Green Banking for Sustainable Development

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Abstract

The ever-increasing threat of global climate change, environmental pollution, and the destructive impact of human activities highlight the need for more detailed research into tools to increase a country's environmental sustainability. In addition, it promotes the search for additional sources of funding for these activities. For developing countries, one of the main sources of environmentally sustainable development is international bank financing. Therefore, this study aims to analyze how international green banking affects the environmental sustainability of developing countries. For this purpose, the data series were compiled for the period of 2010 to 2020. The annual data for panel regression analysis are retrieved from the OECD and World Bank Open Data. The identified effects can be useful for government officials in terms of determining the benefits of using international green banking for gaining environmental sustainability.

Keywords: international banking; green banking; environmental sustainability strategies; green innovation; environmental performance; corporate social responsibility

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Introduction and Literature Review

One of the most pressing issues of today, attracting public attention around the world, is environmental. Their manifestations are energy crisis, air and water pollution, rising morbidity and more. Significant rates of world economic development only increase the consumption of natural resources, thereby deepening the existing problems in the world. Thus, the analysis of statistical data showed a steady increase in global consumption of electricity, water, carbon emissions. This increases the risk of depletion of non-renewable energy resources and threatens national and international environmental security (Chien et al., 2021; Tu et al., 2021; Nawaz et al., 2021). At the same time, despite the destructive impact of economic activity on the environment, economic development creates favorable conditions for scientific progress, the introduction of green technologies (use of renewable energy sources, smart technologies, green innovations, etc.). This, in general, allows society to solve environmental problems (Hsu et al., 2021). The success of these measures depends on the availability of sufficient financial resources.

According to the International Energy Agency (IEA), achieving the global goal of reducing emissions by 45% by 2030 and reaching net zero by 2050 requires an increase in investment almost three times (from 760 billion US dollars in 2019 to 2,200 billion US dollars in 2030). Emerging markets need $1 trillion a year in public and private financing to transition to a zero net income economy[1].

The liberalization of financial flows, the integration and globalization of financial and economic systems have significantly accelerated the cross-border movement of funds and the development of the international banking sector, which expands the opportunities for attracting external capital. The concept of green banking as the most innovative tool of environmental policy, which comes from the active participation of international financial institutions in overcoming environmental challenges, has become widespread. Six principles of green banking were formulated, which became the basis for a roadmap to bring the activities of international financial institutions and their approaches to capital allocation in line with the Sustainable Development Goals (SDGs). Mechanisms for prioritizing financial support are to be developed (Bhardwaj, Malhotra, 2013; Taghizadeh-Hesary, Yoshino, 2020; Malliga, Revathy, 2016; Zapotichna, 2023). An increasing number of banks are picking up this trend and aligning their policies with these goals, primarily by digitizing services (Deka, 2018). Doing so they contribute to energy saving and resource conservation (Jha, Bhome 2013). The poorest countries are increasingly being given concessional funding or grants to achieve the SDGs. The implementation of such measures, in addition to direct positive effects for the environment, forms a new image of the public perception of banks as entities not only focused on making a profit, but also making a great contribution to improving the environment[2].

The dynamics of the green bond market deserves special attention[3], the statistics of which are most fully presented in the reports of the Climate Bond Initiative (Climate Bonds Initiative, CBI). In 2021, its volume crossed the threshold of half a trillion dollars, and if the current dynamics are maintained, it can reach one "green trillion" as early as 2024.[4]

Experts estimate the annual volume of green bonds issuance in different ways, while giving a general guideline for assessing current investments. Thus, in order to achieve the set climate goals, governments, politicians and investors must increase the global volume of green bond issuance to $5 trillion per year by 2025 (CBI, 2022). According to the IMF and IEA, achieving zero CO2 emissions by 2050 over the next two decades will require additional investments of 0.6% to 1% of global GDP, totaling between $12 trillion and $20 trillion (IMF, 2021a, 2021b), and according to McKinsey's calculations, a total of $9 trillion per year should be invested in these projects (MGI, 2022).

Reuters' survey of economists conducted in the fall of 2021 revealed significant discrepancies in dollar estimates of the required total investment, reflecting the diversity of methodologies used. The median value was $44 trillion. In turn, Oxford Economics experts put the total amount of investment needed in energy and other sectors by 2050 at nearly $140 trillion, the highest estimate found in the survey (CBI, 2022). The top four green bond issuers in 2021 were the United States, Germany, France and China (about 54%)[5]. In institutional terms, more than 3/4 of the issue of such

[1] https://www.un.org/en/climatechange/net-zero-coalition, accessed 10.04.2023

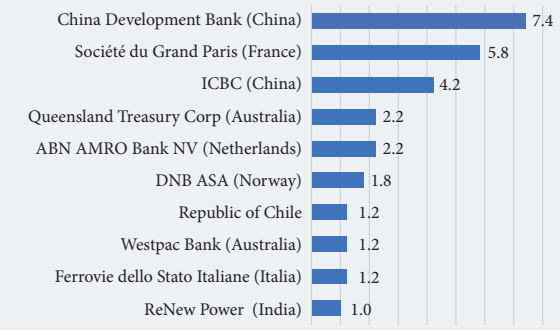
[2] Currently, with the participation of international financial institutions, a number of global environmental programs are being implemented, including the United Nations Environment Finance Initiative (United Nations Environment program Finance Initiative, UNEP FI) and Equator Principles (Equator Principles, EP). UNEP FI brings together over 500 financial institutions (mainly international banks and insurance companies) to develop mechanisms to promote sustainable development and environmental responsibility. (More details: https://www.unepfi.org/members, accessed 12.02.2023). The Equator Principles underlie credit risk management and are applied by international banks in providing financial and advisory support for environmental and socially oriented projects with a budget of more than $10 million (EPA, 2020). This initiative was joined by 138 financial institutions in 38 countries, which account for more than 70% of total project funding in rapidly developing countries.

[3] Target bonds issued for projects aimed at improving the environmental situation or minimizing damage to the environment.

[4] This goal was first identified in the framework of the «Conference of the Parties» (CoP) 2016 (https://unfccc.int/event/cop-22, accessed 15.02.2023).

[5] There are 21 sovereign green bonds were priced in 2021, including a GBP10bn (USD13.7bn) UK Gilt, the largest single debut sovereign green bond to date and the largest green bond of 2021. A smaller GBP6bn (USD8.25bn) deal followed in the UK later in the year, placing it among the top largest sovereign green bond issuers in the world. Consistently committed, the German state-owned development bank Kreditanstalt für Wiederaufbau (KfW) and the financial conglomerate, the largest US mortgage agency Fannie Mae, became the leading green issuers of the year (2nd and 3rd places) with a total volume of USD13.6bn and 13.4bn, respectively.

Figure 1. **Top 10 Climate Bonds Certified Issuers in 2021 (*$bn*)**



Source: (CBI, 2022).

securities falls on development banks and TNCs, the top 10 rating of which is shown in Fig. 1. At the end of 2021, the total amount of green bonds issued by banks in 58 countries reached $522.7 billion, which is 75% higher than the corresponding figures at the end of 2020.

Over the past 10 years, international banks have been a key contributor to environmental sustainability through their partner networks through proximity to direct beneficiaries. The European Bank for Reconstruction and Development (EBRD) holds the lead in allocating green investments. In particular, it provided loans for solar energy projects in Kazakhstan ($16.7 million) and Azerbaijan ($114.2 million) (EBRD, 2021a)[6]. In 2022, the EBRD committed an additional €2 billion to the "Green Cities", which aims to assist city administrations in preparing environmental strategies, financing sustainable infrastructure and technology exchange. Projects in the field of energy, green building and building renovation, renewable energy, water and wastewater treatment, solid waste disposal, etc. receive support. Over 50% of the total EBRD investment has already been allocated to the green economy direction[7]. Given the growing dynamics of bank financing in this direction, the question arises of assessing its contribution to the achievement of the SDGs, which is the subject of our study.

Table 1 lists the main studies in this area with key findings emphasizing the significant role of international banks in achieving the SDGs both at the national and interstate levels. However, the ambiguous environmental effects of these activities indicate the need for their in-depth study on a larger sample of countries and over a longer time horizon. Meanwhile, researchers approach the assessment of the contribution of banks in a fragmented way. Some consider banks only from the standpoint of transforming internal business processes, while others consider their intermediary functions in achieving the SDGs through certain "green" instruments (soft lending, the issuance of "green" bonds, etc.). The objective of our study is to comprehensively assess these two components using the example of studying the contribution of banks to the reduction of CO_2.

Materials and Methods

The information base of this study is the annual data obtained from the Organization for Economic Co-operation and Development, Statista and the World Bank Open Data (World Bank) for 2010-2020. The hypotheses established in the paper will be tested based on a data series from such countries as Austria, Denmark, Finland, France, Sweden, Czech Republic, Netherlands (EU countries with the best indicators according to the level of achievement of Sustainable Development Goals) and Ukraine, Azerbaijan, Greece, Moldova, Georgia (non-EU countries with medium and low level of achievement of Sustainable Development Goals). The choice of countries is due to the possibility of taking into account the different specificities of green banking (these countries differ in the features of the banking system, the types of their construction, the role of the state in achieving the Sustainable Development Goals) and the availability of a complete array of data necessary for calculations. Data collection and preprocessing was performed using the Microsoft Office Excel toolkit, and Stata 16 software packages were used for further econometric analysis. The study of the effect of international bank financing on environmental sustainability was carried out using two groups of indicators described in Table. 2.

The application of the macroeconomic approach is aimed at evaluating the effectiveness of the green banking policy in the country, and not at the level of an individual bank. This will allow us to determine the role of green banking in state environmental management and effective financing of eco-projects. The use of the micro-approach is more justified when evaluating the activity of a separate banking institution, determining its role in achieving the Sustainable Development Goals,

[6] In the first case, the project partner was the Green Climate Fund, the second was attended by a consortium consisting of: EBRD, Asian Development Bank, Japan International Cooperation Agency and Abu Dhabi Development Fund.

[7] Other initiatives include the participation of the IMF in joint development programs, the provision of technical assistance and knowledge to partners to solve problems related to the achievement of the SDGs. World Bank Group annually invests more than $65.9 billion to reduce poverty and stimulate economies in developing countries in Sub-Saharan Africa, East Asia and the Pacific, South Asia, Europe, Central Asia, Latin America and the Caribbean, the Middle East and in North Africa. New Development Bank annually mobilizes $7.2 billion for the implementation of infrastructure projects for sustainable development in the BRICS countries and beyond. Islamic Development Bank Group provides more than $7.8 billion to help people in the Middle East, Africa, Asia and Latin America. British Export Credit Agency in 2019 invested $1 billion in the implementation of international projects in the field of renewable energy.

Table 1. **Main studies of the links between banking activity and environmental indicators of the country of presence**

Subject of study	Description, key findings
The impact of green banking on environmental performance (Salvado et al., 2013)	Using questionnaire and research resume methods, the empirical study proved the positive impact of international banking environmentally friendly strategies on the level of eco-innovation and growth of banking sector competitiveness.
The role of international banks in the dissemination of green technologies (Risal, Joshi, 2018)	Using the tools of simple and step-by-step multiple regression analysis based on data from 189 banks, the authors proved the important role of international banks in encouraging the use of environmentally sustainable technologies to enhance the bank's reputation and awareness among customers.
The impact of international green banking on environmental performance of banks (Zhang et al., 2022)	Based on the modeling of structural equations for 352 bankers, the authors substantiate the mediating effect of financing on the relationship between international green banking and the environmental performance of private commercial banks. Empirical calculations have shown that green banking has a significant positive impact on the environmental performance of banks and sources of finance. At the same time, sources of financing environmental programs significantly affect the environmental performance of banks. The main shortcomings hindering the pace of green banking are the lack of customer awareness of green banking, high investment costs, technical barriers, lack of capable and competent staff to evaluate green loans, and difficulties in evaluating green projects. At the same time, increasing the competitiveness of banks, reducing long-term costs and expenses, providing online banking services, improving customer reputation and reducing carbon emissions is identified by the author as the main benefits of green banking.
Bank financing of projects to reduce greenhouse gas emissions (Michonski, Levi, 2010)	Bank-financed projects have reduced greenhouse gas emissions by an average of $3 million per project. These projects are mainly implemented by the World Bank, UNDP and UNEP. A GEF allocation of $2.7 billion in 1992 for climate-related projects reduced greenhouse gas emissions by one billion tons.
Investing in Low Emissions Enterprises (Campiglio, 2016)	The bank's investment in low-carbon emission ventures are considered as one of the main tools for combating climate change. Moreover, the author emphasizes that under certain economic conditions (low level of development, underdeveloped banking system, etc.), banks tend to shy away from lending to low-carbon activities even in the presence of a carbon price. In the opinion of the author, the use of a macroeconomic approach in the study of green banking will allow the evaluation of the effectiveness of the state monetary policy in the field of decarbonization of the economy. The data are especially relevant for developing countries, where the central bank system usually involves stronger state control over the distribution of loans and a wider range of monetary policy instruments than a single interest rate.
The role of international banks in shaping green policy principles (Tandon, Setia, 2017)	Based on primary and secondary analysis data and Garrett's ranking techniques the study concluded that the international banks play an important role in shaping green policy principles. State Bank of India's financing of a project to install wind turbines for individual use has reduced the country's dependence on polluting thermal energy, increased the country's energy neutrality and reduced its carbon footprint.
The contribution of foreign banks to the country's environmental performance (Gopi, 2016)	An example of a study that notes the negative impact of foreign financial structures on the environmental situation in the country. By financing projects, the implementation of which has a negative impact on the environment, banking institutions indirectly threaten the environment.

Source : compiled by the author based on the materials of the listed works.

Table 2. **Indicators for assessing the impact of international bank financing on environmental sustainability**

Group	Components
1) The CO_2 emissions (metric tons per capita) will be used as a generalizing indicator of the level of load on the environment.	The first group includes indicators that determine the level of financial support of international financial institutions and transnational banks for environmentally friendly measures: • environmentally related R&D expenditure (% GDP); • energy public RD&D budget (% GDP); • annual investment needs for renewable energy, energy efficiency and low-emission vehicle (bn); • climate bonds (bn); • green loan (bn); • firms using banks to finance investment (% of firms); • foreign bank assets in total banking assets (%).
2) Green policy indicators of international financial institutions (two components as independent variables)	Includes indicators that characterize banking institutions as direct participants in the process of achieving sustainable development goals: • total number of online non-cash transactions (millios); • number of internet card transactions; • share of contactless payments in the total number of non-cash card payments (%).

Source : compiled by the author.

Table 3. **Descriptive statistics of all the variables for all countries**

Variable	Description	Mean	Min → Max	St. Dev.
C_O2	CO_2 emissions (metric tons per capita)	5.032	0.047 → 17.051	3.785
BFI	Firms using banks to finance investment (% of firms)	24.02	17.03 → 51.36	15.06
FBA	Foreign bank assets in total banking assets (%)	21.36	17.05 → 44.69	9.02
NCT	Total number of online non-cash transactions (millios)	39.58	31.89 → 68.96	14.32
ICT	Number of internet card transactions (millios)	41.69	33.91 → 69.30	16.02
SCP	Share of contactless payments in the total number of non-cash card payments (%)	48.69	38.19 → 69.28	19.68
RDE	Environmentally related R&D expenditure, % GDP	0.08	0.020 → 0.155	0.032
EPB	Energy public RD&D budget, % GDP	0.01	0.01 → 0.090	0.002
INV	Annual investment needs for renewable energy, energy efficiency and low-emission vehicle, bn	839	235 → 1012	13256
CB	Climate Bonds, bn	24	7 → 32	15
GL	Green loan, bn	123	52 → 164	24

Notes: Min – minimum value. Max – maximum value. St. Dev– Standard deviation.

Source: author's calculations.

and the level of its transparency. However, taking into account that most projects of an environmental nature are financed by several sources of funding, as well as the fact that not all organizations publish their reports in terms of sustainable development policy, there is no complete information on the volume of international bank financing of environmental sustainability by individual banks in individual countries the use of a micro approach within this study has a number of limitations. Table 3 shows the results of descriptive statistics for all variables used to analyze the impact of international green banking on environmental sustainability. As a result of statistical analysis, the same number of observations was used for each of the analyzed indicators (n = 190). This number of samples allowed to balance the analyzed data panel. Macroanalysis was carried out by building regression models of panel data (Bahl, 2012; Purwanto et al., 2021; Chen et al., 2022; Ullah et al., 2021). The use of this method is due to its advantages over the cross-section and time-series data in the analysis of consecutive data series (Kumari, Sharma, 2017).

In general, the dependence of CO_2 emissions on the international green banking can be represented as follows:

$$CO_2 = f(BFI, FBA, NCT, ICT, SCP, RDE, EPB, INV, CB, GL), \quad (1)$$

The advantage of this model is to ensure high reliability of the results. Greater reliability and validity of the results will be ensured through the use of the generalized method of moments (GMM), which minimizes the impact of endogenous factors.

The Hausman test will be used to determine the model that most fully describes the established interdependencies (fixed or random effects) and allows to determine a statistically significant relationship between factor and result variables.[8]

Formalization of the relationship between the CO_2 emissions and green policy of international financial institutions and transnational banks in the field of ensuring environmental sustainability using a regression equation with fixed effects can be done as follows:

$$CO_{2t} = \alpha 0 + \beta_1 X_{1t} + ... + \beta_i X_{it} + \varepsilon_{it}, \quad (2)$$

where X_{it} — the independent variables ((*BFI, FBA, NCT, ICT, SCP, RDE, EPB, INV, CB, GL*); *i* — the subscript of entity (i = 1, … ,10); α_0 — an unknown intercept; $\beta_{i...n}$ — the coefficient of explanatory variables; ε_{it} — the error terms; *t* — time (t = 2010-2020).

Due to the different nature of the outcome and independent variables, it is important to transformed them into a comparable form and avoid the difficulties associated with the dynamic properties of data series. This can be achieved by logarithmic the right side of the equation as follows:

$$CO_{2t} = \alpha_0 + \beta_1 lnX_{1t} + ... + \beta_i lnX_{it} + \varepsilon_{it} \quad (3)$$

Formalization of dependencies using the equation of random effects can be done as follows:

$$CO_{2t} = \alpha + \beta lnX_{1t} + \mu_{it} + \varepsilon_{it} \quad (4)$$

where X_{it} – the independent variables (*BFI, FBA, NCT, ICT, SCP, RDE, EPB, INV, CB, GL*); α — an unknown

[8] Given the confirmation of the statistical significance of factors and resulting variables, the formalization of the relationship between indicators should be carried out using a model of fixed effects. Otherwise, it is advisable to use a model of random effects.

intercept; β — the coefficient of explanatory variables; ε_{it} — the error terms; μ_{it} — the random heterogeneity specific to the i-observation (constant through time).

In the next step, we will test the relationship between the CO_2 emissions and policy of international financial institutions and transnational banks in the field of ensuring environmental sustainability using the Hausman test. The choice of the most acceptable model was made based on the following equation:

$$p = (\beta_{RE} - \beta_{FE}) \times (\Sigma FE - \Sigma RE) \times (-1) \times (\beta_{RE} - \beta_{FE}) \quad (5)$$

where β_{RE} — coefficient estimated from a random-effects regression model; β_{FE} — coefficient estimated from a fixed regression model; ΣFE — fixed effects covariance matrix; ΣRE — random effects covariance matrix.

Exceeding the p-level above 0.05 allows us to confirm the hypothesis about the link between the CO_2 emissions and policy of international financial institutions and transnational banks. On the contrary, the insignificant value of the Hausman test confirms the alternative hypothesis, which indicates the acceptability of the fixed effects model.

An important component of testing the validity of the hypotheses established in the paper and improving the reliability of the results is the procedure of panel regression analysis. To this end, we estimate the correlation between the analyzed variables by the Pearson coefficient using the following equation:

$$R = \frac{E((CO_2 - E(CO_2))(Y - E(Y)))}{\sqrt{var(CO_2)var(Y)}}, \quad (6)$$

where E(Y) – independent variables; var (CO2) and var(Y) – the variance of CO2 and independent variables.

The interpretation of the results is presented in Table. 4.

At the last stage, a series of data will be test on the presence of single roots using Levin, Lin and Chu, Im, Pesaran, Shin W-Stat method, ADF-Fisher Chi-square and PP-Fisher Chi-square. The general equation is specified as follows:

$$CO_{2t} = \rho_i \gamma_{it-1} + \sum_{j=1}^{p_i} \varphi_{ij} \varepsilon_{it-j} + \ldots + \delta_i X_{it} + u_{it}, \quad (7)$$

where ρ_i — the number of lags; X_{it} — the independent variables; ε_{it} — the stationary error; i — the index of essence (i = 1, …, 10); u_{it} – a stationary process.

To check the data for non-linearity of the relationship between them, an assessment of long-term relationships between indicators will be carried out using the method of autoregressive distributed distances (ARDL), which has the following form:

$$lnCO_2 = \beta_0 + \sum_{i=0}^{n} \beta_{1i} ln\, CO_{2\,t-1-i} + \sum_{k=1}^{P} \sum_{i=0}^{m} \beta_{2i} ln\, P_{k\,t-i} + \omega DU_t(T_b) + \varepsilon_t, \quad (8)$$

where DUt – is a dummy variable representing a structural break); P_k – is the k-th indicator characterizing the green policy of international financial institutions and transnational banks in the field of ensuring environmental sustainability.

Results

The initial stage of modeling the link between the CO_2 emissions and green policy of international financial institutions and transnational banks is to check all series of data for stationarity. To this end, we will analyze the indicators using Levin, Lin and Chu (LLC), Im, Pesaran, Shin W-Stat (IPS), ADF-Fisher Chi-square (ADF), and PP-Fisher Chi-square (PP) tests for the presence of single roots. To avoid the presence of erroneous regression and conversion of all exogenous variables to stationary, we will analyze the variables for the presence of single roots in the first difference. The results of the analysis are confirmed the hypothesis of the presence of unit roots at the level of statistical significance of 1, 5 and 10% (Table 5). Since P-values (Prob.) for all analyzed indicators are less than 0.05, which allows us to accept the null hypothesis about the stationarity of the data set. In this way, the analyzed indicators do not change their characteristics over time. ARDL modeling and hypothesis testing of a causal relationship between variables revealed a significant effect of the activities of international banks to achieve environmental sustainability, expressed in a negative correlation between green policy and the growth of CO2 emissions (Table 6). Annual investment needs for renewable energy, energy efficiency and low-emission vehicle, energy public RD&D budget and climate bonds have the greatest impact on CO_2 emissions. Thus, a 1% increase in the volume of annual investment needs for renewable energy, energy efficiency and low-emission vehicle leads to a decrease in CO_2 emissions by 0.45%, an increase in the volume of energy public RD&D budget - by 0.36%, the volume of climate bonds - 0.54%. At the same time, number of internet card transactions, share of foreign bank assets in total banking assets, share of contactless payments in the total number of non-cash card payments have almost no effect on the level of carbon intensity of the economy. The correlation coefficient for these indicators does not exceed 0.1%.

Thus, the obtained results testify to the important role of bank capital in ensuring the decarbonization of the economy. At the same time, indicators of the country's banking sector development do not have a significant impact on the resulting indicator. The reason for this situation may be that the bank's implementation of the green investment policy does not depend on the size of the bank's capital and the volume of its operations but is a purposeful policy of the bank's management to comply with the principles of environmental responsibility. The results shown in Table 7 indicate a high level of reliability of the model with fixed effects (R-Squared - 0.890). Thus, all analyzed exogenous variables can explain the change in carbon emissions by 89.0%.

Table 4. **R-values and the level of correlation between CO2 emissions and the green policy of international banks**

R-value	Correlation between variables
0 < R < 0.2	No correlation
0.2 < R < 0.5	Low
0.5 < R < 0.7	Average
0.7 < R < 0.9	Strong
0.9 < R < 1.0	Highly strong
R < 0	Negative

Source: author.

The analysis of the strength of the connection between the indicators confirms the previous results regarding the importance of the indicators that determine the level of financial support of international financial institutions and transnational banks for environmentally friendly measures in reducing CO_2 emissions. Thus, a 1% increase in climate bonds leads to a 0.284% reduction in CO_2 emission, the amount of green loans – by 0.257%, environmentally related R&D expenditure – by 0.245%, energy public R&D budget – by 0.325%, annual investment needs for renewable energy, energy efficiency and low-emission vehicle – by 0.358%. The indicators that characterize banking institutions as direct participants in the process of achieving sustainable development goals practically do not affect the volume of CO_2 emissions. For example, an increase in the number of transactions on Internet cards by 1% leads to a decrease in CO_2 emissions by 0.004%.

At the next stage we will evaluate the parameters of the random-effects model. The results in Table 8 confirm the high reliability of the regression parameters from the random effects model (R-square is 0.784). Similar to the results obtained in Table 7, the evaluation of the parameters of the regression model of random effects (Table 8) confirmed the negative link between CO_2 emissions and indicators of green policy of international financial institutions and transnational banks. Thus, an increase in climate bonds by 1% leads to a reduction in CO_2 emissions by 0.46%, global loans – by 0.32%.

At the same time, the indicators obtained using the random-effects model exceed the correlation coefficients for the fixed-effects model. 0.564 compared to 0.245 for the share of environmentally related R&D expenditure, 0.658 compared to 0.358 for annual investment needs for renewable energy, energy efficiency and low-emission vehicle, etc.

Taking into account the obtained discrepancies, the Hausman test was carried out in order to identify the model that most reliably characterizes the relationship of the considered indicators (Table 9). The results were in favor of the fixed individual effects model. For all analyzed dependent variables p-level is less than 10%, and the value of the coefficient of determination is quite high.

The last stage of the study is to verify the validity of the hypotheses established in the paper using weighted least square statistical method, the advantage of which is the ability to neutralize the problems of autocorrelation

Table 5. **Panel unit root results**

tests	Stat. param.	Variables										
		Unit Root in Level										
		CO_2	BFI	FBA	NCT	ICT	SCP	RDE	EPB	INV	CB	GL
LLC	Stat.	–2.87	–1.02	–0.96	–2.58	–2.84	–2.69	0.98	–1.54	–3.14	–2.85	–1.25
	Prob.	0.00*	0.00*	0.01*	0.01*	0.00*	0.00*	0.05*	0.02*	0.01*	0.00*	0.01*
IPS	Stat.	1.37	1.45	1.35	1.95	1.58	2.04	–0.58	–0.69	3.69	–0.56	21.35
	Prob.	0.05	0.01*	0.00*	0.00*	0.01*	0.01*	0.00*	0.01*	0.01*	0.00*	0.00*
ADF	Stat.	17.87	1.05	1.98	1.65	1.28	2.36	34.29	28.47	2.02	17.36	17.85
	Prob.	0.04	0.01*	0.01*	0.01*	0.00*	0.00*	0.05	0.00*	0,03	0.02*	0.04*
PP	Stat.	26.94	27.89	31.05	33.78	24.69	22.36	54.97	46.98	31.65	45.94	23.68
	Prob.	0.01	0.01*	0.01*	0.01*	0.00*	0.00*	0.01	0.01*	0.69	0.02*	0.00*
Unit Root in 1st Difference												
LLC	Stat.	–6.87	–4.87	–5.81	–6.35	–7.82	–4.36	–5.21	–6.87	–5.17	–8.98	–1.75
	Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IPS	Stat.	–3.58	–2.58	–1.97	–2.69	–2.47	–2.47	–2.68	–5.19	–8.96	–7.52	–6.24
	Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ADF	Stat.	51.89	66.54	61.95	58.47	51.69	63.58	61.28	66.59	47.29	55.69	24.69
	Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PP	Stat.	147.95	98.87	85.47	59.68	88.74	76.98	87.87	113.27	107.96	187.89	98.24
	Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: * p < 0.01, ** p < 0.05, *** p < 0.1. L

Source: author's calculations.

Table 6. **Results of the correlation analysis**

	CO_2	BFI	FBA	NCT	ICT	SCP	RDE	EPB	INV	CB	GL
CO_2	1.00	–0.11	–0.05	–0.17	–0.08	–0.05	–0.24	–0.36	–0.45	–0.54	–0.21
BFI		1.00	0.08	0.06	0.04	0.14	0.08	0.09	0.04	0.10	0.05
FBA			1.00	0.21	0.29	0.33	0.17	0.19	0.21	0.28	0.26
NCT				1.00	0.85	0.74	0.25	0.24	0.18	0.21	0.26
ICT					1.00	0.89	0.26	0.19	0.11	0.16	0.14
SCP						1.00	0.17	0.23	0.21	0.26	0.21
RDE							1.00	0.22	0.64	0.28	0.11
EPB								1.00	0.71	0.39	0.09
INV									1.00	0.27	0.17
CB										1.00	0.16
GL											1.00

Source: author's calculations.

and heteroskedasticity of panel data series. The coefficients shown in Table 10 confirm the preliminary results of the relationship between the analyzed data series. The regression coefficient for the indicators of the green loan and CO_2 emissions is 0.486 (at the level of statistical significance 1%), climate bonds — 0.527, environmentally related R&D expenditure — 0.621, energy public RD&D budget — 0.477. This confirms the negative statistically significant link between CO_2 emissions and international green banking. At the same time, a separate group of indicators has an insignificant impact on CO_2 emissions, in particular: regression coefficient for a number of companies using banks to finance investment (at the level of statistical significance 1%) – 0.086, share of foreign bank assets in total banking assets – 0.011, total number of online non-cash transactions – 0.166.

At the last stage, based on ARDL modeling, we will evaluate the presence of a long-term nonlinear relationship between indicators (Table 11). For all analyzed indicators, the p-value does not exceed 0.05, which indicates the feasibility of using this model to formalize the relationship between indicators. Indicators that determine the level of financial support of international financial institutions and transnational banks for environmentally friendly measures have the greatest impact on CO_2 emissions. A change in the volume of environmentally related R&D expenditure by 1% leads to a decrease in the volume of CO_2 emissions by 0.228% with a time lag of 2 years, energy public RD&D budget – 0.15%; annual investment needs for renewable energy – 0.346%, climate bonds – 0.183%. At the same time, the influence of share of foreign bank assets in total banking asset, number of internet card transactions, share of contactless payments in the total number of non-cash card payments is insignificant and without a time lag. A change in the share of firms using banks to finance investment leads to a change in CO_2 emissions with a time lag of 1 year.

Azerbaijan: Banking Sector Towards a Greener Growth Model

In Azerbaijan, the development of green banking is still at an early stage. Thus, according to the study, for the period of 2012-2016, the issuance of directive instructions on green banking by the Central Bank of Azerbaijan was not revealed (Allakhverdiyeva, Sorokina, 2021). And this is despite the fact that it was during this period that international financial institutions allocated "green" resources to Azerbaijan.[9] According to an OECD study, during that period, among other things, an obstacle to the development of environmental lending in the EU Eastern Partnership countries (including Azerbaijan) were regulatory barriers, expressed in the absence of state support and proper strategic planning, which often turned out to be a more serious factor, than the availability of funding. Among these countries, Azerbaijan had the smallest number of partner banks (2) participating in the distribution of funds under IFI environmental credit lines, and the lowest scores in assessing the development of climate and sustainable energy policies (OECD, 2016).

In recent years, the republic has been making significant efforts to protect the environment, develop a more environmentally friendly model of economic growth, with the priority of turning the country towards a more sustainable and flexible economy[10]. Adopted in 2021, the Azerbaijan 2030 agenda[11] lists green growth and a

[9] For example, in the second half of 2013, the European Investment Bank (Azerbaijani partner – AccessBank), through the Green for Growth Fund, which invests in energy efficiency and increased financing in renewable energy, invested $1.7 million; and the International Bank for Reconstruction and Development (Azerbaijani partner – Bank Respublika) – $47.1 million (for a period of 20 years with a 5-year grace period) for a project to support the improvement of solid waste management in Baku (Baybikova, Sterligova, 2014).

[10] https ://blogs.worldbank.org/europeandcentralasia/green-growth-mirage-or-reality-azerbaijans-future, accessed 15.05.2023.

[11] The full title is " Azerbaijan 2030: National Priorities for Social and Economic Development". https://www.economy.gov.az/ru/post/872/azerbaycan-qlobal-dayaniqli-inkisaf-meqsedleri-indeksinde-movzusunda-tedbir-kecirilib, accessed 15.05.2023.

Table 7. **Panel regression results for the fixed-effects model**

Variables	Coefficient	Std. Error	t-Statistic	Prob
BFI	–0.012*	0.016	–5.548	0.000
FBA	–0.008*	0.011	–2.561	0.000
NCT	–0.015*	0.008	–3.548	0.000
ICT	–0.004*	0.112	–4.658	0.000
SCP	0.007*	0.006	–5.985	0.000
RDE	–0.245*	0.012	–24.365	0.000
EPB	–0.325**	0.023	–7.985	0.000
INV	–0.358*	0.095	–10.256	0.000
CB	–0.284*	0.045	–9.854	0.000
GL	–0.257*	0.023	–7.921	0.000
R-Squared	0.890			
Prob (F-statistic)	0.000			

Note: * p < 0.01, ** p < 0.05, *** p < 0.1.

Source: author's calculations.

Table 8. **Panel regression results for the random-effects model**

Variables	Coefficient	Std. Error	t-Statistic	Prob
BFI	–0.019*	0.025	–5.145	0.000
FBA	–0.024*	0.018	–2.032	0.000
NCT	–0.017*	0.011	–3.145	0.000
ICT	–0.001*	0.032	–3.854	0.000
SCP	0.004*	0.012	–4.154	0.000
RDE	–0.564*	0.023	–17.365	0.000
EPB	–0.258**	0.031	–5.854	0.000
INV	–0.685*	0.112	–8.245	0.000
CB	–0.458*	0.068	–5.205	0.000
GL	–0.327*	0.042	–6.542	0.000
R-Squared	0.784			
Prob (F-statistic)	0.000			

Note: * p < 0.01, ** p < 0.05, *** p < 0.1.

Source: author's calculations.

Table 9. **Hausman test**

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
BFI	0.0007	0.0006	1.1317	0.0028	0.0015	0.0029
FBA	–0.0120	0.0191	–0.5497	0.0001	–0.0939	0.0699
NCT	0.1434	0.0402	0.1724	0.0001	–0.3733	0.4104
ICT	–0.0445	0.0560	–0.6898	0.0000	–0.2856	0.1968
SCP	–0.6768	0.0144	–0.5820	0.0050	–0.7119	0.4866
RDE	0.0112	0.0163	0.6035	0.0000	0.0001	0.0001
EPB	–0.0525	0.0663	–0.8154	0.0000	–0.3376	0.2326
INV	–0.8001	0.0170	–0.6880	0.0059	–0.8416	0.5752
CB	0.0133	0.0193	0.7135	0.0000	0.0001	0.0001

Source: author's calculations.

clean environment as one of the five strategic priorities that underpin Azerbaijan's future development. As part of this goal, along with the prospective economic development of the country, the importance of improving the environment, investing in renewable energy sources, reducing the carbon footprint, and addressing other domestic environmental problems is emphasized, and activities are currently being carried out to achieve these goals.

Thus, one of the subgoals of the national "green roadmap" adopted in the republic in 2022 is the use of incentives by banks to finance electric and hybrid cars[12]. With this in mind, the Central Bank of Azerbaijan (CBA) has developed an action plan aimed at incorporating resilience and climate risks into public and private financing mechanisms, supporting the macroeconomic and regulatory framework for

Table 10. **Robustness test**

a) Multi-dimension variables

Variables	Coefficient	Std. Error	t-Statistic	Prob
BFI	–0.086*	0.008	–12.7406	0.000
FBA	–0.011*	0.011	–29.6156	0.000
NCT	–0.166**	0.211	–19.9091	0.000
ICT	–0.615*	0.031	–10.7753	0.000
SCP	–0.790*	0.073	–16.4565	0.000
RDE	–0.621*	0.014	–7.85813	0.000
EPB	–0.477*	0.018	–13.2904	0.000
INV	–0.411*	0.009	–10.9856	0.000
CB	–0.527*	0.023	–7.19308	0.000
GL	–0.486*	0.017	–12.7406	0.000

b) One-dimension variables

R-Squared	0.891
Prob (F-statistic)	0.920
Adjusted R-squared	0.000
Durbin-Watson stat.	0.301
Schwarz criterion	0.131
Hannan-Quinn criterion	0.032
Akaike info criterion	–0.02

Note: * p < 0.01, ** p < 0.05, *** p < 0.1.

Source: author's calculations.

[12] The full title is «Roadmap for conducting assessments, preparation and implementation of proposals to stimulate and encourage the use of environmentally friendly modes of transport.» https ://report.az /ru /biznes /v-azerbajdzhane -razrabotana-dorozhnaya-karta-po-pooshreniyu-primeneniya-ekologichnyh-avtomobilej/, accessed 15.05.2023.

Table 11. **ARDL Regression**

a) Multi-dimension variables

Variables	Coefficient	Lag	Std. Error	p-value	Prob
BFI	–0.017	1	0.125	–1.45	0.006
FBA	–0.003	0	0.265	–1.65	0.006
NCT	–0.015	0	0.254	–1.85	0.001
ICT	–0.005	0	0.165	–0.85	0.014
SCP	–0.001	0	0.104	–0.65	0.025
RDE	–0.228	2	0.365	–1.36	0.003
EPB	–0.150	2	0.095	–0.95	0.004
INV	–0.346	2	0.085	–0.96	0.042
CB	–0.183	2	0.116	–0.84	0.007
GL	–0.269	2	0.165	–0.87	0.024

b) One-dimension variables

R-Squared	0.796
Adjusted R-squared	0.775

Source: author's calculations.

the implementation of these new priorities. In turn, the Association of Banks of Azerbaijan (ABA) gave relevant recommendations to banks. Along with this, they are preparing proposals for a green finance mechanism and green bonds, as well as forming a legal framework related to green finance in the country. All of these actions, in our view, are the right steps to minimize market uncertainty about greening growth while reducing transition costs.

Azerbaijan's efforts to switch to a "green" path of economic development and improve environmental performance have earned recognition and support from the international community and organizations such as UNDP, EU, World Bank, EBRD, Islamic Development Bank, etc.[13] The World Bank report on Azerbaijan highlights low-carbon hydrogen production and offshore renewable energy production, climate-smart agriculture and land use, and the development of a "blue" economy with a focus on exploitation as potential business segments that can attract and stimulate the growth of green banking and the preservation of the Caspian Sea and its coastline (World Bank, 2022). The country's ambitious green energy export plans are gaining momentum and are already being implemented in specific initiatives[14]:

- leading international companies in the field of renewable energy have signed contracts and memorandums of understanding for the production of more than 25 GW of renewable energy in Azerbaijan;
- the construction of the first wind and solar power plants began;
- in December 2022 between the governments of the Republic of Azerbaijan, Georgia, Romania and Hungary signed "Agreements on strategic partnership in the field of development and transmission of "green" energy".

Great opportunities for Azerbaijan in the development of the green economy in general and green banking, in particular, are associated with the prospects for the development of the territory of Karabakh, opening against the backdrop of progress in resolving the Armenian-Azerbaijani conflict (Hajiyeva, Musayeva-Gurbanova, 2022). Declaring Karabakh a zone of "green" energy, Azerbaijan has provided for the period 2022-2026. a plan of specific measures towards the decarbonization of the economy of this region of the country. Here are just a few of them (EBRD, 2021b) :

- creation of production and service sites for green technologies (an agreement on the formation of a «green» energy zone was signed with the Japanese company TEPSCO)[15];
- a joint project with the British company BP for the production of solar energy[16];
- laying the idea of "green" development in the Master Plans of three cities of the Karabakh economic region ("Cities of the Future"), developed by the Swiss city planning and architecture company SA Partners GmbH together with the government of the republic.

The above opportunities create favorable conditions both for the Central Bank of Azerbaijan and its commercial banks, and for international financial institutions to overcome the inertia observed in the formation and development of green banking in the country and to fully participate in this process.

Conclusion

Due to the aggravation of environmental problems and the low effectiveness of existing tools to deal with them, there is a growing demand for innovative mechanisms for solving these problems on a global scale, including the reorientation of economic entities towards the

[13] For example, EBRD, Asian Development Bank (ADB), Japan International Cooperation Agency (JICA) and Abu Dhabi Development Fund (ADFD) have provided a 114.2 million dollar loan for a photovoltaic (PV) solar power plant project in Azerbaijan (https ://www .ebrd.com/work-with-us/projects/psd/52221.html , accessed 15.05.2023) . Along with this, the EBRD, within the framework of the Green Cities program, allocated a loan of 10 million euros for the introduction of intelligent systems for collecting municipal solid waste and optimizing public transport routes in the city of Ganja (https://www.azernews.az/business/193690. html, accessed 15.05.2023).

[14] https://minenergy.gov.az/en/foto-qalereya/energetika-naziri-azerbaycan-xezerin-yasil-enerji-potensialini-avropaya-elektrik-enerjisi-yasil-hidrogen-ammonyak-olaraq-tedaruk-etmek-niyyetindedir, accessed 15.05.2023.

[15] http://www.tepsco.co.jp/english/topic/etopic_20210517.html, accessed 10.06.2022; https://minenergy. gov.az/en/xeberler-arxivi/yaponiyanin-tepsco-sirketi-ile-gorus-kecirilib, accessed 10.06.2022.

[16] https://www.bp.com/en_az/azerbaijan/home/news/press-releases/The-Ministry-of-Energy-and-bp-agree-on-next-stepsin-solar-project.html, accessed 15.06.2023.

principles of sustainable development. Every year more and more international financial institutions and transnational banks are involved in these processes. Numerous studies show their important contribution to the achievement of the SDGs, along with factors such as the level of economic growth (Nejat et al., 2015; Luqman et al., 2019; Shahbaz et al., 2021), social responsibility of the population and business (Sadiq et al., 2022; Debnath, Roy, 2019) and others.

This article is devoted to substantiating the role of the green practice of international banks as one of the most relevant ways to stimulate the introduction of corporate social responsibility principles, the implementation of environmental programs, the use of innovative resource-saving technologies, etc. Empirical calculations have confirmed the positive impact of global financial institutions on the dynamics of environmental development, expressed in a decrease in the volume CO_2 emissions through significant investments in environmental initiatives. The internal indicators of the development of the banks themselves do not produce significant external effects for the environment. A possible explanation is that the vast majority of environmental programs are implemented by the state or business. At the national level, the share of green initiatives implemented by banks is insignificant.

The results of the study give reason to expand the list of traditional mechanisms for stimulating sustainable development and to actively use the international green banking business to promote these processes. State institutions (in particular, players in the global financial market) should develop and implement appropriate policies aimed at encouraging banking institutions to support environmental initiatives and introduce green technologies to reduce the burden on the environment.

The main limitation of this study is the small sample size of the factor indicators. To date, there are no comprehensive studies of international green finance in relation to programs implemented to achieve the SDGs. As a result, it is not possible to generalize the essence of the impact of the green practice of international banks on sustainable development indicators for all countries and sources of funding. Another limiting factor is the low level of transparency in the activities of specific banks, especially from countries with underdeveloped economies, which publish only a small part of information about their activities, especially in the environmental aspect. In the course of further research, it is advisable to expand the list of indicators characterizing the financial parameters of environmental sustainability policy and develop strategies for solving these problems.

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