green investment from a macroeconomic perspective, arguing that it was necessary to reduce greenhouse gas emissions and air pollutants without reducing the production and consumption of non-energy goods. Golub et al. (2011) described green investment in terms of international trade and emphasised that the concept of "green" is often limited to what we produce rather than how we produce and use the product. The definition of Eurostat (2009) extends this approach. According to it, "green investment" includes not only goods and

services but also technology. That is why it should be divided into investment in environmental protection and resource management activities.

The main areas of green investment are as follows: supply of low-emission energy sources (including renewable energy, biofuels and nuclear energy); energy efficiency in the supply and consumption sectors; carbon capture and sequestration (including reforestation and agriculture); conservation of biodiversity (including endangered species and sensitive ecosystems in modified, natural and critical habitats) and identification of legally protected areas. The criteria for assessing "greenery" are also related to the feasibility of climate change strategies, energy consumption, eco-efficiency, implementation of environmental management systems, conservation of biodiversity and product management. Green investments are implemented in economic activities that have a significant impact on the environment: agriculture, manufacturing, mining, forestry, transport, construction, energy, etc.

The implementation of green investment will be fostered by the European Green Deal. It is a set of policy initiatives by the EU with the overarching aim of making the EU climate-neutral in 2050. In order to tackle climate change and environmental degradation challenges, the European Green Deal will transform the EU into a modern, resource-efficient and competitive economy. To achieve the goals set by the European Green Deal, the European Commission has committed itself to mobilise at least €1 trillion in green investment in 2021-2030 and to allocate 30% of the EU budget for green investment in 2021-2028 (European Commission, 2019).

Another EU document focusing on green investment is the EU Biodiversity Strategy for 2030, which addresses the key drivers of biodiversity loss through its conservation and restoration, and by promoting change in a wide range of environmental, economic and social areas. This strategy is in line with the European Green Deal. Green investments are aimed at restoring nature, combating the decline of insect pollinators, creating urban greening platforms and reducing the negative impact of agriculture on biodiversity (European Commission, 2020b).

Green real economy covers not only green investment but also public green policies. Three levels of public green policy can be identified: national, regional and international. The outcomes of these policies must correspond to the intended objectives but should, in general, boost the real economy towards greening at different spatial scales. Usually, the boosting is done through governmental interventions directed towards increasing efficiency of green investment. According to Kemp-Benedict (2018), investors and firms interact through market valuation of "green" and "brown" assets and changing productivity and costs due to learning by doing and network effects. The policy was required to start the transition in leading sectors to make green investments attractive.

Green financial tools and instruments are supplied by private and public actors operating in the green financial sector and public funding. Among such actors are green capital markets, financial institutions, governmental and multilateral funds. Despite the nature of green finance suppliers, all funds accumulate money from society. The only difference is that some of them accumulate money from private investors on a voluntary basis (green capital markets,

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

financial institutions) and some of them on a governmental basis (public and multilateral funds).

The biggest supplier of financial instruments is the green financial market. According to Wang and Zhi (2016), if the market mechanism of green finance is rational, green finance can guide the flow of funds and achieve effective management of environmental risk and optimal allocation of environmental resources and social resources. An effective policy will allow avoidance of the information asymmetry phenomenon and solve the moral hazard. The main green instruments are green bonds, green stocks, green venture capital and weather derivatives.

Green bonds are the most popular financing instrument. Green bonds are fixed-income securities that raise capital for a project with specific environmental benefits. Green bonds must comply with the guidelines for the voluntary green bond issuance process – the Green Bond Principles. They include the use of proceeds, the project evaluation and selection process, management of proceeds and reporting. These principles are intended for market participants. They provide information on the key characteristics of green bonds and the environmental impact of investing in green bonds, and facilitate market transactions while ensuring market integrity. Bongaerts and Schoenmaker (2019) pointed out that if green bonds are issued to refinance existing green projects that were previously financed by conventional bonds, they do not generate additional capital for environmental protection and climate action. Tolliver et al. (2019) argue that although some green bond issuers publish post-issuance reports, they provide a limited view of the role of green bonds in pursuing environmental policy objectives. In contrast, Flammer (2019) demonstrated the approach that corporate green bonds improve environmental footprints and financial performance among firms and attract environmentally aligned investors.

Green bonds were first issued by the European Investment Bank in 2007, but it took several years for their market to grow significantly. The volume of outstanding green bonds started at $230 million in 2010 and rose sharply from around $4.8 billion in 2013 to roughly $142 billion by 2017 (Tolliver et al., 2019). The issuance was boosted by the Green Bond Principles set out by a consortium of investment banks in 2014. Green bonds as a financial instrument have received some criticism. They can be issued by business organisations whose other activities (other than the funded project) have little greenery or even have a negative impact on the environment. The lack of a uniform classification and labelling of “greenery” leads to the phenomenon of “greenwashing”: green public relations and green marketing are used fraudulently to convince the public that an organisation’s products, goals and policies are environmentally friendly. The lack of consistent reporting requirements also poses problems for information transparency. However, Sangiorgi and Schopohl (2021), using survey evidence from European asset managers, revealed that preferential capital treatment for low-carbon assets and minimum standards for green definitions receive the highest investor support, but respondents are divided on whether a strict definition of “green” or a less strict definition would be more beneficial for scaling up the green bond market. Finally, the majority of bonds issued by business organisations are redeemed by institutional investors, which partially restricts their supply to other investors on the financial markets.

DISCUSSION

Green bonds can be issued by governments, municipalities, agencies, business organisations and financial institutions. The interest on green bond coupons is paid, and green bonds are redeemed from all of the issuer's activities rather than from the cash flows generated by a particular green project, so the default risk depends on the issue's overall credit risk. For this reason, green bonds have the same credit rating as other debt obligations of the issuer. Green bonds usually have tax benefits such as tax exemptions and tax credits, making them a more attractive financial instrument compared to conventional bonds. Tax incentives provide a monetary incentive to address important challenges in mitigating climate change, adapting to climate change and conserving biodiversity. Green bond prices and yields are also less volatile, as investors tend to choose a "buy and hold strategy". Nevertheless, the issuer of green bonds incurs higher costs due to various requirements imposed on them, which results in a higher coupon rate than for conventional bonds. The controversial nature of this approach was proved by Zhang et al. (2021). They revealed that green projects and the issuance of green bonds help lower the corporate costs of capital in three channels: reducing information asymmetry, improving security liquidity and lowering bond issuers' perceived risk. It should be pointed out that the authors investigated the implied costs of capital and the weighted average costs of capital.

A lot of researchers have investigated the premiums of green bonds. In most cases, their findings have confirmed positive green bond premiums (Gianfrate and Peri, 2019; Hachenberg and Schiereck, 2018; Nanayakkara and Colombage, 2019). Such research findings are based on the following arguments: investors appreciate the green label of the bonds; environmentally responsible investors are not only interested in the return of their portfolios but also have a clear position on the assets in which they invest; investors agree to fund activities that provide environmental or climate change mitigation benefits. According to MacAskill et al. (2021), a portion of investors are willing to pay a higher price for green bonds and therefore accept a lower yield. Issuers may benefit from engaging with the green bond market to finance low-carbon initiatives at a lower cost. As more issuers become aware of plausible capital-raising benefits of the green premium, there are implications for the growth of the green bond market overall. Negative premiums of green bonds were identified by Zerbib (2019), who revealed that the negative premium is more pronounced for financial and low-rated bonds. Fatica et al. (2021) found that among corporate issuers, the negative premium materialises only in favour of non-financial green issuers. This phenomenon is explained by the fact that financial institutions are engaged in green lending rather than investing directly in green assets.

In order to make green bonds more attractive, policymakers should take measures to scale up the green bond markets, for example, favourable tax rates for green bond holders (Agliardi & Agliardi, 2021). As there exist feedback effects between green bonds and investor attention, a policy that informs investors about green bonds can influence incentives to invest in this market (Pham & Huynh, 2020). Lin and Su (2022) suggested several targeted policy implications and managerial contributions, such as improving the popularity of green bonds through discount encouragement; paying more attention to the issuers with better "green images"; guiding the issuer behaviour through monetary policy; promoting a more complete green financial system to reduce the potential issuance costs and risks. Finally, Flammer (2021) did not find pricing differences for corporate green bonds. However, he argued that

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

green bonds issued by the same issuers are more likely to have a negative premium compared to those issuers that issue green bonds for the first time, and Larcker and Watts (2020) found no pricing difference on the market for green municipal bonds. Some research has focused on the identification of pricing factors of green bonds. Empirically documented pricing factors include credit rating and sector (Gianfrate & Peri, 2019), liquidity (Febi et al., 2018), treasury and corporate bond prices (Reboredo, 2018) and green label (Hyun et al., 2021). MacAskill et al. (2021) made a systematic review of premiums on green bonds and revealed the following premium determinants: bond governance, bond credit rating, bond type and study timeframe.

Another area of research is related to the spillover effect and portfolio formation. Reboredo (2018) confirmed that green bonds are affected by substantial price spillovers from corporate and treasury fixed-income markets and that large price swings on stock and energy markets have a negligible impact on green bond prices. Naeem et al. (2022) found higher total time-varying risk spillovers during extreme high volatility periods than those with average and low volatility. They pointed out that these findings are useful for investors wishing to implement green diversification portfolio strategies in extreme volatility periods. Moreover, the findings can be seen as an encouragement to policymakers to establish efficient policies to promote green finance. Boutabba and Rannou (2022) studied the term structure of the liquidity premium of the green bond market and concluded that green bond investors prefer "buy and hold" strategies because they are compensated for higher liquidity along the entire maturity spectrum. Pham (2021) revealed that the dependence between green bonds and green equity during normal market conditions is relatively small. On the other hand, green bonds and green equity are more connected during extreme market movements, where they boom and bust together. Tang and Zhang (2020) showed that institutional ownership, especially by domestic institutions, increases after the issuance of green bonds. Moreover, stock liquidity also improves significantly, i.e., issuance of green bonds is beneficial to existing shareholders. According to Han and Li (2022), the inclusion of green bonds in portfolios is beneficial for investors from both the increase in return and the decrease in volatility.

Green stocks (green chip stocks, green shares) are stocks issued by environmentally friendly companies, i.e., companies within a specific sector that is closely linked with the environment or companies that adopt environmentally-oriented practices (Vizzotto, 2012). According to Vizzotto (2012), investing in green shares of companies that adopt green practices means that those investors are aware of the relationship between the environment and the company's share value. Of course, what makes a company environmentally friendly is open to debate. For example, some investors see investments in large-scale hydropower projects as environmentally friendly as this reduces the dependence on fossil fuels, while other investors see the implementation of such large-scale hydropower projects as disrupting ecosystems. Activities of companies issuing green stocks can be linked to production of solar, wind and geothermal energy, recycling of waste into energy, production of plug-in hybrid vehicles, production of organic food, sustainable and environmentally friendly farming, and so on.

Green stocks, such as green bonds, have been criticised for fraudulent use of public relations and marketing by companies issuing green stocks to convince the public that their products,

goals and policies are environmentally friendly. In this way, these companies shift their focus from environmentally friendly activities to one or more environmentally friendly projects they support. The company's activities consist of all its projects, making it difficult to determine whether its activities meet the "greening" criteria. Despite the existing phenomenon of "greenwashing", it is sometimes sufficient for a company to produce a product using at least a slightly cleaner technology than its competitors in order for its activities to meet the green criteria. Companies that issue green stocks are usually government-subsidised or receive a tax shield, and potential investors are aware of this. On the one hand, both subsidies and tax incentives may be eliminated in the future, so a decline in profits may reduce the market value of green stocks. On the other hand, the government may impose additional taxes on companies that produce environmentally unfriendly products, leading to a shift in investment from conventional to green stocks. Mumtaz and Yoshino (2021) disclosed that higher sensitivity to environmental issues compels firms to follow green measures. The proportion of investment is higher if the firms account for greenness measures.

Nasdaq, one of the world's largest stock exchange operators, supports Nasdaq Green Designations, which aim to increase the visibility and transparency of business organisations for investors seeking environmentally friendly investments. Companies can apply to the exchange operator for two voluntary designations: Nasdaq Green Equity Designation and Nasdaq Green Equity Transition Designation. The first designation is attainable for companies with more than 50% turnover consisting of environmentally friendly activities and which continue to invest in these activities. The second designation is attainable for companies that intend to become environmentally friendly and plan a significant share of future investments in these activities. Companies applying for the designation are assessed by an expert approved by Nasdaq. These designations are offered to new and existing issuers on European main markets and the First North Growth Market. Approved issuers are marked with a symbol in the list of stocks, and the expert assessment report and additional relevant information are provided on the issuer's information page.

Only a few studies have focused on green stocks at the corporate level. Feldman et al. (1997) focused only on the environmental aspect of corporate social responsibility (CSR) and suggested that companies that are able to improve their environmental performance can reduce the betas of their capital asset pricing models (CAPM) and increase their stock prices by up to 5%. Heinkel et al. (2001) examined the issue of SRI from the perspective of the impact of environmentally friendly behaviour on a firm's costs of equity capital. They argued that socially responsible investors will not invest in firms whose environmental policies are questionable, so the demand for shares of such firms would come only from "neutral" investors. According to them, this lack of demand will increase the costs of capital for polluting firms relative to green firms. Meric et al. (2012) studied the impact of a company's green score on its stock price and found that a company's green score and its stock price are significantly negatively related. The argument is that the costs of staying green may adversely affect a company's profitability, and investors pay a lower price for green company stocks compared with non-green company stocks. So, there is no incentive for companies to go green and to keep green.

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

DISCUSSION

The green risk premium (greenium) of stocks and its drivers has been analysed by Alessi et al. (2021), Borghesi et al. (2022), Pástor et al. (2021), etc. Specifically, Alessi et al. (2021) provided evidence of the existence of a pricing factor linked to climate risk and found that the greenium is negative. They constructed an index of greenness and environmental transparency at the individual company level, taking into account the company's GHG emission intensity and the quality of its environmental disclosure. Estimation of a model with a time-varying risk premium and drivers of the greenium are foreseen as future research directions. The economic rationale in the model of Pástor et al. (2021) is that while green assets have lower expected returns because they provide a hedge against climate risks, they could outperform brown stocks if investors' preferences change. Meanwhile, some researchers looked for events and determinants influencing the greenium. Borghesi et al. (2022) collected green policy announcements for EU countries made over the year 2020 and revealed the presence of a positive impact on both brown and green stocks. They concluded that the impact on the green portfolio is larger, so green policy announcements can be a key driving force of the whole economic system. Moreover, the increasing cumulative abnormal return gap with respect to the green sectors is likely to induce and possibly accelerate the green transition process in the medium or long run. Bouri et al. (2022) provided empirical evidence that climate policy uncertainty is a significant determinant of the performance of green energy stocks relative to brown energy stocks. Their findings highlighted the predictive information of climate policy uncertainty for price dynamics of green and brown energy equity. The authors concluded that climate policy uncertainty influences the preference of investors for green energy stocks, which matters for asset pricing, style rotation strategies and asset allocation. Finally, Venturini (2022) made a literature review on climate change, risk factors and stock returns and discussed the types of data needed to analyse the climate risk drivers that shape the dynamics of the equity market.

The other direction of research is related to the connectedness, spillover effects, hedging and diversification effects of including green stocks in investors' portfolios. They investigated the aforementioned phenomena taking into account geographical regions, investment horizons, market conditions, etc. Janda et al. (2022) investigated the dynamic connectedness between oil prices and stock returns of clean energy-related and technology companies on Chinese and US financial markets and made suggestions for hedging the assets. Some papers (Hong et al., 2019; Monasterolo and de Angelis, 2020) have focused on climate risk hedging portfolios. Chakrabarti and Sen (2021) investigated the nature of the time-varying market risk of investment in green stocks across the USA, Europe and the Asia-Pacific region. They disclosed that the US and European green stocks have significant volatility spillover from the local market and are strongly integrated with the global market. For the Asia-Pacific green stocks, there is no spillover from the local market, and they are weakly integrated with the global market. In the USA and Europe, the global crisis weakens financial integration, while it is strengthened in the Asia-Pacific region. Pham (2021) revealed that the dependence between green bonds and green equity during normal market conditions is relatively small; however, they are more connected during extreme market movements. In addition, the spillover effects between the green bonds and green equity are short-lived, as the degree of connectedness dissipates in the medium and long-term investment horizons. According to Tzouvanas and Mamatzakis (2021), stocks with superior environmental performance have

lower idiosyncratic risk but higher systematic risk, so by investing in environmental stocks, the financial markets would improve in terms of efficiency.

Green venture capital is similar to conventional venture capital, but there are some differences. The scope of investment projects financed by green venture capital is limited to environmental protection. According to Gu et al. (2018), start-ups in the green sector are typically of small size, high risk and large capital demand, and therefore have high uncertainty in their production and operations. As with any other high-technology industry, green technology is characterised by long development periods due to the newness of the market and the complexity of the technologies (Criscuolo & Menon, 2015). However, green technologies require radical innovations that take a long time to implement (Ghosh & Nanda, 2010), and green investments have a longer duration (Cumming et al., 2016; Randjelovic et al., 2003). Moreover, the last but not least difference lies in the environmental prerogatives of investors in conventional and green venture capital. As pointed out by Randjelovic et al. (2003), conventional venture capitalists usually regard environmental issues as a risk factor in their investment decision process (environmental issues are seen as a potential liability for start-ups). Green venture capitalists, on the other hand, regard the capacity of green innovation as an additional value to the company.

Weather derivatives are financial instruments that can be used by organisations or individuals as part of a risk management strategy to mitigate the risks related to adverse or unexpected weather conditions. Weather derivatives are index-based instruments that usually use observed weather data such as rainfall, temperature, humidity, snowfall, stream flow and wind. They have been traded since 1997. The weather derivatives market traces its roots to the deregulation of the US energy industry (Brockett et al., 2005). Pollard et al. (2008) emphasised the main differences between weather derivatives and traditional weather insurance. Using weather derivatives, firms do not need to specify any insurable interest or demonstrate that weather affected their business, and they need compensation. Moreover, weather insurance covers firms against high-risk, low-probability events. Weather derivatives are designed to compensate firms for low-risk, high-probability events.

Recently, global warming has been increasing the impact of weather conditions on the volatility of cash flows of any business organisation operating in such industries as energy, agriculture, construction, tourism, etc. According to Bressan and Romagnoli (2021), nowadays, weather derivatives can be important instruments for several reasons. The first reason is the current unpredictable climate and the losses associated with it. This issue needs to be addressed from the perspectives of both real economy and financial institutions. According to the researchers, financial institutions need to protect their portfolios from climate risk and, at the same time, to operate as the issuers and the counterparties for weather/climate derivative transactions. It means that mispricing can transform climate risk into financial stability risk. Regarding the protection of the real economy, this is particularly important in low-income countries where extreme weather events are more frequent and more difficult to cope with. Finally, when the market was born, the main issue for energy producers was to hedge sales. Nowadays, energy production and consumption are very different. Increased reliance on renewable energy, such as solar, wind and hydro, is changing

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

the risk management strategy of producers and consumers: they need protection from the absence of sun or wind or droughts.

Despite the increased significance of weather derivatives in the context of climate change, the literature review has revealed that most research focuses on the pricing of weather derivatives, weather forecasting and modelling. Benth and Benth (2012) pointed out some important issues to be addressed when modelling the temperature for application on the weather derivatives market. Svec and Stevenson (2007) focused on the problem that the temperature-based weather derivative market is largely illiquid. They stated that one of the barriers is the uncertainty surrounding the pricing of these derivatives and proposed new techniques for modelling and forecasting temperature. According to Bressan and Romagnoli (2021), mispricing of financial derivatives can increase rather than reduce the climate physical risk and hence the concerns for financial stability. Another important research direction is the application of weather derivatives in business risk management. Štulec et al. (2019) conducted a weather sensitivity analysis in large food stores and proposed the design of customised weather derivatives as tools for offsetting failed sales due to adverse weather; Buchholz and Musshoff (2014) investigated the potential of weather derivatives to cope with the economic disadvantages for farmers resulting from a reduction in water quotas and increased water prices; Matsumoto and Yamada (2021) constructed a hedging portfolio based on energy and weather derivatives, which can minimise revenue fluctuations.

The role of green capital markets is twofold: they provide funding for green investment and supply financial instruments to investors. Also, potential investors can invest in green stock and bond market indices as well as diversify their portfolios by choosing green exchange-traded funds or mutual funds.

Green loans are bank lending designed to finance the transition to a net-zero carbon economy through environmentally responsible projects focused on climate change mitigation and adaptation and other environmental protection projects such as the protection and restoration of biodiversity and ecosystems. The initiation of green lending in 2005 was launched by US banks such as Wells Fargo and Bank of America. These banks initiated financing of the construction of sustainable or environmentally friendly buildings. Since 2005 the green loan market has developed worldwide.

Despite the growth of the green loan market, the problem of quantifying the green loan market remains. The International Finance Corporation of the World Bank Group identifies green loans according to the business nature of the project, corporation and industry. Gilchrist et al. (2021) described these three levels in the following order: (i) the share of green finance can first be identified by the level of the project; (ii) if project-level information is unavailable or not useful, the percentage of green loans that provide environmental benefits could be estimated at the industry level; (iii) the share of green revenue per operating company could also be used to identify green activities.

At the EU level, the Taxonomy Regulation was published on 22 June 2020 and entered into force on 12 July 2020. The Taxonomy Regulation sets six environmental objectives: climate change mitigation; climate change adaptation; sustainable use and protection of water and marine resources; transition to a circular economy; pollution prevention and control;

protection and restoration of biodiversity and ecosystems (European Commission, 2020a). Gilchrist et al. (2021) stated that green loans are loans given to borrowers generating revenue from green economic activities according to the EU taxonomy, and quantified them. Despite the different approaches to green loans, the Green Loan Principles of the International Capital Market Association (ICMA) have to be followed. These principles specify that 100% of the proceeds should be used for green-eligible activities. Xing et al. (2021) revealed that firms with higher environmental disclosure quality do not obtain more loans, and only green innovation promotes access to corporate loans. They showed that green-washing hinders enterprises from obtaining more loans.

There is a debate on whether a firm's environmental profile affects the costs of its bank loans. Javadi and Masum (2021) found that firms in locations with higher exposure to climate change pay significantly higher spreads on their bank loans and suggested that lenders increasingly view climate change as a relevant risk factor. The findings of Chava (2010) revealed that firms with environmental concerns such as hazardous waste, substantial toxic chemical emissions and climate change concerns pay higher interest rates on their bank loans. Firms that derive substantial revenue from environmentally beneficial products pay lower interest rates on their bank loans. One of the main factors influencing lower interest rates could be an increase in the number of lenders adopting environmentally responsible lending policies. Moreover, increasing the number of lenders can potentially impact the environmental policies of borrowers (Heinkel et al., 2001). The reduction of interest rates could be realised not only through increased competition between lenders but also through government subsidies (Giraudet et al., 2021; Huang et al., 2019; Taghizadeh-Hesary & Yoshino, 2019). Giraudet et al. (2021) stated that lenders are able to charge high-interest rates for home energy retrofits in laissez-faire, and the government needs to offer them generous subsidies in order to make them willing to issue zero-interest loans. Huang et al. (2019) derived a threshold value for loaning interest rate and proved the effectiveness of government subsidies as an intervention supporting green innovation and environmental protection. Taghizadeh-Hesary and Yoshino (2019) pointed out that establishment of green credit guarantee schemes and returning a portion of the tax revenue can reduce the risk of green finance and increase the rate of return of green energy projects.

The most popular definition of a green mortgage is a mortgage that offers a lower interest rate to borrowers who buy a more energy-efficient real property. The Energy Efficiency Mortgage Action Plan (EeMAP) initiative explores the link between energy efficiency and borrowers' reduced probability of default and an increase in the value of energy-efficient properties. According to Weber (2005), there are two environmentally friendly mortgage products: environmental construction loans (so-called energy-efficient mortgages) and green mortgages. The first type of mortgage dominates all over the world. However, considering the nature of a mortgage (a loan used either by purchasers of real property to raise funds to buy real estate or by existing property owners to raise funds for any purpose while putting a lien on the property being mortgaged), a green mortgage can be described as a loan given for financing of any environmentally friendly project. Mathew et al. (2021) revealed that borrowers need to disclose energy costs in loan applications because of incentives such as lower interest rates for energy-efficient buildings.

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

DISCUSSION

Insurance companies provide green insurance products. They are emerging rapidly around the world, from agricultural solutions to home rebuilding. Green insurance products can be divided into renewable energy insurance, green building insurance, green agriculture insurance, green car insurance, environmental liability insurance, and more. The main benefits of green insurance products are as follows: to combat climate change, foster risky technological innovations, prevent loss and encourage risk-reducing client behaviour. According to Chen et al. (2021), green insurance is not only the main way to deal with environmental pollution risks and protect the legitimate rights and interests of any victims of pollution but also an important mechanism and policy tool for strengthening the supervision of companies' environmental risks. Wang et al. (2017) pointed out that green insurance cannot improve innovation and expected profits of firms, but it reduces risk. Moreover, both green insurance subsidy and governmental subsidy promote firms' innovation, but a green insurance subsidy is associated with a lower risk to innovate than a direct subsidy.

The drivers of environmental insurance are regulatory requirements, contractual obligations and risk management strategies (Balmer & Hendry, 2009). Regulatory requirements could be national and regional. For example, the European Parliament and the European Council adopted the Environmental Liability Directive in 2004, while certain forms of environmental insurance may be compulsory in a particular EU country. As a contractual requirement, environmental insurance can be incorporated into merger and acquisition or purchase/sale agreements to handle liability for pre-existing pollution conditions. The implementation of a risk management strategy allows mitigation of the financial impact of environmental losses on the company's financial results due to the influence of stakeholders and corporate fiduciary responsibility to shareholders, disclosure of requirements driven by increasing transparency, and increasing enforcement in local jurisdictions.

Green finance in the form of green subsidies can be provided through governmental funds at both national and regional levels. In general, a green subsidy is a financial contribution from the government to environmental protection activities. According to Charnovitz (2014), governments use green subsidies for one or more of the following purposes: to enhance public goods, to improve quasi-public goods such as knowledge-based capital, to redistribute income, to compensate for market failure and to compensate for government failure. The government's financial contribution could be realised through three main channels: direct transfer of funds (grants, loans, bonds, compensation of interests, loan guarantees), fiscal incentives (feed-in tariffs, carbon taxes, pollution permits, tax credits) and purchase of goods and services (green public procurement, various contingent payments such as payments on production of generally available ecosystem services, non-production of goods, etc.). As pointed out by Charnovitz (2014), unlike environmental policies that operate through regulation, green subsidies are fiscal policies that operate through the market. Fiscal policy is needed when there is a market failure that can be adjusted through an economic intervention. The classic failure is the negative externality from production or consumption. Nagy et al. (2021) and Renström et al. (2021) analysed green subsidies as fiscal policy instruments. According to Nagy et al. (2021), optimal investment decisions related to renewable energy projects depend on the availability of a subsidy, the size of the subsidy, and the withdrawal risk of the subsidy. They revealed that the larger the subsidy withdrawal probability, the smaller the welfare-maximising subsidy rate, so policymakers should try to

reduce subsidy withdrawal risk. Renström et al. (2021) pointed out that an increase in subsidies on abatement activity increases the scale of the economy and can also decrease pollution and pollution premium and increase per-capita consumption.

More specific and more recent types of green subsidies are feed-in tariffs, carbon taxes, pollution permits, green certificates, emission certificates and public procurement. A feed-in tariff is a fiscal policy mechanism designed to accelerate investment in renewable energy technologies by offering long-term contracts to renewable energy producers. A carbon tax is a tax levied on carbon emissions required to produce goods and services. This tax is imposed on companies that burn carbon-based fuels, including coal, oil, gasoline and natural gas, in order to mitigate or remove the negative externalities. According to Fischer (2016), policies that support green goods (such as feed-in tariffs for renewable energy) are much more popular internationally than policies that impose a cost on negative externalities (such as carbon taxes). Pollution permits give business organisations a legal right to emit a certain amount of carbon dioxide per year. If emitting less, they can sell pollution permits to other organisations, and vice versa: companies emitting more can buy permits from others. Pollution permits provide market incentives for business organisations to reduce pollution and external costs associated with it.

A green certificate is a tradable commodity proving that a certain amount of electricity is generated using renewable energy sources. Various aspects of green certificate systems have been investigated by Amundsen and Nese (2009), Aune et al. (2012) and Heimvik and Amundsen (2021). According to Aune et al. (2012), a common EU certificate market does not ensure efficiency in energy consumption if the targets are differentiated across countries. Amundsen and Nese (2009) pointed out that a combination of tradable green certificates with a system of tradable emission permits may yield outcomes contrary to the set targets for renewable energy. Later, Heimvik and Amundsen (2021) revealed that the use of a tradable green certificate scheme can achieve a specific dynamic emission target (UNFCCC, 2015) but always results in overinvestment in new green generation capacity. Moreover, they disclosed that this scheme is not as cost-effective as an optimal emission fee but is more effective than a green subsidy.

Green public procurement (GPP) is a voluntary instrument. Despite that, it has a key role to play in the EU's efforts to become a more resource-efficient economy. It can help drive a critical mass of demand for greener goods and services that would otherwise be difficult to get onto the market. GPP is, therefore, a strong driver of eco-innovation. To be effective, GPP requires the inclusion of clear and verifiable environmental criteria for products and services in the public procurement process. Cheng et al. (2018) presented a conceptual model that exhibits the fundamental and core role of environmental criteria in the process of GPP. According to them, the main focus of researchers is directed towards identifying barriers and opportunities for GPP uptake under the current regulatory framework and investigation and assessment of the "greenness" of public procurement as well as integration of environmental considerations into procurement processes. Moreover, there is a lack of theoretical studies to assess GPP as an environmental policy instrument, as well as to fully understand its innovative features.

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

DISCUSSION

Financial resources for environmental protection are pooled in multilateral climate funds managed by national governments. The largest multilateral climate funds are the Climate Investment Funds (CIF), the Green Climate Fund (GCF), the Adaptation Fund (AF) and the Global Environment Facility (GEF). These funds were used to fund projects worth $2.78 in 2016. India, Ukraine and Chile received the largest total support, while Tuvalu, Samoa and Dominica received the largest support per capita. The USA is the largest donor, while Norway is the largest contributor by population. Multilateral climate funds use a variety of financing instruments, including grants, debt capital and equity, and risk mitigation measures.

The CIF was established in 2008. It provides funding for investments in clean technologies, energy security, climate resilience and forest sustainability in developing and middle-income countries. The GCF was established in 2010 and is central to the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) Financial Mechanism and the provisions of the historic Paris Agreement (UNFCCC, 2015). It is the world's largest climate fund, providing financing for developing countries to reduce emissions. The AF was established in 2001 in order to finance investment projects in developing countries under the Kyoto Protocol, particularly those vulnerable to the adverse effects of climate change. The GEF was first established in 1992. This independent financial organisation provides grants for projects related to conservation of biodiversity, reduction of negative effects of climate change, conservation of the ozone layer, sustainable forest management and urban development, enhancement of food security, and so on.

Commonly, research focuses on financing issues of multilateral climate funds and effective management of international assets. Cui and Huang (2018) stressed the issue that the Green Climate Fund is confronted with the problem of insufficient financing. According to them, financing of this fund heavily depends on contributions from developed countries, even if the donor parties are extended to emerging economics. The decision of the USA to withdraw from climate finance will significantly increase the burden on other donors, especially the EU countries. Antimiani et al. (2017) showed that despite the high costs associated with the implementation of mitigation actions, most developing countries would face even higher costs in the case of inaction. Biagini et al. (2014) studied Global Environment Facility projects and concluded that future refinements of the costs of various adaptation actions, a mixture of technical and management options, and evaluation of the efficiency of actions implemented will be key to informing the future global adaptation agenda. Later, Schulz and Feist (2021) focused on digital technologies such as blockchain and distributed ledger-based systems as a transformative potential for international climate finance, and first of all the Green Climate Fund.

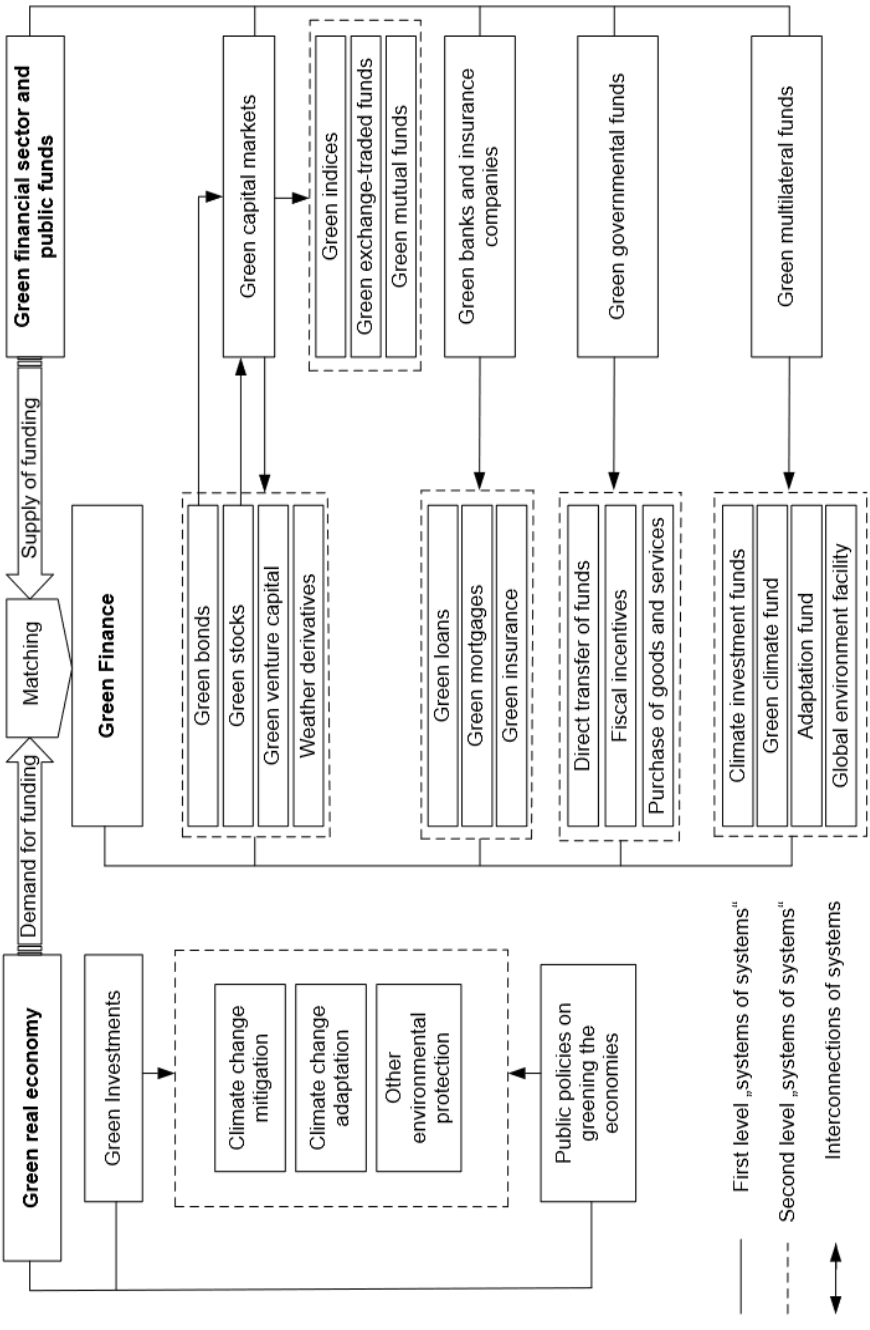


Figure 2 | Conceptual Framework of Role of Green Finance in Greening Economy
Source: authors

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.317

The "systems of systems" approach requires to structuring green economy into real economy, which concerns production, purchase and flow of goods and services, and the financial sector and public funds involved in transactions of money and other financial assets representing ownership or claims to ownership of real sector goods and services (Figure 2). Green real economy covers green investment and public policies on greening economies. The green financial sector and public funds provide financing for implementation of green investments and support of public policies. Green finance stands between these two systems. It covers financial tools and instruments that are (i) necessary to finance green real economy and (ii) supplied by the green financial sector and governments. Matching supply and demand for financing is important for assurance of greening the economy and reaching the main goals related to environmental protection.

The list of presented and described financial instruments and tools is not finite. This is the limitation of our conceptual framework and means that it can be developed in the future. However, the framework not only presents the role of green finance in greening the economy but also reveals the interconnections between the pool of different concepts.

Conclusions

Green finance is used to fund activities related to climate change mitigation, adaptation to climate change and other environmental protection goals such as water management, biodiversity, landscape protection, etc. The main role of green finance is to provide financial instruments and tools necessary to achieve environmental protection goals. In order to achieve environmental protection goals and to reach the target effectiveness of green investments, we have to overcome a lot of challenges, such as the "greenwashing" phenomenon; pricing, forecasting and modelling of financial instruments and tools; choosing the best (most efficient or effective) financial instrument or tool; making green finance more attractive for investors; changing investors' behaviour towards more environmentally friendly, etc.

Business and public organisations, as well as individuals, can change their behaviour through investing in real investment projects or financial assets. The latter investment allows diversifying portfolios and increasing their return and efficiency, and indirectly supports environmental protection activities, while financing of green projects allows supporting environmental protection directly. The aforementioned investment opportunities are voluntary. However, society (organisations and individuals) participates in green investing and financing processes by providing money for public funds, i.e., paying taxes. Public funds accumulate huge amounts of money through which direct transfer of funds, fiscal incentives and purchase of goods and services can be used for greening the economy at national, regional and global levels.

The developed conceptual framework presents the role of green finance as well as different financial instruments and tools in greening the economy, both real and financial. In addition, the framework reveals the interconnections between the different economic and financial concepts of "green", their similarities and differences. Finally, the literature review and

construction of the conceptual framework reveal the main clustered directions of future research: research related to the effectiveness of the implementation of green investment projects and public policies on greening the economy, research related to the effectiveness of using green governmental funds, research into financial instruments in terms of their attractiveness to investors, as well as the development of financial markets, and investigation of the impact of green financial instruments on investor portfolio diversification, return and efficiency.

References

Agliardi, E., & Agliardi, R. (2021). Pricing Climate-related Risks in the Bond Market. *Journal of Financial Stability*, 54. https://doi.org/10.1016/j.jfs.2021.100868.

Alessi, L., Ossola, E., & Panzica, R. (2021). What Greenium Matters in the Stock Market? The Role of Greenhouse Gas Emissions and Environmental Disclosures. *Journal of Financial Stability*, 54. https://doi.org/10.1016/j.jfs.2021.100869.

Amundsen, E. S., & Nese, G. (2009). Integration of Tradable Green Certificate Markets: What can be Expected? *Journal of Policy Modeling*, 31(6), 903–922. https://doi.org/10.1016/j.jpolmod.2009.09.002.

Antimiani, A., Costantini, V., Markandya, A., Paglialunga, E., & Sforna, G. (2017). The Green Climate Fund as an Effective Compensatory Mechanism in Global Climate Negotiations. *Environmental Science and Policy*, 77, 49–68. https://doi.org/10.1016/j.envsci.2017.07.015.

Arnold, R. D., & Wade, J. P. (2015). A Definition of Systems Thinking: A Systems Approach. *Procedia Computer Science*, 44, 669–678. https://doi.org/https://doi.org/10.1016/j.procs.2015.03.050.

Aune, F. R., Dalen, H. M., & Hagem, C. (2012). Implementing the EU Renewable Target through Green Certificate Markets. *Energy Economics*, 34(4), 992–1000. https://doi.org/10.1016/j.eneco.2011.07.006.

Baker, M. P., Bergstresser, D. B., Serafeim, G., & Wurgler, J. A. (2018). *Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds*. National Bureau of Economic Research.

Balmer, M., & Hendry, B. (2009). International Environmental Risk and Insurance. *Environmental Claims Journal*, 21(4), 337–341. https://doi.org/10.1080/10406020903361787.

Benth, J. Š, & Benth, F. E. (2012). A Critical View on Temperature Modelling for Application in Weather Derivatives Markets. *Energy Economics*, 34(2), 592–602. https://doi.org/10.1016/j.eneco.2011.09.012.

Biagini, B., Bierbaum, R., Stults, M., Dobardzic, S., & McNeeley, S. M. (2014). A Typology of Adaptation Actions: A Global Look at Climate Adaptation Actions Financed through the Global Environment Facility. *Global Environmental Change*, 25(1), 97–108. https://doi.org/10.1016/j.gloenvcha.2014.01.003.

Bongaerts, D., & Schoenmaker, D. (2019). The Next Step in Green Bond Financing. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3389762.

Borghesi, S., Castellini, M., Comincioli, N., Donadelli, M., Gufler, I., & Vergalli, S. (2022). European Green Policy Announcements and Sectoral Stock Returns. *Energy Policy*, 166, 113004. https://doi.org/10.1016/j.enpol.2022.113004.

Bouri, E., Iqbal, N., & Klein, T. (2022). Climate Policy Uncertainty and the Price Dynamics of Green and Brown Energy Stocks. *Finance Research Letters*, 47, 102740. https://doi.org/10.1016/j.frl.2022.102740.

Boutabba, M. A., & Rannou, Y. (2022). Investor Strategies in the Green Bond Market: The Influence of Liquidity Risks, Economic Factors and Clientele Effects. *International Review of Financial Analysis*, 81, 102071. https://doi.org/10.1016/j.irfa.2022.102071.

Bressan, G. M., & Romagnoli, S. (2021). Climate Risks and Weather Derivatives: A Copula-based Pricing Model. *Journal of Financial Stability*, 54, 100877. https://doi.org/10.1016/j.jfs.2021.100877.

Brockett, P. L., Wang, M., & Yang, C. (2005). Weather Derivatives and Weather Risk Management. *Risk Management and Insurance Review*, 8(1), 127-140. https://doi.org/10.1111/j.1540-6296.2005.00052.x.

Buchholz, M., & Musshoff, O. (2014). The Role of Weather Derivatives and Portfolio Effects in Agricultural Water Management. *Agricultural Water Management*, 146, 34-44. https://doi.org/10.1016/j.agwat.2014.07.011.

Chakrabarti, G., & Sen, C. (2021). Dynamic Market Risk of Green Stocks across Regions: Where does the Devil Lie? *Journal of Cleaner Production*, 303, 127028. https://doi.org/10.1016/j.jclepro.2021.127028.

Charnovitz, S. (2014). Green Subsidies and the WTO. (Working Paper No. RSCAS 2014/93). Robert Schuman Centre for Advanced Studies Retrieved May 6, 2022, from https://scholarship.law.gwu.edu/faculty_publications.

Chava, S. (2010). Do Environmental Concerns Affect the Cost of Bank Loans? (Working paper) George Institute of Technology-College of Management. Retrieved May 10, 2022, from https://www.equator-principles.com/.

Chen, Q., Ning, B., Pan, Y., & Xiao, J. (2021). Green Finance and Outward Foreign Direct Investment: Evidence from a Quasi-natural Experiment of Green Insurance in China. *Asia Pacific Journal of Management*, 39, 899-924. https://doi.org/10.1007/s10490-020-09750-w.

Cheng, W., Appolloni, A., D'Amato, A., & Zhu, Q. (2018). Green Public Procurement, Missing Concepts and Future Trends – A Critical Review. *Journal of Cleaner Production*, 76, 770–784. https://doi.org/10.1016/j.jclepro.2017.12.027.

Criscuolo, C., & Menon, C. (2015). Environmental Policies and Risk Finance in the Green Sector: Cross-country Evidence. *Energy Policy*, 83, 38–56. https://doi.org/10.1016/j.enpol.2015.03.023.

Cui, L., & Huang, Y. (2018). Exploring the Schemes for Green Climate Fund Financing: International Lessons. *World Development*, 101, 173–187. https://doi.org/10.1016/j.worlddev.2017.08.009.

Cumming, D., Henriques, I., & Sadorsky, P. (2016). "Cleantech" Venture Capital around the World. *International Review of Financial Analysis*, 44, 86–97. https://doi.org/10.1016/j.irfa.2016.01.015.

Dziwok, E., & Jäger, J. (2021). A Classification of Different Approaches to Green Finance and Green Monetary Policy. *Sustainability*, 13(21), 11902. https://doi.org/10.3390/su132111902.

European Commission (2019). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions the European Green Deal.

European Commission (2020a). Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the Establishment of a Framework to Facilitate Sustainable

Investment, and Amending Regulation (EU) 2019/ 2088. Official Journal of the European Communities.

European Commission (2020b). Communication from The Commission to The European Parliament, The European Council, The Council, The European Economic and Social Committee and The Committee of the Regions. Biodiversity Strategy for 2030. Bringing Nature Back into Our Lives.

Eurostat (2009). The Environmental Goods and Services Sector: a Data Collection Handbook. Technical Report. Office for Official Publications of the European Communities.

Eyraud, L., Wane, A., Zhang, C., & Clements, B. (2011). Who's Going Green and Why? Trends and Determinants of Green Investment (IMF Working Paper No. WP/11/296). Retrieved May 17, 2022, from https://www.imf.org/external/pubs/ft/wp/2011/wp11296.pdf.

Fatica, S., Panzica, R., & Rancan, M. (2021). The Pricing of Green Bonds: Are Financial Institutions Special? *Journal of Financial Stability*, 54, 100873. https://doi.org/10.1016/j.jfs.2021.100873.

Febi, W., Schäfer, D., Stephan, A., & Sun, C. (2018). The Impact of Liquidity Risk on the Yield Spread of Green Bonds. *Finance Research Letters*, 27, 53–59. https://doi.org/10.1016/j.frl.2018.02.025.

Feldman, S. J., Soyka, P. A., & Ameer, P. G. (1997). Does Improving a Firm's Environmental Management System and Environmental Performance Result in a Higher Stock Price? *The Journal of Investing*, 6(4), 87–97. https://doi.org/10.3905/joi.1997.87.

Fischer, C. (2016). Strategic Subsidies for Green Goods. Resources for the Future Discussion Paper, 2016, 16-12. Retrieved May 2, 2022, from www.rff.org.

Flammer, C. (2019). Corporate Green Bonds. *Academy of Management Proceedings*, 2019(1), 15250. https://doi.org/10.5465/ambpp.2019.15250abstract.

Flammer, C. (2021). Corporate Green Bonds. *Journal of Financial Economics*, 142(2), 499–516. https://doi.org/10.1016/j.jfineco.2021.01.010.

Ghosh, S., & Nanda, R. (2010). Venture Capital Investment in the Clean Energy Sector. (Working Paper 11-020). Harvard Business School Entrepreneurial Management. http://dx.doi.org/10.2139/ssrn.1669445.

Gianfrate, G., & Peri, M. (2019). The Green Advantage: Exploring the Convenience of Issuing Green Bonds. *Journal of Cleaner Production*, 219, 127–135. https://doi.org/10.1016/j.jclepro.2019.02.022.

Gilchrist, D., Yu, J., & Zhong, R. (2021). The Limits of Green Finance: A survey of Literature in the Context of Green Bonds and Green Loans. *Sustainability*, 13(2), 1–12. https://doi.org/10.3390/su13020478.

Giraudet, L. G., Petronevich, A., & Faucheux, L. (2021). Differentiated Green Loans. *Energy Policy*, 149, 111861. https://doi.org/10.1016/j.enpol.2020.111861.

Golub, S. S., Kauffmann, C., & Yeres, P. (2011). Defining and Measuring Green FDI. An Exploratory Review of Existing Work and Evidence. https://doi.org/10.1787/5kg58j1cvcvk-en.

Gu, W., Qian, X., & Lu, J. (2018). Venture Capital and Entrepreneurship: a Conceptual Model and Research Suggestions. *International Entrepreneurship and Management Journal*, 14(1), 35–50. https://doi.org/10.1007/s11365-017-0463-6.

Hachenberg, B., & Schiereck, D. (2018). Are Green Bonds Priced Differently from Conventional Bonds? *Journal of Asset Management*, 19(6), 371–383. https://doi.org/10.1057/s41260-018-0088-5.

Hafner, S., Jones, A., Anger-Kraavi, A., & Pohl, J. (2020). Closing the Green Finance Gap – A Systems Perspective. *Environmental Innovation and Societal Transitions*, 34, 26–60. https://doi.org/10.1016/j.eist.2019.11.007.

Han, Y., & Li, J. (2022). Should Investors Include Green Bonds in their Portfolios? Evidence for the USA and Europe. *International Review of Financial Analysis*, 80, 101998. https://doi.org/10.1016/j.irfa.2021.101998.

Heimvik, A., & Amundsen, E. S. (2021). Prices vs. Percentages: Use of Tradable Green Certificates as an Instrument of Greenhouse Gas Mitigation. *Energy Economics*, 99, 105316. https://doi.org/10.1016/j.eneco.2021.105316.

Heinkel, R., Kraus, A., & Zechner, J. (2001). The Effect of Green Investment on Corporate Behavior. The *Journal of Financial and Quantitative Analysis*, 36(4), 431–449. https://doi.org/10.2307/2676219.

Höhne, B. N., Khosla, S., Fekete, H., & Gilbert, A. (2012). Mapping of Green Finance Delivered by IDFC Members in 2011. Retrieved May 18, 2022, from https://www.idfc.org/wp-content/uploads/2019/03/idfc_green_finance_mapping_report_2012_06-14-12.pdf.

Hong, H., Li, F. W., & Xu, J. (2019). Climate Risks and Market Efficiency. *Journal of Econometrics*, 208(1), 265–281. https://doi.org/10.1016/j.jeconom.2018.09.015.

Huang, Z., Liao, G., & Li, Z. (2019). Loaning Scale and Government Subsidy for Promoting Green Innovation. *Technological Forecasting and Social Change,* 144, 148–156. https://doi.org/10.1016/j.techfore.2019.04.023.

Hyun, S., Park, D., & Tian, S. (2021). Pricing of Green Labeling: A Comparison of Labeled and Unlabeled Green Bonds. *Finance Research Letters*, 41, 101816. https://doi.org/10.1016/j.frl.2020.101816.

Jaakkola, E. (2020). Designing Conceptual Articles: Four Approaches. *AMS Review*, 10(1–2), 18–26. https://doi.org/10.1007/s13162-020-00161-0.

Jabareen, Y. (2009). Building a Conceptual Framework: Philosophy, Definitions, and Procedure. *International Journal of Qualitative Methods*, 8(4), 49-62. https://doi.org/10.1177/160940690900800406.

Janda, K., Kristoufek, L., & Zhang, B. (2022). Return and Volatility Spillovers between Chinese and U.S. Clean Energy Related Stocks. *Energy Economics*, 108, 105911. https://doi.org/10.1016/j.eneco.2022.105911.

Javadi, S., & Masum, A.-A. (2021). The Impact of Climate Change on the Cost of Bank Loans. *Journal of Corporate Finance*, 69, 102019. https://doi.org/10.1016/j.jcorpfin.2021.102019.

Kemp-Benedict, E. (2018). Investing in a Green Transition. *Ecological Economics*, 153, 218–236. https://doi.org/10.1016/j.ecolecon.2018.07.012.

Larcker, D. F., & Watts, E. M. (2020). Where's the Greenium? *Journal of Accounting and Economics*, 69(2–3), 101312. https://doi.org/10.1016/j.jacceco.2020.101312.

Lin, B., & Su, T. (2022). Green Bond vs Conventional Bond: Outline the Rationale behind Issuance Choices in China. *International Review of Financial Analysis*, 81, 102063. https://doi.org/10.1016/j.irfa.2022.102063.

Lindenberg, N. (2014). Definition of Green Finance. German Development Institute. Retrieved May 4, 2022, from https://www.die-gdi.de/uploads/media/Lindenberg_Definition_green_finance.pdf.

Loiseau, E., Saikku, L., Antikainen, R., Droste, N., Hansjürgens, B., Pitkänen, K., Leskinen, P., Kuikman, P., & Thomsen, M. (2016). Green Economy and Related Concepts: An Overview. *Journal of Cleaner Production*, 139, 361–371. https://doi.org/10.1016/j.jclepro.2016.08.024.

MacAskill, S., Roca, E., Liu, B., Stewart, R. A., & Sahin, O. (2021). Is There a Green Premium in the Green Bond Market? Systematic Literature Review Revealing Premium Determinants. *Journal of Cleaner Production*, 280, 124491. https://doi.org/10.1016/j.jclepro.2020.124491.

Mathew, P., Issler, P., & Wallace, N. (2021). Should Commercial Mortgage Lenders Care about Energy Efficiency? Lessons from a pilot study. *Energy Policy*, 150, 112137. https://doi.org/10.1016/j.enpol.2021.112137.

Matsumoto, T., & Yamada, Y. (2021). Simultaneous Hedging Strategy for Price and Volume Risks in Electricity Businesses Using Energy and Weather Derivatives. *Energy Economics*, 95, 105101. https://doi.org/10.1016/j.eneco.2021.105101.

Meric, I., Watson, C. D., & Meric, G. (2012). Company Green Score and Stock Price. *International Research Journal of Finance and Economics*, 82, 15-23.

Monasterolo, I., & de Angelis, L. (2020). Blind to Carbon Risk? An Analysis of Stock Market Reaction to the Paris Agreement. *Ecological Economics*, 170, 106571. https://doi.org/10.1016/j.ecolecon.2019.106571.

Moon, C., & Bace, E. (2020). Green Finance for Entrepreneurs: Current Perspectives and Conceptual Model. Proceedings of the European Conference on Innovation and Entrepreneurship (pp. 412-418), ECIE. https://doi.org/10.34190/EIE.20.090.

Mumtaz, M. Z., & Yoshino, N. (2021). Greenness, Mood, and Portfolio Allocation: A Cross-country Analysis. *Environmental Challenges,* 5, 100325. https://doi.org/10.1016/j.envc.2021.100325.

Naeem, M. A., Conlon, T., & Cotter, J. (2022). Green Bonds and Other Assets: Evidence from Extreme Risk Transmission. *Journal of Environmental Management*, 305, 114358. https://doi.org/10.1016/j.jenvman.2021.114358.

Nagy, R. L. G., Hagspiel, V., & Kort, P. M. (2021). Green Capacity Investment under Subsidy Withdrawal Risk. *Energy Economics*, 98, 105259. https://doi.org/10.1016/j.eneco.2021.105259.

Nanayakkara, M., & Colombage, S. (2019). Do Investors in Green Bond Market Pay a Premium? Global Evidence. *Applied Economics*, 51(40), 4425–4437. https://doi.org/10.1080/00036846.2019.1591611.

Pástor, Ľ., Stambaugh, R. F., & Taylor, L. A. (2021). Sustainable Investing in Equilibrium. *Journal of Financial Economics*, 142(2), 550–571. https://doi.org/10.1016/j.jfineco.2020.12.011.

Pham, L. (2021). Frequency Connectedness and Cross-quantile Dependence between Green Bond and Green Equity Markets. *Energy Economics*, 98, 105257. https://doi.org/10.1016/j.eneco.2021.105257.

Pham, L., & Huynh, T. L. D. (2020). How does Investor Attention Influence the Green Bond Market? *Finance Research Letters*, 35, 101533. https://doi.org/10.1016/j.frl.2020.101533.

Pollard, J. S., Oldfield, J., Randalls, S., & Thornes, J. E. (2008). Firm Finances, Weather Derivatives and Geography. *Geoforum*, 39(2), 616–624. https://doi.org/10.1016/j.geoforum.2006.03.008.

Randjelovic, J., O'Rourke, A. R., & Orsato, R. J. (2003). The Emergence of Green Venture Capital. *Business Strategy and the Environment*, 12(4), 240–253. https://doi.org/10.1002/bse.361.

Reboredo, J. C. (2018). Green Bond and Financial Markets: Co-movement, Diversification and Price Spillover Effects. *Energy Economics*, 74, 38–50. https://doi.org/10.1016/j.eneco.2018.05.030.

Renström, T. I., Spataro, L., & Marsiliani, L. (2021). Can Subsidies Rather than Pollution Taxes Break the Trade-off Between Economic Output and Environmental Protection? *Energy Economics*, 95, 105084. https://doi.org/10.1016/j.eneco.2020.105084.

Sangiorgi, I., & Schopohl, L. (2021). Why do Institutional Investors Buy Green Bonds: Evidence from a Survey of European Asset Managers. *International Review of Financial Analysis*, 75, 101738. https://doi.org/10.1016/j.irfa.2021.101738.

Sarumathi, S. (2014). Green Purchase Behavior-A Conceptual Framework of Socially Conscious Consumer Behavior. *Global Journal of Finance and Management*, 6(8), 777-782.

Schulz, K., & Feist, M. (2021). Leveraging Blockchain Technology for Innovative Climate Finance under the Green Climate Fund. *Earth System Governance,* 7, 100084. https://doi.org/10.1016/j.esg.2020.100084.

Štulec, I., Petljak, K., & Naletina, D. (2019). Weather Impact on Retail Sales: How can Weather Derivatives Help with Adverse Weather Deviations? *Journal of Retailing and Consumer Services*, 49, 1–10. https://doi.org/10.1016/j.jretconser.2019.02.025.

Svec, J., & Stevenson, M. (2007). Modelling and Forecasting Temperature Based Weather Derivatives. *Global Finance Journal*, 18(2), 185–204. https://doi.org/10.1016/j.gfj.2006.04.006.

Taghizadeh-Hesary, F., & Yoshino, N. (2019). The Way to Induce Private Participation in Green Finance and Investment. *Finance Research Letters*, 31, 98–103. https://doi.org/10.1016/j.frl.2019.04.016.

Tang, D. Y., & Zhang, Y. (2020). Do Shareholders Benefit from Green Bonds? *Journal of Corporate Finance*, 61, 101427. https://doi.org/10.1016/j.jcorpfin.2018.12.001.

Tolliver, C., Keeley, A. R., & Managi, S. (2019). Green Bonds for the Paris Agreement and Sustainable Development Goals. *Environmental Research Letters*, 14(6), 64009. https://doi.org/10.1088/1748-9326/ab1118.

Tzouvanas, P., & Mamatzakis, E. C. (2021). Does it Pay to Invest in Environmental Stocks? *International Review of Financial Analysis,* 77, 101812. https://doi.org/10.1016/j.irfa.2021.101812.

UNFCCC. (2015). Adoption of the Paris Agreement, 21st Conference of the Parties, Paris: United Nations https://unfccc.int/sites/default/files/english_paris_agreement.pdf

Venturini, A. (2022). Climate Change, Risk Factors and Stock Returns: a Review of the Literature. *International Review of Financial Analysis*, 79, 101934. https://doi.org/10.1016/j.irfa.2021.101934.

Vizzotto, V. D. (2012). Green Shares: Concept, Design and Principal Agent Problem in the Environmental Mutual Fund Industry. *Revista SINTESE Direito Empresarial*, IV(27).

Wang, C., Nie, P, Peng, D., & Li, Z. (2017). Green Insurance Subsidy for Promoting Clean Production Innovation. *Journal of Cleaner Production*, 148, 111–117. https://doi.org/10.1016/j.jclepro.2017.01.145.

Wang, Y., & Zhi, Q. (2016). The Role of Green Finance in Environmental Protection: Two Aspects of Market Mechanism and Policies. *Energy Procedia,* 104, 311–316. https://doi.org/10.1016/j.egypro.2016.12.053.

Weber, O. (2005). Sustainability Benchmarking of European Banks and Financial Service Organizations. *Corporate Social Responsibility and Environmental Management*, 12(2), pp.73-87. https://doi.org/10.1002/csr.077.

Xing, C., Zhang, Y., & Tripe, D. (2021). Green Credit Policy and Corporate Access to Bank Loans in China: The Role of Environmental Disclosure and Green Innovation. *International Review of Financial Analysis*, 77, 101838. https://doi.org/10.1016/j.irfa.2021.101838.

Zadek, S., & Flynn, C. (2013). South-Originating Green Finance: Exploring the Potential South-Originating Green Finance: Exploring the Potential Finance Initiative Changing finance. International Institute for Sustainable Development. Retrieved May 10, 2022, from https://www.zadek.net.

Zerbib, O. D. (2019). The Effect of Pro-environmental Preferences on Bond Prices: Evidence from Green Bonds. *Journal of Banking and Finance*, 98, 39–60. https://doi.org/10.1016/j.jbankfin.2018.10.012.

Zhang, R., Li, Y., & Liu, Y. (2021). Green Bond Issuance and Corporate Cost of Capital. *Pacific Basin Finance Journal*, 69, 101626. https://doi.org/10.1016/j.pacfin.2021.101626.

The research paper passed the review process. | Received: January 6, 2022**; Revised:** June 29, 2022**; Accepted:** August 12, 2022**; Pre-published online:** September 8, 2022; **Published in the regular issue:** May 25, 2023.