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Green finance research around the world: a review of literature

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Abstract

This paper reviews the existing research on green finance. It identifies the important themes in the green finance literature, particularly, the strategies to increase green financing; efforts to make green investment profitable; promoting green financing using technology and policy, the role of regulators and financial institutions in the green finance agenda, and the challenges of green financing. Several cross-country observations about the challenges of green finance and solutions to green finance issues are documented. The findings show that green finance has the potential to make a significant difference in the environment, society and for climate change mitigation, but many challenges abound such as the lack of awareness about green finance, inconsistent definitions of green finance, lack of policy coordination for green financing, inconsistent policies, and lack of profitable incentives to investors and financial institutions who are willing to invest in climate change mitigation.

Keywords: literature review, green finance, green investment, climate change, sustainable finance, green bonds, green banks, sustainable development goals, climate finance, environment, green loan, climate change mitigation. Paris Agreement, COP26.

JEL Code: F64, F65, G21, Q01, Q56.

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1. Introduction

In this paper, I review the existing research on green finance. In the review, I identify the dominant research themes in the green finance literature, and suggest important areas for further research in green finance academic and policy discourse. Broadly defined, green finance is the acquisition and utilization of funds for activities that protect the environment and deliver a fair return to investors or lenders (Berensmann and Lindenberg, 2019; Ozili, 2021a). The objective of green finance is to increase the level of financial flows from financial institutions to economic agents involved in projects and activities that preserve the environment towards achieving the sustainable development goals (Lee and Baral, 2017; Force, 2015).

The need to reduce harm to the environment, caused by fossil fuel emissions, has led to calls for divestment from fossil fuel activities, and a shift to investing in low-carbon projects and activities that protect the environment in a sustainable way (Bergman, 2018; Cleveland and Reibstein, 2015). This call has both national and international dimensions. At the national level, many countries like Canada, Japan, Mexico and the United Kingdom have issued policy statements to increase citizens' awareness about the negative effects of fossil fuel emissions on the climate, and the associated climate change risks. At the international level, countries have signed the Paris Agreement which is a legally binding international treaty on climate change mitigation (Dimitrov, 2016; Blau, 2017). The purpose of the Paris Agreement is to limit global warming to below 2 or 1.5 degree Celsius (Rogelj et al, 2016; Hoegh-Guldberg et al, 2018). The members of the United Nations Climate Change Conference of the Parties, popularly known as (COP26), have also made some commitment to reduce greenhouse gas emissions. To achieve the Paris Agreement objective and the COP26 mandate, a lot of financial resources need to be mobilized (Tollefson, 2018). These financial resources are commonly referred to as green finance or green financial instruments. The transition to 'low carbon' or 'environment-friendly' economic activities requires novel financing to cater for the needs of a small but growing green economy (Dikau and Volz, 2021; Lamperti et al, 2019; Sachs et al, 2019a). Therefore, proponents of a green economy have proposed 'green finance' as a viable solution to meet the financing needs of individuals, corporations and governments involved in projects and activities that preserve the environment

in a sustainable way (Mohd and Kaushal, 2018; Falcone and Sica, 2019; Soundarrajan and Vivek, 2016).

Green finance is a recent innovation that offers an alternative financing pathway to individuals, corporations and governments willing to fund and invest in green activities or low carbon activities (Huang et al, 2019). The benefits of green finance include: the distribution of funds to preserve the environment (Wang and Zhi, 2016), the flow of funds to sustainable trade and investment activities (Eyraud et al, 2013), low-risk financing (Taghizadeh-Hesary and Yoshino, 2019), and the development of green investment and financing instruments (Sachs et al, 2019a). Despite these benefits of green finance, it is important to understand that green finance is only one aspect of sustainable finance for sustainable development. Apart from green finance, there are other sustainable finance options such as social finance, blue finance and digital finance, among others (Ozili, 2021a).

In this paper, I focus on green finance. The level of interest in green finance has increased significantly in the industry. An example that illustrates the growing interest in green finance is the green finance schemes developed by many financial institutions and corporations such as: the green home loans by Bendigo Bank in Australia; the government-led 'green' mortgage initiatives by Dutch banks in Europe; solar energy financing by NRB bank in the United States; environmental home equity program by Bank of America in the United States; clean air auto loan products by VanCity in Canada; the issuance of climate credit card by Radobank in Europe, and the Landcare Term Deposit by Westpac in Australia.¹ Meanwhile, interest in green finance among academics and researchers is relatively low, and the number of scientific articles focusing on green finance is still very low.

Some studies have emerged recently in the green finance literature. These studies examine a number of issues such as: private participation in green finance (Taghizadeh-Hesary and Yoshino, 2019); the role of green finance in achieving the United Nations sustainable development goals

¹ https://www.unepfi.org/fileadmin/documents/greenprods_01.pdf

(Meena, 2013; Dörry and Schulz, 2018; Sachs et al, 2019a); closing the green financing gap (Hafner et al, 2020); the role of central banks in green financing (Volz, 2017); the development of the green finance sector (Weber and ElAlfy, 2019); the definition problems of green finance (Lindenberg, 2014; Berrou et al, 2019), and the interrelationship between green finance and other alternative finance instruments such as digital finance and social finance (Ozili, 2021a).

At this juncture, I will like to commend Zhang et al (2019) for their review of existing green finance research. They used a bibliometric analysis approach, and show that there is no generally agreed definition of green finance. They also suggest the need for more research on green finance in developing countries. To complement Zhang et al (2019), I bring together in this article the most recent developments in green finance research. The aim is to provide a comprehensive understanding of green finance to academics, policy makers and practitioners. To do this, I review the policy, practitioner and academic literatures on green finance to identify the most salient developments and issues in the green finance literature, and thereafter, suggest some directions for further research.

This review article contributes to the literature in the following ways. One, the review contributes to the sustainable finance literature. Studies in this literature include Dörry and Schulz (2018), Schumacher et al (2020), Durrani et al (2020), Ozili (2022a), etc. In the paper, I show that green finance is one approach to fund activities geared towards achieving the sustainable development goals. Two, this paper contributes to the literature that examine how innovative finance contributes to development. Studies in this literature include O'Sullivan (2005), Fagiolo et al (2020), Egger and Keuschnigg (2015) and Zhu et al (2020). In the paper, I show that green finance is an innovative approach for environmental financing for sustainable development. Three, this paper contributes to the literature that suggest ideas towards achieving the United Nations 2030 sustainable development goals (Bebbington and Unerman, 2018; Bernstein, 2017). The paper shows that green finance is mostly considered to be a sustainable financing tool to help achieve the United Nations sustainable development goals. Four, this review article provides a guide to both researchers and practitioners on the subject of green finance, highlighting the main issues, the challenges, real-observations, and some research areas that need further investigation.

Finally, the remarks about the future directions for green finance research in this review article are limited to issues in the literature that I find to be particularly significant. My aim in this review is to elicit comments and stimulate debates that will advance green finance research in the literature.

The rest of the paper is organised as follows. Section 2 presents the methodology. Section 3 discuss several green finance concepts. Section 4 discuss the existing green finance research around the world. Section 5 suggests some directions for future research. Section 6 presents the conclusions.

2. Methodology

The articles used in the review are journal articles, industry practitioner papers and policy reports. The selection of articles was done manually. A systematic search was conducted on Google Scholar using article abstract search and a search on the body-of-articles. This approach was taken on the assumption that the article abstract and the content of an article would contain the dominant green finance keywords used in the article search. The keywords are “green finance”, “green bonds” and “green financing”. Thesis and dissertation articles were excluded from this review. A further search was conducted on Google search engine to extract useful practitioner white papers and policy reports. A 2010 cut-off year was applied to ensure that the review captures the recent research in the green finance literature.

3. Conceptual literature

This section presents some important concepts that have dominated the green finance literature in recent years such as: green finance definitions; the importance of green finance; green finance products and instruments; the promoters of green finance; strategies for promoting green financing and investments, among others.

3.1. Definitions of green finance

There are several definitions of green finance. Lindenberg (2014) defines green finance as the financing of public and private green investments. Ozili (2021a) defines green finance as the financing of projects that yield economic benefits while promoting a sustainable environment. Wang and Zhi (2016) define green finance as finance that integrates environmental protection with economic profits. Lindenberg (2014) shows that green finance encompasses all investments in environmental goods and services, and investment in activities that reduce damage to the environment and the climate. Also, in public policy, green finance involves the financing of public policies that encourage the implementation of environment protection projects or environment damage mitigation projects and initiatives (Lindenberg, 2014). Bahl (2012) defines green finance as the financing of environment-friendly activities, green technology, and projects that reduce pollution.

3.2. Why green finance is important

Green finance is important because of its perceived benefits. Green finance promotes the construction of smart cities in the long run (He et al, 2020). Green finance promotes inclusive economic growth (Wang and Wang, 2020). Investments in green projects can reduce short- and long-term carbon emission levels (Li et al, 2021). Green financing will benefit institutional shareholders interested in impact investing (Tang and Zhang, 2020; Barber et al, 2021). Green financing has diversification benefits to investors in corporate and treasury markets (Reboredo, 2018). Increase in green financing can reduce funding for fossil fuel activities that pose a risk to the environment and the climate (Sachs et al, 2019a, Ozili, 2022a).

3.3. Green finance products and instruments

A 'traditional' financial product, service or instrument can be made 'green' if the product, service or instrument is used to raise funds that will be spent on environmentally-friendly investments, projects or activities (Li et al, 2018). Examples include: a loan issued at low interest rates to plant trees in some communities, syndicated loans to finance cross-border green projects, green mortgage loans, solar energy financing, and clean air auto loan products.

Green instruments are instruments used to raise funds for green projects. The literature documents some examples of green finance instruments such as: green bonds, structured green funds (Lindenberg, 2014; Sachs et al, 2019b; Chang et al, 2019); carbon market instruments, community-based green funds (Sachs et al, 2019b); green bond grant scheme (Chang et al, 2019); international climate fund (GFI, 2016); green venture capital and green venture fund (Randjelovic et al, 2003; Nassiry and Wheeler, 2011).

3.4. Promoters of green finance

The main agents promoting the growth and development of green finance are banks, institutional investors, research institutes, public agencies, central banks, financial regulators, international financial institutions, and universities (Berensmann and Lindenberg, 2016; Ozili, 2019). Oh and Kim (2018) and Ozili (2022b) show that private firms such as commercial banks and private equity funds play an important role in promoting green finance. For instance, the European Investment Bank (EIB) plays a key role in financing renewable energy projects and energy efficiency improvement projects in Europe while government agencies in European countries tend to focus on providing an enabling policy environment for green projects (Wang and Zhi, 2016).

3.5. Strategies for increasing green financing and investments

Berensmann and Lindenberg (2016) suggest some strategies for increasing the flow of private capital to green projects and activities. They include: designing an enabling business environment that facilitates green financing; developing standards and rules for disclosure that would promote the growth of green finance assets; providing financial and regulatory incentives to encourage green financing and investments, fostering greater transparency in the definition of green

finance; and finally, existing financial, environmental and regulatory policies should be better coordinated. Tu et al (2020) show that the presence of an efficient legal framework for green bond operations is crucial for developing green bond markets while Oh and Kim (2018) suggest that the government need to collaborate with private firms to improve green financing.

3.6. Making green investment a profitable venture through green financing

Sachs et al (2019a) show that financial institutions show more interest in fossil fuel projects than green projects, mainly because there are unknown risks associated with green investment, and they offer a low rate of return compared to fossil fuel investment. Taghizadeh-Hesary and Yoshino (2019) offered two ideas on how to increase private participation in green investment. The first idea is the creation of green credit guarantee schemes. The second idea is to return a portion of the tax revenue, originally generated from the spillover effect of green energy supply, to investors. They suggest that these two approach can reduce the risk of green investment and increase the rate of return to green investors.

3.7. Using technology to advance green finance and green investment

Taghizadeh-Hesary and Yoshino (2019) suggest that the use of distributed ledger technologies (or blockchains) can increase transparency in green financing and investment. Ozili (2021a) show that digital finance innovations can facilitate the funding of green projects which implies that digital finance is an enabler of green finance. Also, Ozili (2022c) shows that a blockchain-based central bank digital currency can increase the volume of financial activities in various sectors of the green economy particularly the circular economy.

Nassiry (2018) suggests three broad areas for the application of Fintech to green finance, namely, (i) blockchain applications for sustainable development; (ii) blockchain use-cases for renewable energy, decentralized electricity market, carbon credits and climate finance; and (iii) innovation in financial instruments, including green bonds. Zhang et al (2018) argue that a government should provide a friendly regulatory environment that allows blockchain and other innovative technologies to supplement existing institutional frameworks towards achieving a sustainable environment and development goals.

3.8. The role of regulatory agencies and institutions

Volz (2017) examined the role of central banks in greening the financial system. Volz (2017) showed that central banks can use several tools and policy instruments to green the financial system. Some suggested tools that can be used by central banks include: discount policy, reserve requirements, capital requirements, open market operations, foreign exchange intervention, macro prudential policies, risk guidance, central bank communication, international cooperation among central banks. Some suggested policy instruments include: capital controls, interest rate controls, and offering swap lines. Ozili (2021b) also explored some options that central banks can use to reduce climate risk towards promoting a green economy. The options include: (i) imposing a climate change capital surcharge; (ii) imposing a fixed-rate risk capital - based on Tier 2 capital; (iii) a reduction in lending to industries whose activities destroy the environment and climate; (iv) creating a climate bank; and (v) requiring financial institutions to relocate their important assets to areas less prone to climate change events.

3.9. Challenges of green finance

Berensmann and Lindenberg (2016) identified some microeconomic challenges to green finance. The challenges include: problems in internalizing environmental externalities, information asymmetry problems, inadequate analytical capacity, lack of clarity in the definition of “green” in green finance, maturity mismatch between short-term and long-term green investment, the relatively short-term time horizon of savers and investors, lack of effective coordination between financial and environmental policies, and the lack of clarity on the extent of government support for the transition to a green economy. Falcone and Sica (2019) document other challenges to green finance. They include (i) uncertainty about government policies; (ii) limited policy support for the commercialization of new technologies; (iii) scarce involvement of financial suppliers in the biomass sector; (iv) finance not being tailored to small-scale investment needs; (v) the short-term orientation of financial instruments; (vi) limited knowledge about financing options; and (vii) limited technical expertise within companies.

Gilchrist et al (2021) also identified some challenges of green finance for corporations. The challenges include (i) difficulty in the analysis of green finance, (ii) lack of consistency in assessing

corporate greenness, (iii) the ambiguous definition of corporate greenness, and (iv) the unavailability of green data. Ntsama et al (2021) showed that institutional, financial, and political barriers in low-income and middle-income countries are responsible for the undeveloped green markets while Schletz et al (2020) state that the inability of green investment vehicles to grow green investment is partly attributed to high transaction costs for green certification and monitoring. Guild (2020) showed that poor institutional design of the renewable energy sector creates misaligned incentive structure for players in the renewable energy sector. Schletz et al (2020) explored the potential of blockchain-based security tokens to address market failure in green finance. They identified some challenges such as: software risk, regulatory uncertainty, and immature investment infrastructure.

4. Green finance research around the World

This section reviews some developments, observations, arguments and research evidence on green financing in several regions of the World.

4.1. Europe

Most studies on green finance in Europe are policy reports. There are very few academic studies. A European commission report (2017) shows that the common green financing strategies adopted in Europe are (i) 'green bonds' that are issued following green bond principles, (ii) 'green lending' by banks involved in green loan origination, and (iii) 'green equity investment'.

In Austria, Breitenfellner et al (2020) analyse the green finance market in Austria. They predict that the annual investment in Austria's green economy will grow to an estimated EUR 17 billion between 2021 and 2030. They argue that public funding alone will not be sufficient, and that private capital should be mobilized to fund sustainable (or green) projects. They further argue that green finance will be a major breakthrough in achieving this goal. They acknowledge some existing weaknesses in the Austria financial system. They state that the Austrian market for sustainable finance products is underdeveloped by international standards, it is dominated by

mutual funds and driven by institutional investors and not by private investors. They also point out that customers' awareness of sustainable finance products is still low in Austria.

In Italy, Falcone and Sica (2019), in their survey of Italian biomass producers, observe that the availability of green finance options does not prevent biomass producers from facing institutional and financial difficulties in funding their investment projects. Some of the difficulties encountered by the biomass producers are: uncertainty about government policies, the minimal involvement of financial suppliers in the biomass sector, the short-term orientation of green financial instruments, and the limited knowledge of available financing options.

In the United Kingdom, CBI (2019) shows that many businesses and financial institutions are embracing the opportunities that green finance brings. Other businesses and financial institutions have not embraced green finance due to lack of knowledge, lack of awareness about green finance, limited access to clear data and an inadequate policy. CBI (2019) recommends that the UK finance industry should be encouraged to move towards green financing. CBI (2019) also recommends that existing financial legislations should be re-examined to identify where incentives can be built-in to encourage green finance.

In the Netherlands, a report by New Pathways (2020) documents that green funds allow individuals to invest in funds specifically directed at qualifying green projects such as renewable energy, wildlife conservation, and organic farmland. At least 70% of the funds' volume should be invested in qualifying green projects (New Pathways, 2020). Between 2000 and 2009, there were 6,066 projects financed with over €7.3bn of funding from quarter of a million individual investors (New Pathways, 2020).

In Russia, Damianova et al (2018) show that Russian authorities need to put the right conditions and incentives in place to encourage financial institutions and private investors to participate in green financing. They identified some challenges to the development of green finance in Russia. The challenges are: (i) the absence of a champion public sector agency to coordinate all relevant stakeholders towards green financing; (ii) lack of many pipeline of green projects due to modest carbon reduction targets, underdeveloped green procurement, weak enforcement of existing environmental regulations and sector-level targets; (iii) lack of a regulatory framework for green

finance instruments; and (iv) lack of awareness about the risks and return opportunities associated with green finance. To address the challenges of green finance development in Russia, Damianova et al (2018) suggest some solutions which include: (i) revisiting climate change commitments and assessing the financing needs of the green sector (e.g. green buildings, clean transport, renewable energy, waste management, sustainable agriculture etc.); (ii) identifying a national green finance champion, and establishing a coordination body represented by the key stakeholders; (iii) developing a green finance roadmap and corresponding action plan; (iv) exploring the potential impact of climate change and the low-carbon transition on macroeconomic and financial stability; (v) incorporating a green agenda in public policy institutions' mandates and public procurement; and (vi) raising awareness about green finance and building capacity at all levels.

In Ukraine, Sokolova et al (2019) show that the Ukrainian government has not shown significant interest in the green economy. For this reason, non-governmental organizations in Ukraine have a more direct influence in the process of building a green economy than the government itself. Meanwhile, the creation of the Ukrainian Green Bank "Ukrgasbank" has increased the prospects of green financing in Ukraine even though the creation of the green bank was not a government-led initiative.

In the European Union, Chuah (2020) critically analyse an EU green shipping finance facility, and argue that a finance facility, however green, will always have contractual constrictions, policy constraints and finance prudential limits, which calls into question the usefulness of "green finance."

4.2. Asia

In Asia, there are notable developments in green finance. Tolliver et al (2021) show that the amount of green finance in Asia has increased to meet the growing demand for sustainable economic development in the region. Countries like Japan, China, and South Korea have witnessed significant increase in green bond issuance. China has been a global leader in green bond issuance since 2015 while green bond issuance by large financial corporations and development banks in Japan and South Korea continue to grow. Meanwhile, Escalante et al

(2020) found a lack of diversity in green bond market participation in China. In Hong Kong, HKGFA (2020) documents some of the green finance development in some parts of Asia. HKGFA (2020) reports that there is a cross-agency steering group established to accelerate the growth of green and sustainable finance, and support the government's climate strategies. There is also a self-assessment framework to enable the measurement of "greenness baseline" of individual authorized institutions. There is also a comprehensive database platform dedicated to providing investors with information about sustainable (and green) investment options in Hong Kong's securities market. Meanwhile, in mainland China, HKGFA (2020) reports the existence of Shanghai-Singapore financial co-operation, and virtual events on China green bond market.

Volz (2018) acknowledges that green investment is difficult in Asia for many reasons. They include: the difficult investment conditions; adverse regulatory and legal environment; inconsistent policies; cumbersome permission procedures; lack of awareness of environmental and climate risks; lack of training for staff responsible for assessing environmental and climate risk in the finance industry; shortage of staff with experience in green lending; shortage of bankable and investable projects; lack of mandatory environmental risk analysis; and lack of environmental, social and governance (ESG) disclosure requirements. Volz (2018) suggests some solutions to enhance green finance in Asia. They include: raising awareness about environmental and climate risks in the financial sector; developing capacity in the finance industry for environmental risk analysis and management through knowledge-building and knowledge sharing; building up capacity in the finance industry needed to develop green lending instruments; enhancing transparency through ESG disclosure requirements; providing incentives for the financing of green projects; supporting the development of new market segments such as the green bond market or climate risk insurance; developing long-term local currency refinancing sources for banks to enable them to extend long-term credit.

In India, Jena and Dhruba (2020) show that there is a growing need to sensitize India's financial sector on the importance and benefits of green finance. They also suggest that a sustained, market-led collaborative action is needed to accelerate green capital flows in India, beginning with an agreed formal definition of green finance. Other efforts include: formulating policies to incentivize green finance, and introduce penalties for carbon-intensive investment.

In Singapore, Chang (2019) identifies some challenges and solutions for promoting green financing in Singapore. Some identified challenges include the following: (i) small and medium-sized enterprises (SMEs) in Singapore do not have access to the process of issuing green bonds because they are small and are not capable of taking on projects that can be financed by green bonds; (ii) lack of awareness of green finance by SMEs; (iii) the domestic market for green bonds is small in Singapore; (iv) transparency and reporting are two main risks in the green bond market. Chang (2019) suggests the following solutions which include (i) establishing clarity for what constitutes “green,”; (ii) releasing more information on bond issuers’ ESG performance; (iii) enhancing the transparency of the quality of financial instruments for green investments, (iv) creating demand for green investments by establishing green pockets; (v), build and share knowledge and capacity; (vi) jump-start green finance markets and investment, and (vii) define the value of green.

4.3. Africa

There are very few studies on green finance in Africa. In policy circles, South Africa is the only African country that has a formal national strategy for green finance. In December 2017, Nigeria became the first country in Africa, and only the fourth in the world, to issue a sovereign green bond. The ‘green climate fund’ was the biggest cumulative multilateral climate fund active in Sub Saharan Africa in 2019, followed by the Least Developed Countries Fund and the World Bank administered Clean Technology Fund (Watson and Schalatek, 2019).

In the African region, Morocco and Nigeria have developed national plans for sustainable green financing. In South Africa, the Johannesburg Stock Exchange created a dedicated green segment in the stock exchange. Kenya has launched green bonds guidelines in a joint collaboration between the capital market authority and the Nairobi Securities Exchange. Seychelles and Namibia have announced the issuance of blue and green bonds, respectively. Mauritius and Gabon have developed national roadmaps to launch green bonds. Central Africa has started to develop its green capital market.

Zadek and Flynn (2013) show that south-originating green finance (SGF) flows are growing in South Africa. This is because South Africa has sophisticated financial markets which offer

opportunities for financial institutions to invest in longer-term green investments. In 2012, Nedbank created South Africa's first Green Bond. The bond was issued by the Industrial Development Corporation of South Africa. The green bond is a fixed-term investment available to all individuals and earns interest at a fixed rate of up to 7.5% for the duration of the investment. All funds invested in the green bond are set aside for renewable energy projects that contribute towards growing South Africa's green economy.

UNEP (2015) suggests some policy options that can help to mobilize capital towards a green economy in the African continent. They include: the provision of green and inclusive credit guidelines and incentives, the issuance in green bonds, and the inclusion of green securities and green stocks in African stock exchange. Dia (2019) suggests that African countries have begun to experiment with innovative finance such as crowd-funding for clean energy in Uganda and green bond financing in Nigeria. Marbuah (2020) explores the green bonds market in Africa, and show evidence of modest growth of the green bonds market in Africa. The market is dominated by a small number of states with a cumulative issuance of less than 1 per cent of global volumes, meanwhile, multilateral development institutions have the largest green bonds issue in Africa.

LSEG (2020) recommends that African countries will need to look at scaling down their exposure to the fossil fuel industry, and African governments will need to make public policy shifts in favour of a greener and more climate-resilient economy. Government involvement will be vital in developing the African green finance markets through the creation of policies that make holding green assets more attractive.

Overall, the success factors that are crucial for developing the green finance market in Africa are: effective interaction between public officials and private actors, international collaboration and capacity building, active underlying securities markets, improved disclosure and capital market incentives; and the provision of strong guidance on what is 'green' and the agreed definition has to be consistent with international guidelines.

4.4. North and South America

CBI (2017) shows that the rise of the green bond market in Brazil and Mexico has helped to boost cross-regional trade. UNEP (2019) documents that Argentina issued three green bond deals between 2017 and 2018: two green bonds from sub national institutions and one green bonds from a financial institution. ECLAC (2017) documents the developments in the green bond market in Latin America and the Caribbean. The ECLAC (2017) report shows that the region issued US\$ 8.4 billion in bonds in local and international markets between 2014 and 2017 (as of August 31, 2017). The bulk of the region's green-focused bonds of US\$7.1 billion were issued in international markets. On average, green bonds represented only 1.6% of the total Latin American and Caribbean bond issuance in international markets in the period. In the first half of 2017, green bonds accounted for 3.7% of the region's total international debt issuance (ECLAC, 2017).

Similarly, Ketterer et al (2019) show that there is need to ensure that local 'green' definitions and standards are aligned with internationally accepted guidelines to avoid confusion and reputational risk in the Latin and Caribbean region. They suggest that more information should be provided to improve international investors' understanding of general bond market performance and green bond performance in the Latin American and Caribbean region.

In Mexico, Lovells (2019) documents that the first Mexican green bond was issued in 2015 to fund wind energy generation projects in Mexico. The government of Mexico City in 2016 became the first local government in Latin America to launch a local green bond to finance climate-resilient infrastructure. The second local green bond was issued in 2017 for US\$80million for the construction of the Metrobus Line 7's road corridor, which financed the construction of terminals. The third local green bond in Mexico City was issued in 2018 for US\$57million for 27 projects related to energy efficiency projects, the maintenance of the Metrobus, and improvement in drinking water and sewage infrastructure in certain communities in Mexico City.

In Canada, ECCC (2018) shows that an expert panel on sustainable finance recommended that (i) the Canadian government should embed climate-related risk into the monitoring, regulation and supervision of Canada's financial system; (ii) expand Canada's green fixed income market; and (iii) set a global standard for transition-oriented financing.

4.5. Oceania

There are very few studies on green finance for countries in the Oceania continent.

In New Zealand, NZGIF (2019) shows that the government established a green investment bank in New Zealand. The bank is called the 'New Zealand Green Investment Finance'. The purpose of the bank is to accelerate investment that reduce greenhouse gas emissions in New Zealand. Meanwhile, the OECD defines a green investment bank as a public, quasi-public or non-profit entity established specifically to facilitate private investment into domestic low-carbon, climate-resilient infrastructure. NZGIF (2019) shows that the aim of the New Zealand Green Investment Fund is to use private finance to rapidly scale up emissions reduction, and investment in clean and innovative technologies and companies. RIAA (2019) shows that green financing prospects are already underway in New Zealand due to the establishment of a green investment fund, and the creation of green bonds.

In Australia, Geddes et al (2018) identify the significant financing gap affecting the large-scale deployment of low-carbon technologies. They suggest that State investment banks can play a key role in closing the finance gap by encouraging private investment into low-carbon investments. They suggest that State investment banks can enable financial sector learning, create trust for green projects, and take a first-mover or early-mover role in offering green financing options. Subsequently, Geddes et al (2020) analyse the parliamentary debate about the establishment and design of Australia's Clean Energy Finance Corporation, which is equivalent to the UK's green investment bank. They find that the political controversy in Australia was partisan on all debate topics. Debates on higher-level establishment concepts especially the role of the State in the establishment received more attention in Australia.

4.6. Green finance developments in the G20 countries

Table 1 below shows the trend in green finance developments among the G20 countries from 2016 to 2017. China, United Kingdom and Mexico have the largest achievements in green financing, followed by Turkey, South Africa, Brazil, France and India. The green finance developments are broadly categorized into: (i) support for the development of local green bond markets; (ii) promoting international collaboration for cross-border investment in green bonds, and (iii) improving the measurement of green finance activities and their impacts.

G20 Member Countries	Support for the development of local green bond markets	Promoting international collaboration for cross-border investment in green bonds	Improving the measurement of green finance activities and their impact
Argentina	*		
Australia	*		
Brazil	*	*	
Canada	*	*	
China	*	*	*
France	*	*	
Germany	*		
India	*	*	
Indonesia	*		
Italy	*		
Japan	*		
Mexico	*	*	*
Russia	*		
Saudi Arabia			
South Africa	*	*	
South Korea	*		
Turkey	*		*
UK	*	*	*
US	*		
EU	(N/A)	*	
International	*		*

Source: UNEP (2017) United Nations Environment Progress (2017) report, p.14

4.7. Differences in green finance terminology across continents

The terminology used to describe green finance may vary across different countries and continents because of the different ways in which policy makers and practitioners interpret green finance both in a national context or cross-border context. In the end, country-specific green finance terminologies will converge into a common continental terminology that allows for continental comparison of green finance terminologies. Table 2 below shows some of the common green finance terminologies used in some continents.

Table 2: Specific terminologies for green finance in continents	
Continent	Common terminologies for green finance
North America	Green financial assets; green investment; sustainable finance; green funds; green bonds.
South America	Green bank; green bonds; green sovereign bonds.
Africa	Green Sukuk; climate finance; green bonds; green climate fund.
Oceania	Sustainable finance; green loans; green bonds
Asia	Sustainable finance; green loans, green bonds, green investment
Europe	Green bond; sustainable finance; climate finance; green investment; climate awareness bond.

5. Some gaps and areas for further research

In this section, some directions for further research are suggested.

5.1. More research on green innovations and risk-return tradeoff

Green innovations will be essential in addressing the complex environmental and sustainability challenges of green financing. There is a need to examine how green innovation can contribute to expanding green financing and investment options. Green entrepreneurs can also play an important role in identifying green opportunities for profitable investments. Future studies should examine how green innovation and entrepreneurs can contribute towards expanding green investment and funding options. Also, future studies can empirically examine the link between green finance and green innovation. Innovation in green financing and investment

comes with risks, and the higher the risk, the higher the return. Currently, there is a scant literature on the tradeoff between risk and expected return in green financing and investment. Future studies should also assess, in greater depth, the tradeoff between green risk and expected green return.

5.2. Causality between green investment and environmental change

There is need for more research studies that explore the causality between green investment and environmental change. There are many questions to be asked in this area: for instance, does environmental change create the need for green investment? Or, does green investment lead to environmental change? Can a one-time investment in green project lead to a significant change in environmental outcomes? Is there a direct or indirect causation between green investment and environmental outcome? Can institutional weakness affect the potential for green investment to make a positive change in environmental outcomes? Can government support, or the lack of it, affect the causality between green investment and environmental outcomes? What is the best approach to estimate the causality between green investment and environmental change? Future research can shed some light on these issues.

5.3. Identifying the boundaries of private and public sector involvement

Future studies should identify the boundaries of private sector and public sector participation in green financing. Presently, there is little research in the literature about the limits of private sector participation and public sector participation in green financing. There is a need to identify the limit of private sector participation and the limit of public sector participation in green financing. Excessive citizen involvement in green financing may lead to environment policies being dominated by divergent private interests. Similarly, involvement by many companies may lead to agency conflicts as companies will have to choose the extent to which they want to pursue green interests while pursuing their core profitability objectives. Public sector agents will also have to determine how much fiscal resources will be committed to the green economy. In sum, there has to be a defined limit for private and public sector involvement since the private sector

and the public sector are not perfect substitutes or complements. Future studies should suggest ideas on how to set the boundaries of private and public sector involvement in green financing.

5.4. Synergy between green finance, social finance and digital finance

Research on green finance, social finance and digital finance is growing rapidly. Nonetheless, the three concepts 'green finance', 'digital finance' and 'social finance' should not be seen as separate concepts. Ozili (2021a) presents a conceptual relationship between green finance, digital finance, and social finance. Future studies should explore, in greater depth, the link or interrelationship between green, digital and social finance. Furthermore, future studies can identify other synergistic benefits of combining green, digital and social finance for a sustainable environment and society. There are potential synergistic benefits to be gained from using them as complements for achieving the sustainable development goals.

5.5. Effect of regulation on green businesses, innovation and activities

Regulation often impose extra burden on pro-green companies and financial institutions through high cost of compliance with green regulations. Green corporations and entrepreneurs may receive rewards for complying with green regulations and may receive penalties for non-compliance with green regulations. Excess green regulation can discourage green innovation and ultimately reduce the size of pro-green activities. Therefore, there is a need to explore the optimal level of regulation needed to support green businesses and encourage green innovation. Future studies should find the right balance between imposing green regulation and encouraging green innovation, while at the same time, promoting effective regulation.

5.6. More research on green finance opportunity in developing countries

Future studies can explore the green finance opportunity in developing countries. Future studies can also explore how the challenging policy and institutional environments affect the development of green finance and investment markets in developing countries. Such studies should take into account the unique institutional and policy barriers that exist in developing countries.

5.7. More research about the usefulness of mainstream tools of financial analysis in assessing the viability of green projects and investment opportunities

Future studies can assess the usefulness of mainstream tools of financial analysis in assessing whether proposed green projects are viable in terms of profitability and sustainability. There are two schools of thought on this. One perspective argues that a new set of tools should be developed and used to assess green financing and green investment opportunities. The second perspective argues that existing mainstream tools of financial analysis can be used to evaluate green financing and investment opportunities. The latter perspective seems more plausible even though there is yet no evidence to show that adapting existing mainstream financial analysis tools will be more effective in assessing green financing investment and opportunities.

6. Conclusion

This paper presented a literature review of green finance research and identified some fruitful areas for future research. The findings show that green finance has the potential to make a significant difference in the environment and society but many challenges abound such as the lack of awareness, inconsistent definitions, lack of policy coordination, inconsistent policies, and lack of incentives to investors and financial institutions, among others. Some suggested areas for further research include: the need for more research on green innovation and risk-return tradeoff; two, the need to explore the causality between green investment and environmental change; three, the need to identify the boundaries of private and public sector involvement in green financing; four, the need to examine the synergy between green finance, social finance and digital finance; five, the need to investigate the effect of regulation on green businesses and activities; six, the need to explore the green finance opportunity in developing countries, and finally, more research is needed to explore the usefulness of mainstream tools of financial analysis in assessing the viability of green projects and investment opportunities. This study has one limitation. Some relevant research studies may have been omitted despite my effort to include all existing relevant research studies. My hope is that this review article will encourage finance researchers and environmentalists to explore the important issues in green finance

particularly those issues that were not covered in this review article. Many of the tools and ideals in the mainstream finance literature can be useful in solving the problems of green finance, and have the potential to significantly enrich the literature in a meaningful way.

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