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THE EFFECT OF INTERNATIONAL GREEN BANKING PRACTICES ON ENVIRONMENTAL SUSTAINABILITY: AN EMPIRICAL STUDY

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Abstract. One of the biggest problems of today, the consequences of which are observed in all aspects of human functioning, are environmental. 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 the country's environmental sustainability. In addition, it provokes 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 2010 to 2020. The annual data for panel regression analysis are retrieved from the OECD and World Bank Open Data. The empirical analysis employed a set of estimation procedures such as the panel unit root test (Levin, Lin & Im, Pesaran, Shin W-Stat; ADF-Fisher Chi-square; and PP-Fisher Chi-square methods), the Pearson correlation, fixed- and random-effects models, generalized method of moments (GMM), Hausman and the robustness tests. The identified effects can be useful for government officials in terms of determining the benefits of using international green banking towards gaining environmental sustainability.

Keywords: *international green banking, environmental sustainability, green financing, environmental performance, multinational banks.*

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1. Introduction

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 (World Bank data) showed a steady increase in global consumption of electricity, water, carbon emissions. In recent years, the risk of depletion of non-renewable energy resources has increased significantly, which creates another cause for concern for the world community. This provokes adverse climate change, increases environmental pollution 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).

One of the main documents regulating the problems of sustainable development are

the 2030 Agenda for Sustainable Development and Sustainable Development Goals (SDG) developed in 2015 by the UN General Assembly. These documents define a list of measures aimed at improving the economic and environmental situation in the world. However, the problems of recent years (COVID-19 pandemic and economic crisis) have significantly slowed down and threatened to reduce the prospects for achieving these goals in the near future.

A significant gap in the financial capacity to fund these activities in countries around the world leads to the search for additional sources of accumulation of funds. International banking is a key part to this process.

International banking institutions are a principal source for environmental sustainability due to the large network of branches of banking institutions in the world and proximity to the direct beneficiary. The resources of international banks play a key role in financing environmentally friendly programs and supporting sustainable development in the world, especially during periods of financial crisis.

Despite the general problems caused by the pandemic and the crisis in the economy, the performance of the international banking sector is assessed as positive and as an important component of global financial services for economic stability.

A significant number of international banks, together with the International Monetary Fund (IMF), are constantly focusing their efforts on achieving the SDG. Due to the implementation of innovative financial solutions, these institutions have made some progress in meeting quality of life standards, including environmental sustainability. The financial resources allocated by these organizations (direct financing and financial support of public and private institutions) have a significant impact on sustainable development.

Thanks to a wide range of financial services provided by international banks (capital market operations, investment banking, securities brokerage and lending, risk management, operational and technology centers, research and development centers, credit services, treasury operations and intra-group financial activities) beneficiaries have the opportunity to fund sustainable development programs through a significant number of tools and areas of development.

Today, at the international level, a number of environmental protection initiatives are being implemented with the direct participation of international banks. Thus, one of the most common is the the United Nations Environment Program Finance Initiative (UNEP FI) and Equator Principles (EPs). UNEP FI is a network of financial institutions (mainly international banks and insurance companies) that are committed to developing mechanisms to promote sustainable development and mechanisms for their environmental responsibility. Measures to establish and promote the relationship between sustainability and financial performance of the organization are implemented by establishing cooperation with more than 200 members, including leading international banks, investment funds and insurance companies.

The principles of the equator are the basis of credit risk management in terms of identification and assessment of environmental and social risks in the implementation of project financing by international banks. The principles were first developed in 2003 and put into practice by ten global financial institutions. These principles are applied in project financing and related consulting activities for projects above $10 million. Today, the Equator Principles are signed by financial institutions in 32 countries, whose funding is more than 70% of the total project funding in countries with rapid economic development. In recent years, along with traditional instruments for financing environmental programs,

international green banking has become important as an integral part of the international banking business, aimed at creating conditions for better living conditions and sustainable development for present and future generations (Bahl, 2021; Sachs *et al*., 2021).

International banks are increasingly resorting to concessional financing or grants directly aimed at implementing SDGs in the poorest countries. One of the activities of the International Monetary Fund is the implementation of joint development programs, technical assistance and knowledge to partners to address issues related to the achievement of the SDG.

For example, the World Bank Group annually directs more than $65.9 billion in search solutions that reduce poverty and build shared prosperity in developing countries in Sub-Saharan Africa, East Asia and the Pacific, South Asia, Europe and Central Asia, Latin America and the Caribbean. Middle East and North Africa. New Development Bank annually mobilizes $7.2 billion to implement infrastructure and sustainable development projects in the BRICS and other market economies and developing countries. Islamic Development Bank Group is allocating more than $7.8 billion to empower people in the Middle East, Africa, Asia and Latin America to ensure their sustainable future.

The European Bank for Reconstruction and Development has developed the Green Cities program (totaling more than €1.5 billion) to help cities develop environmental action plans, facilitate access to sustainable infrastructure financing and share technical expertise. The object of financing are measures in the field of energy, green building and reconstruction of buildings, renewable energy, water and wastewater treatment, solid waste management, etc.

The implementation of this measures on the one hand helps to enhance the reputation and image of these banks, promotes their visibility among customers and demonstrates their commitment to environmental protection. On the other hand, this policy, by supporting and implementing environmentally friendly technologies, reduces the burden on the environment, carbon emissions and more.

At the same time, the role of international green banking in sustainable development is not fully understood. There are still many issues that need to be studied in more detail: which components of the sustainable development mechanism are most sensitive to the level of international green banking in the country, the effectiveness of these mechanisms in the world, how effective international green banking is compared to more traditional tools for sustainable development.

2. Literature Review

Liberalization of financial flows, integration and globalization of financial and economic systems significantly accelerate the pace of cash flow and stimulate the development of the international banking sector, which is characterized by banking activities that cross national borders. This creates additional opportunities to raise capital at much higher volumes and rates.

According to Tandon &Setia (2017) based on primary and secondary analysis data and Garrett's ranking techniques concluded that the international banks play an important role in shaping green policy principles.

On the other hand, Gopi (2016), the international banking is one of the catalysts for environmental degradation. By financing projects, the implementation of which has a negative impact on the environment, banking institutions indirectly threaten the environment. Awareness of this problem has led to a revision of the policy of banking

institutions at the international level and the implementation of policies for the use of incentive tools to encourage projects that demonstrate their concern for the environment.

Awareness of the growing role of international banks in achieving the SDG has contributed to the emergence of the concept of "green banking" as the most innovative component of environmental sustainability policy. The preconditions for the emergence of this concept and the active involvement of the banking sector in these activities were the world community's awareness of the effects of the environmental crisis and environmental pollution, which are asking the international banking industry to take an active part in overcoming the environmental crisis and global warming. Every year, this concept covers more and more aspects that can be implemented through direct or indirect participation of financial institutions in ensuring environmental sustainability, in particular: green finance, green marketing and green behavior, and so on.

United Nations representatives, with the support of the 30 most powerful international banks in the world, identified six principles of sustainable banking. These principles are based on the implementation of the roadmap to increase public confidence in international banking institutions and bring the main vectors of their activities (operational activities, specific decisions and even the principles of capital allocation) in line with the principles of sustainable development defined by international rules (Paris Climate Agreement or 17 UN Sustainable Development Goals), national and regional programs in a particular country.

According to these principles, international green banking is to streamline the decision-making process for responsible capital allocation: where is the best place to invest and who is best not to lend? These activities require verification of clients, projects and partners for compliance with the principles of sustainable development, as well as the introduction of key performance indicators (KPIs) on environmental and social benefits of projects (Bhardwaj & Malhotra, 2013; Taghizadeh-Hesary & Yoshino, 2020; Malliga & Revathy, 2016).

Today, one of the mainstream developments of scientific thought in the field of sustainable development, the most common tool for solving climate problems, environmental pollution and ensuring sustainable development of the country is international green banking (Aubhi, 2016; Jayabal & Soundarya, 2016; Ritu, 2014; Shaumya & Arulrajah, 2017; Tandon & Setia, 2017; Mamedov & Qurbanov, 2022). Every year, more and more banks are transforming their policies towards sustainable development, social responsibility and ethical behavior.

Today, international green banking is implemented in various forms: replacement of banking services in branches with online customer service; creating opportunities to pay bills online; opening accounts in online banks, not in large multi-branch banks, etc (Deka, 2018).

Jha & Bhome (2013) among the most common international green banking strategies for sustainable development are: Going Online (e-banking, which reduces the use of paper, energy, and expenditure on projects assists in power saving and resource preservation); Using Green Checking Accounts; Green Loans for households (loans with low or differentiated interest rates for the purchase of solar equipment); Power Saving Equipment (using of solar-powered ATM); Green Credit Cards; Green product and services; Green Strategies; Green Checking Accounts; Saving Papers (use of recycled paper products with the highest post-consumer waste content possible).

The implementation of all these operations promotes the development and exchange of sustainable business practices in support of environmentally friendly

initiatives in the world and reduces the negative impact on the environment.

However, despite the fact that green banking is already considered an integral part of the international banking system, it is still not popular in most middle- and low-income countries. In addition, a significant number of scholars emphasize that the implementation of international green banking policy, in addition to the direct environmental effect has a positive effect on the activities of banking institutions. The implementation of these measures shapes the community's perception of this financial institution as one that is not only profit-oriented, but also cares about the environment and ultimately leads to an increase in their reputational value.

Salvado et al. (2013) based on an empirical study using questionnaire and research resume methods proved the positive impact of international banking environmentally friendly strategies on the level of eco-innovation and growth of banking sector competitiveness.

Risal and Joshi (2018) in their study analyzed the impact of green banking on environmental activities in Nepal. 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.

Zhang et al. (2022) analyzed the impact of international green banking on green finance and environmental performance of banks. Based on the modeling of structural equations for 352 bankers, the authors substantiate the mediating effect of green finance 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 green finance. At the same time, sources of green finance 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.

Thus, the results of the analysis of the existing scientific contributions on the development of international banking as part of the implementation of policies to achieve sustainable development goals showed the important role of these processes at both national and international levels. At the same time, some of their aspects require more detailed research on the example of more countries and over a longer time horizon. Therefore, the primary purpose of this study is to determine the impact of international banking on environmental sustainability. The main hypothesis of the study is the assumption that international banking plays an important role in achieving sustainable development goals in terms of all their components (reduction of energy consumption, carbon emissions, water use, etc.).

3. 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 on

the basis of 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, Luxembourg, Georgia (countries with medium and low level of achievement of sustainable development goals). Data collection and preprocessing was performed using the Microsoft Office Excel toolkit, and Stata software packages were used for further econometric analysis.

The study of the impact of international bank financing on environmental sustainability will be conducted in the context of the following indicators:

1) As an indicator characterizing the effectiveness of achieving the sustainable development goals (outcome variable), the CO2 emissions (metric tons per capita) will be used as a generalizing indicator of the level of load on the environment.

2) Indicators characterizing the green policy of international financial institutions and transnational banks in the field of ensuring environmental sustainability (independent variables): 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 (%); 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 (%). This group of indicators characterizes two components of ensuring environmental sustainability. The first group includes indicators that determine the level of financial support of international financial institutions and transnational banks for environmentally friendly measures. The second group of indicators includes indicators that characterize banking institutions as direct participants in the process of achieving sustainable development goals (the level of online operations).

Table 1 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.

Table 1. Descriptive statistics of all the variables for all countries

Vari-able	**Description**	**Mean**	**Min→Max**	**St. Dev.**
CO_2	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.

The role of international green banking in ensuring the environmental sustainability of the country will be assessed 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).

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 movement (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.

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.

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:

$$CO_{2t} = \alpha_0 + \beta_1 X_{1t} + \ldots + \beta_i X_{it} + \varepsilon_{it} \quad (2)$$

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; $\beta_{i\ldots n}$– 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:

$$CO_{2t} = \alpha_0 + \beta_1 ln X_{1t} + \ldots + \beta_i ln X_{it} + \varepsilon_{it} \quad (3)$$

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

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

where X_{it} – the independent variables ($BFI, FBA, NCT, ICT, SCP, RDE, EPB, INV, CB, GL$); α – an unknown 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 CO2 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:

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

where β_{RE} – coefficient estimated from a random-effects regression model; β_{RE} – coefficient estimated from a fixed regression model fixed effects; $\sum FE$ – fixed effects covariance matrix; $\sum RE$ – 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(CO_2) and var(Y) – the variance of CO_2 and independent variables.

Interpretation of the obtained results can be carried out as follows:

$0 < R < 0.2$ – they are not correlation between the CO_2 emissions and green policy of international financial institutions and transnational banks;

$0.2 < R < 0.5$ – the low level of correlation;

$0.5 < R < 0.7$ – an average level of correlation;

$0.7 < R < 0.9$ – the strong correlation between variables;

$0.7 < R < 0.9$ – the highly strong correlation between variables;

$R < 0$ – the negative correlation between variables;

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.

4. 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. In order 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 2).

Table 2. 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.	0.08	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.	0.07	0.01*	0.01*	0.01*	0.00*	0.00*	0.47	0.00*	1.58	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

Notes: * p < 0.01, ** p < 0.05, *** p < 0.1. L
Source: author's calculations.

At the next stage we will analyze the presence of correlation between the analyzed variables, which will confirm the hypothesis of a causal relationship between them and significant impact of international green banking on environmental sustainability. Table 3 shows the results of the correlation analysis between variables, which confirms the link between the CO_2 emissions and indicators of green policy of international financial institutions and transnational banks.

Table 3. 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.

Thus, the results of the analysis show that there is a negative impact the indicators of green policy of international financial institutions and transnational banks on the CO2 emissions. The development of environment-related technologies and the energy public RD&D budget have the strongest impact on sustainable development indicators (medium and low levels of correlation). International green banking (climate bonds, green loan) have a positive impact on the environmental sustainability of the country. Thus, an increase in the volume of climate bonds issued by 1% leads to a reduction in CO_2 emissions by 0.54%. At the same time, are not correlation between the share of firms using banks to finance investment, the share of foreign bank assets in total banking assets, total number of online non-cash transactions, number of internet card transactions and the share of contactless payments in the total number of non-cash card payments and CO2 emissions. Confirmation of the hypothesis of a causal link between the analyzed indicators allows us to evaluate the parameters of the model, which most fully describes the link between the CO2 emissions and indicators of green policy of international financial institutions and transnational banks (fixed effects or random-effects model).

Table 4. 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			

Notes: * p < 0.01, ** p < 0.05, *** p < 0.1.
Source: author's calculations.

The results shown in Table 4 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%. At the same time, the obtained values show a negative relationship between the CO_2 emission and all independent variables. Thus, a 1% increase in climate bonds leads to a 0.28% reduction in CO_2 emission, and the number of transactions on Internet cards – by 0.004%.. At the next stage we will evaluate the parameters of the random-effects model. The results in Table 5 confirm the high reliability of the regression parameters from the random effects model (R-square is 0.784).

Table 5. 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			

Notes: * p < 0.01, ** p < 0.05, *** p < 0.1.
Source: author's calculations.

The evaluation of the parameters of the regression model of random effects (Table 5) 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%. Similar to the results obtained in Table 5, the international green banking effect on achieving sustainable development goals.

Table 6. 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: developed by authors.

The formalization of the link between CO_2 emissions and international green banking using the Hausman test (Table 6) shows that the model with fixed individual effects best describes the relationship between these indicators. 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 and heteroskedasticity of panel data series. The coefficients shown in Table 7 confirm the preliminary results of the relationship between the analyzed data series.

Table 7. Robustness test

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
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-			

Notes: * p < 0.01, ** p < 0.05, *** p < 0.1.
Source: author's calculations

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.

5. Discussion

The actualization of environmental problems and the low effectiveness of existing tools for environmentally sustainable development of the country necessitates the search for innovative mechanisms to stimulate these processes at the global level. Awareness of these trends forces economic entities to reorient their activities in accordance with the principles of sustainable development. Every year more and more international financial institutions and multinational banks are involved in these processes. In this situation, it was they who proved to be the key catalyst in the evolution of sustainable development goals and principles of sustainable growth.

Today, international green banking has become an integral part of global banking policy and a fairly common tool for financing environmental activities. Systematization of scientific literature showed a significant intensification of research on these issues and allowed us to conclude that the level of achieving sustainable development goals depends on a number of exogenous and endogenous factors, including: levels of economic development (one indicator of which is GDP) (Nejat, 2015; Luqman, Ahmad & Bakhsh, 2019; Shahbaz et al., 2021), social responsibility of the population (Sadiq et al., 2022) and business (Debnath & Roy, 2019), political stability, etc. Along with these factors,

international green banking is becoming a very important instrument for ensuring sustainable development.

Given the above, this paper is devoted to substantiating the role of international green banking as one of the most modern ways to encourage compliance with the principles of corporate social responsibility, implementation of environmentally friendly programs, introduction of innovative resource-saving technologies in European countries and more.

According to the hypothesis of the positive impact of international green banking on environmental sustainability, the results of econometric analysis [panel unit root test (Levin, Lin & Im, Pesaran, Shin W-Stat; ADF-Fisher Chi-square; and PP-Fisher Chi-square methods), the Pearson correlation, fixed- and random-effects models, generalized method of moments, Hausman and the robustness tests) proved that international financial institutions and multinational banks has a positive impact on indicators of environmental development (CO2 emission). Their funds, aimed at implementing environmental programs, have a positive impact on the environmental situation in the country and reduce the level of destructive impact on the environment. At the same time, a number of companies using banks to finance investment, share of foreign bank assets in total banking assets, total number of online non-cash transactions, number of internet card transactions, share of contactless payments in the total number of non-cash card payments has insignificant impact on the CO_2 emission, which can be explained by the more destructive impact of the industry on the environment rather than the financial sector. The obtained results are characterized by a high level of statistical significance and confirmed by both random-effects models and fixed-effects models. Along with this, the study concludes that the fixed-effects model more accurately describes the impact of international green banking on environmental sustainability.

Thus, the obtained results form the basis for expanding the list of traditional mechanisms to stimulate environmentally sustainable development and more active use of international green banking to stimulate these processes. Government institutions (including global financial market players) should develop and implement appropriate policies aimed at stimulating business to implement environmental initiatives, create the conditions for financial support for measures to implement green technologies to reduce the burden on the environment. The obtained empirical results form the basis for stimulating the development of green banking in the world as an integral part of ensuring the functioning of the financial sector in accordance with the principles of sustainable development.

The main limitation of this study is the small sample of factor indicators. To date, there are no comprehensive studies on the amount of international green funding in terms of different areas of funding for programs to achieve sustainable development goals. These restrictions do not allow to generalize the nature of the impact of international green banking on sustainable development indicators for all countries and sources of funding. Therefore, further research should be aimed at expanding the list of indicators that characterize the financial conditions of environmental sustainability policy, and developing scenarios for achieving sustainable development goals in the future, depending on the sources of financial support for environmentally friendly measures.

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