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The Green Trilemma: Energy Efficiency, Banking Stability and Climate Risk in the Environmental, Social and Governance Context at World Level

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Abstract:

In the following article, we analyse the relationships among banking stability, the efficiency of the energy system and climate risks at a global level. We present a detailed analysis of the literature relating to the relationship between the banking system and Environmental, Social and Governance (ESG) models. In our research, we try to verify whether it is possible to achieve energy efficiency, stability of the banking system and reduction of climate risk together, *i.e.* the "*Green Trilemma*". The econometric analysis is conducted through the following models: Panel Data with Random Effects, Panel Data with Fixed Effects, Pooled Ordinary Least Squared and Weighted Least Squared-WLS. To estimate the variables, we used World Bank data. The analysis shows that ESG growth is negatively associated with energy efficiency and positively associated with banking stability and climate risk. It therefore follows that the Green Trilemma hypothesis is rejected. Countries can only target banking stability and climate risk through ESG models.

Keywords: banks, energy and the macroeconomy, energy forecasting, valuation of environmental effects, climate risk.

JEL Classification: G21, Q43, Q47, Q51, Q54.

Introduction

In recent years, a vast literature has developed aimed at estimating the impact of ESG factors on credit risk and market risk. According to these studies, environmental and social risks can compromise creditworthiness and therefore cannot be ignored (Stern, 2013). The results achieved are very conflicting due to the high uncertainty that characterizes the occurrence of natural events (Pindyck, 2020) and also due to the difficulty of building robust models for measuring such phenomena (Chodnicka, 2021). Concerning credit risk, it is possible to distinguish the effects of environmental risks on borrowers and financial institutions. On the borrowers' side, for example, recent studies (Höck et al., 2020; Billio et al., 2022; Carbone et al., 2022; Kim et al., 2022, Carrizosa and Gosh, 2022; Chen et al., 2021) empirically verify the presence of a negative trade-off between the best performance in terms of environmental sustainability and the credit risk premium. Other studies show that high emissions and low ESG ratings lead to a higher probability of default and higher credit spreads (Kleimeier & Viehs, 2018; Capasso et al., 2020; Ehlers et al., 2022). Chava (2014) denotes that financial institutions apply more onerous conditions on loans

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granted to companies that pay more attention to environmental issues. In contrast, Kim et al. (2014), analysing the evolution of bank loans in 19 countries, demonstrate that a more ethical behaviour of borrowers reduces loan spreads by approximately 25%. This reduction reaches even more significant dimensions (38%) when the financial institution takes on the characteristics of an ethical bank. Degryse et al. (2023) also reported similar results showing that green banks participating in the UN Environment Financial Program offer better lending conditions to green businesses. In line with the latter findings, Hauptmann (2017) finds that borrowers with higher sustainability ratings pay lower loan spreads only when the lending bank also shows strong sustainability performance. On the side of financial institutions, Birindelli et al. (2022), show that a greater commitment by banks in managing climate issues leads to a lower risk on the loans granted and a reduction in the reputational risk of the intermediary. Therefore, in the light of these studies, the belief is strengthened that, for greater stability of the financial sector, an assessment of customer solvency is increasingly necessary which is based exclusively on the economic characteristics of the latter. This is because natural events can seriously compromise the returns on bank loans granted.

In this work, the focus is on ESG factors that refer to the problem of climate change. The risks associated with the transition towards a low-carbon economy are increasingly gaining ground in the management policies of banking intermediaries, primarily the risk of climate change. This risk can produce significant effects not only on the solvency of borrowers and therefore on credit risk but also market risk following unexpected and sudden changes in share prices, interest rates, exchange rates, and asset prices. raw material. The focus on these non-financial risks has now had a tradition in the scientific debate for more than 15 years. In this regard, some studies (Dell et al. 2009; Burke et al. 2015, Carleton & Hsiang 2016) have highlighted how the impacts produced by these risks can rather robustly hinder the promotion of economic growth paths, reducing the role of investments by businesses as a driver of wealth production in the economic system. Despite this longevity, only in recent years have studies begun to investigate the impacts of climate change on financial assets and the management of financial institutions (Dietz et al., 2016; Dafermos et al., 2018). In particular, the effects produced by natural disasters manifest themselves with greater intensity to the detriment of SMEs which, representing the foundation of global, national, and local markets, supporting 50% of global GDP, constitute the main source of profitability of banking institutions. In this regard, research by UNDRR (2021) highlights that 75% of the losses produced by natural disasters affect this category of businesses more than any other actor. This also confirms the slower pace with which SMEs can react to the manifestation of the aforementioned risks, unlike larger companies. Despite the proven benefits, SMEs currently do not invest enough in risk prevention and reduction activities.

As already mentioned, such investments have a high profitability thanks to a reduced impact and faster recovery times: an analysis produced by the UNDRR (2021) suggests that the adoption of resilience measures can reduce up to a third of disaster losses for SMEs. However, despite a strong overall business case, SMEs do not invest enough, with the adoption rate of these investments being 10-20% lower than other businesses, depending on the sector and region.

A first assessment of the degree of awareness of the differences in climate risk compared to financial risks and therefore of the consequent changes in the policies and management of banking intermediaries is contained in a study by (Faiella and Malvolti, 2020). According to these authors, banks are not yet ready to manage climate risk because they do not have the availability of micro and macroeconomic models that help represent the transmission channels between the climate, the real economy, and the financial markets. The lack of information regarding these links makes it difficult to build new metrics for measuring climate risk and transition risk to achieve a more precise assessment of the institutions most exposed to the aforementioned risks.

Some interesting evidence regarding the reaction of credit institutions towards the physical and transition risk of climate change comes from the Regional Bank Lending Survey conducted by the territorial network of the Bank of Italy on a six-monthly basis (Angelico et al., 2022).

This survey involved over 250 intermediaries, located in the North (150) and the remainder equally distributed between the Center and South and the Islands. Climate risk management is not yet a widespread practice among Italian banks: only 13% of them evaluate the impact of climate risk (physical and transition) in the management of their portfolio compared to a much larger portion of 80%. which intends to do so in the future. Therefore, the integration of climate change risk into the landscape of risks (financial and otherwise) is a real challenge that should not be overlooked for the competitiveness and sustainability of the financial sector. Interventions in favour of this implementation are mainly a prerogative of the larger banks; in fact, around 25% of them have already started analyses on the topic of climate change. The group of banks that are most behind and have not yet undertaken assessments is mainly made up of cooperative credit banks (70% of intermediaries that have not yet started any activity). Most analyses were developed internally, with or without consultancy from external vendors. Banks are first and foremost oriented towards monitoring physical and transition risks over a short-medium term time horizon (3-5 years), aligned with the maturity structure of loans to non-financial companies.

Scenario analyses, and in particular stress tests, represent the tool most used by banks for climate risk management. This is because these tools adopt a forward-looking approach and allow the impact of different scenarios on the intermediaries' portfolios to be compared. Also, in this case, it is the larger banks (with a volume of loans over 1070 million) that are characterized by a greater ability to construct scenario analyses. The share of banks that have not yet planned to start these assessments is mostly made up of cooperative credit banks. Regarding the inclusion of physical risk in the assessment of customer credit risk, a very small share of respondents takes it into account in the assessment of the counterparty (for example by making use of risk maps), while over 40% intend to consider it in the future. The share is higher for banks with greater exposures (over 1070 million) for which it reaches 64%, for significant banks (equal to 100% of the sub-sample), and for those with registered offices in the North (approximately 50%). As regards the assessment of transition risk, over 90% of respondents (around 70% of the sample) planned to take it into account shortly. In this area, no significant differences are observed based on the exposures or location of the intermediaries. As a measure of transition risk, banks use the carbon intensity of their loans, i.e., the greenhouse gas emissions for each euro of credit disbursed to a certain counterparty. Only four banks declared that they know the carbon intensity of their credit portfolio and among these one is a significant bank. These results confirm the difficulty in finding granular information on the direct and/or indirect emissions of the counterparties. In the previous survey conducted in 2020, 95% of banks responding to the questionnaire stated that they had no information on counterparty issues.

This paper has a structure composed of three sections. After the introductory part, the first section offers a review of the literature on the impacts of climate and environmental risks on the strategies, management policies, and governance and control systems of banking intermediaries. The second section contains several empirical exercises aimed at estimating the effects of the efficiency of the energy system and also the risk of climate change on the stability of the banks present in the World Bank's "Environmental, Social and Governance-ESG" database for 192 countries in the period 2000 - 2021. Finally, we attempted to estimate the future trend of banking stability through a comparison between eight machine learning algorithms. The final section concludes.

1. Literature Review

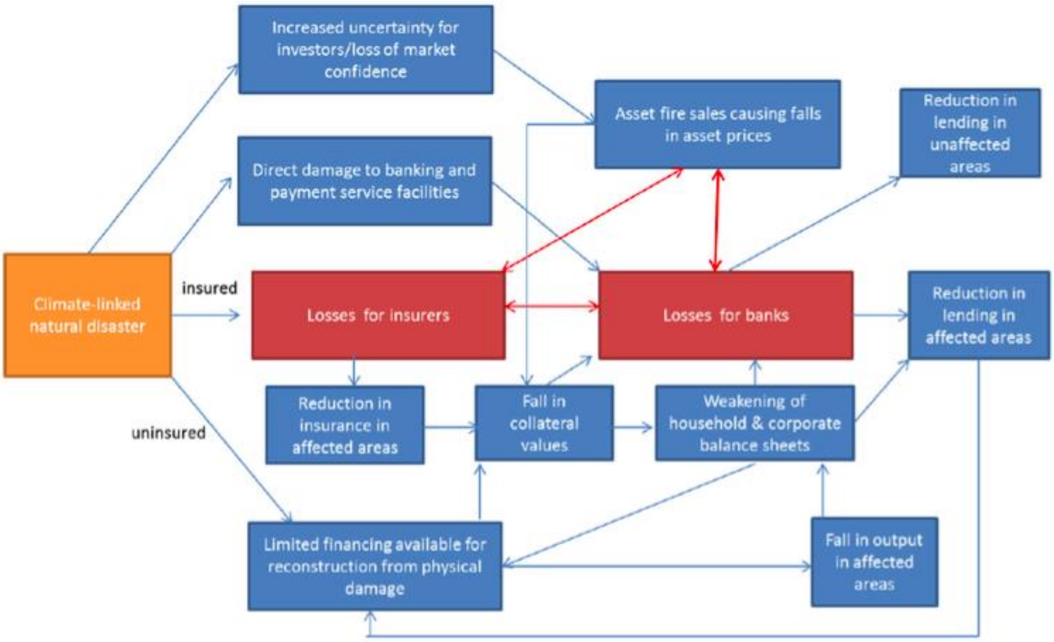
As highlighted by the ECB, we are still far from the perfect integration of the risks associated with the ecological transition with all the other types of purely financial risks, with the governance, management, and control systems. According to this authority, critical issues emerge in managerial practices, in the management of information and data collection necessary to ensure adequate monitoring of climate risk. These critical issues assess climate impacts on the financial system more difficult and consequently increase the difficulty of conceptualizing how environmental impacts - and policies for their mitigation - are transmitted to the real economy and the financial system. The acceleration to be given to this path is increasingly necessary, above all to be able to guarantee access to credit to those companies involved in sectors particularly affected by the issue of ecological and environmental transition. Businesses may be forced to slow down their investments and therefore their ability to contribute to the economic growth of their territories due to the destruction of their physical capital following environmental damage. This has as a consequence an increase in the physical risk connected to climate change and therefore an increase in debt levels to find further financial resources to complement those necessary for the reconstruction of plants, machinery, etc. Consequently, access to bank credit becomes more complex and banks faced with an increase in the number of non-performing loans can react by significantly reducing the supply of credit. Should these effects take on a systemic dimension, a risk of instability of the entire banking system may become increasingly evident.

More recent works also investigate the relationship between the probability of customer default and bank insolvency mediated by the physical risk associated with climate change (Kousky et al., 2020; Correa et al., 2023). The former demonstrates that following a flood event, the value of the properties used as collateral for bank loans is drastically reduced, resulting in a 2.6 - fold increase in the probability of insolvency after two years. This effect would be mitigated in the presence of insurance coverage. Correa et al. (2023), reveal an increase (between 5% and 10%) in the cost of bank loans (spread) applied to borrowers who are most sensitive to this type of risk. In this direction also Do et al. (2021) underline that banks charge higher interest rates to borrowers located in drought-affected areas. Javadi & Masum (2021) empirically demonstrate that firms located in drought-prone regions pay significantly higher spreads on their bank loans (with a spread compared to firms in other regions of approximately +4.4%). Huynh et al. (2020) demonstrate that the interest rate spread on loans is significantly higher for companies that target a customer segment that is more sensitive to climate risk. This tightening is even more marked (almost + 6%) referring to bank loans with long-term maturities aimed at companies with low ratings. Concerning the real estate market (Nguyen et al., 2022) show that credit institutions apply higher interest rates for mortgages on properties located in territorial areas most exposed to the risk of sea level rise (with a differential equal to + 7.5%

compared to companies located in less exposed areas). Kaza et al. (2014) find that mortgages for the purchase of highly energy-efficient houses are characterized by significantly lower risks (about less than a third) compared to those for less efficient houses. Guin et al. (2022), taking into consideration a sample of mortgages in the United Kingdom, evaluate how the riskiness of real estate mortgages is conditioned not only by the energy efficiency of the apartments but also by the solvency of the borrowers. They conclude that the energy efficiency of residential properties reduces the frequency of mortgage defaults and that this result does not change when controlling for other relevant determinants of mortgage default, such as borrower income and loan value.

Batten et al. (2016) highlighted the propagation mechanisms of physical risk within the financial sector (Figure 1). As can be seen from the red rectangles, the presence of less-performing insurance companies following natural disasters could lead to a reduction in their services and in the value of their securities, some of which are present in the portfolio of other credit institutions. According to Regelink et al. (2017), this ineffectiveness of insurance companies is reflected in the premiums requested in the Netherlands which do not perfectly reflect the extent of the flood risks caused by climate change and due to the presence of information asymmetries between the insurance company and the external consultancy firms that manage the evaluation models of these natural events. As can be seen in the lower part of the figure, in particular from the blue rectangles, if the companies are not insured, the reduction in the value of the assets used as guarantees for the credits entails a potentially greater loss for the banks following a greater insolvency of the customers. If the number of potentially impaired loans were particularly high and concerned increasingly larger territorial areas, this could cause a risk of instability in the entire banking system.

Figure 1. Transmission mechanisms of the effects of natural disasters on the financial sector



Source: Batten et al. (2016)

With reference to the second type of climate risk, the so-called transition risk, the inability to contain the emission of greenhouse gases to keep temperatures below 2 degrees centigrade could cause a decrease in the value of energy reserves and the infrastructure for their exploitation. Consequently, there would be an unbridled rush to sell energy securities used as guarantees in bank loans to energy companies. Therefore, both types of climate risk (physical and transactional) can produce significant losses for banking operators. Another important study is the one by Lamperti et al. (2019) from which it emerges that climate change increases the frequency of banking crises, even reaching an increase rate of 148%. The interventions to rescue the banking institutions will entail costs of between 5-15% of the gross domestic product and an increase in the public debt/GDP ratio of 2%. This, causing a departure from the parameters of economic convergence established by the Maastricht Treaty, can put the economic and financial stability of the Member States to the test.

According to the authors, approximately 20% of these effects on the real economy are caused by the worsening of the financial situation of the banks. In light of these results, financial intermediaries can play a key role in the assessment of climate impacts, and ignoring them would lead to an incomplete assessment. Furthermore, financial regulation will have to act as a tool for mitigating climate risks. In order not to be damaged by climate risks, banks must quickly re-modulate the maturities of loans within their portfolio. The transmission channel of the effects of climate risk on the other important type of banking risk, i.e. credit risk, acts through the expiry of loans (Acharya et al., 2023). Brar et al. (2021) demonstrate that there are sectors that show greater sensitivity to climate risks. Among these, are primarily the agricultural sector in Canada which requires a more robust assessment by credit institutions of the riskiness of bank loans. This sensitivity is accentuated in the poorest countries in which the agricultural sector produces the majority of the gross domestic product (Kraemer & Negrilla, 2014; de Bandt, Jacolin, & Lemaire, 2021).

Concerning transition risk, many studies empirically demonstrate the effect of higher risks and spreads on bank loans to businesses and mortgages. Delis et al. (2023) test whether banks charge higher interest rates to fossil fuel firms. The main conclusions they reach are two:

- fossil fuel companies obtain loans more easily than non-fossil fuel companies;
- more green finance-oriented banks offer higher-priced credit to fossil fuel firms. This type of industry has probably, over the years, shown a greater dependence on bank loans than on risk capital financing (equity securities). All this has generated an increase in the demand for bank loans by fossil fuel companies and consequently this increase in the spread.

Furthermore, as highlighted by several studies (Faiella & Cingano, 2015; Faiella & Mistretta, 2015; Lavecchia, 2015) the transition risk could cause an increase in inflation because climate policies could require the use of alternative energy sources that are currently more expensive. Since energy goods are considered necessary goods for satisfying consumer needs and for business investments (therefore with an inelastic demand) all of this would have the ultimate effect of worsening the vulnerability of these subjects. There is also a transition risk of climate change represented by possible effects related to the implementation of new climate and energy policies by companies (primarily a reduction in the value of company assets). Precisely concerning this type of climate risk, (Battiston et al., 2017) highlighted that the amount of banks' loans to carbon-intensive sectors (most vulnerable to this type of risk) is higher than their total capital.

Concerning the relationship between the physical risk of climate change and market risk, the pioneering work is that of Bansal et al. (2016). They, looking at the US stock market between 1934 and 2014, demonstrate that positive changes in temperature trends will reduce stock valuations. Lööf & Stephan (2019) identify positive impacts produced by higher ESG scores in terms of higher stock returns for European listed companies in the period 2005-2017 (also with similar results Viviani et al., 2019; Burger et al., 2022). Therefore, ESG factors can be considered fundamental components for reducing the volatility of financial assets. In this regard, Capelli et al. (2023) propose the construction of a new metric for measuring market risk which, by putting together traditional methodologies (VaR-Value at risk) and ESG factors, can predict unexpected losses more precisely. Furukawa et al. (2020) show that corporate bond and stock prices reflect the physical risk impact of climate change. However, these prices reflect only a few events that are exceptional in terms of the intensity of their effects rather than all available events. In the same vein, (Goldsmith-Pinkham et al., 2022), considering the US municipal bond market, conclude that municipalities exposed to short-term flood risks have premiums that diverge over time compared to those of municipalities far from coastal areas.

Recent studies share the conclusion that expectations of climate shocks are not contained in stock prices. Therefore, investors do not fully anticipate the economic impacts of heat as a first-order physical climate risk. In this regard, (Hong et al., 2019) demonstrate that drought risk is not a determinant of stock prices of food companies operating especially in those regions/countries that have not suffered severe damage from drought for 20-30 years. Addoum et al. (2023), concerning US companies, show that although their profitability is greatly influenced by rising temperatures, stock prices do not respond immediately to thermal shocks. Pankratz et al. (2023) also reach similar results, taking samples of companies outside the USA as reference. Contrary to the latter results, (Alok et al., 2019) demonstrate that portfolio managers consistently devalue stocks related to disaster areas to a much greater extent than managers of distant mutual funds. Concerning the relationship between climate change transition risk and market risk, (Bolton & Kacperczyk, 2021a, 2021b) demonstrate that investors require a higher expected excess return to invest in the securities of companies with higher greenhouse gas emissions both for those operating in the United States and outside. This creates a certain discrepancy in stock prices between various countries. According to these two authors, this extra return would offset the tax on carbon emissions to be paid or other regulatory measures relating to the transition to a low-emission economy. This carbon tax grows proportionally to the size of companies. Bua et al. (2022) studied the climate risk premium on European stock markets and demonstrated a climate risk premium of 7.05% and 6.14% on average per year after 2015, for transition and physical risk, respectively. Dai (2020) arrives at opposite results, according to which there are no significant differences in the ex-ante returns of securities in terms of companies' greenhouse gas emissions.

According to studies of Aswani et al. (2021) and European Central Bank (2022), the presence of excess returns requested by investors in equity securities is strongly conditioned by the quality of the information on climate risk made available not by individual borrowers but rather by banks and third parties who manage financial databases. Disclosures about ESG exposures and issues by companies also impact the equity risk premium by reducing risks for investors (Bolton & Kacperczyk, 2022; Krueger et al., 2023).

In addition to impacts on the cost of bank loans, climate risks can also impact loan volumes. Banks could ration credit to businesses located in territorial areas most exposed to natural events, instead of diverting resources to greener areas. In this regard, (Pagliari, 2023) focuses on territorial banks which, although dimensionally considered to be less significant financial institutions, tend to be more rooted in the territories most subject to flooding and more susceptible to suffering shocks linked to climate change. Concerning the category of local banks, (Chavaz, 2016) investigates the reaction of the mortgage market to the 2005 hurricane season in the USA. They conclude that local banks have been making more loans to businesses in affected areas, but, at the same time, they are selling a larger share of new mortgages on the secondary market. Other studies investigate how banks' behaviour changes following these natural shocks. Blickle et al. (2022) find that disasters increase the demand for loans. Reghezza et al. (2022) find that, following the Paris Agreement, European banks reduced credit to polluting companies. Jung et al. (2023) also reach similar results for US banks. Concerning the relationship between the physical risk of climate change and loan volumes, (Meisenzahl, 2023) finds that after 2015, US banks significantly reduced lending to the areas most affected by floods and fires. These reductions penalized high credit-risk borrowers and products the most (while low-risk borrowers continued to benefit from increased financing although located in the most affected areas).

Accetturo et al. (2022) measure the ability of banks to finance the green transition in Italy by estimating the probability of companies starting green projects conditional on bank lending. Therefore, Italian banks appear to favour the energy and environmental transition. Mueller & Sfrappini (2022) conclude that while US banks appear not to favour the provision of loans to companies less sensitive to the issue of energy and climate transition, European banks reward companies that will instead be more penalized by the new regulation on the subject environmental.

2. Estimating the Green Trilemma

In the following analysis, we took into consideration the analysis of the Green Trilemma. Energy efficiency was estimated using the "*Energy intensity level of primary energy*". Banking stability was approximated through the variable "*Bank nonperforming loans to total gross loans (%)*", and climate risk through the variable "*Land Surface Temperature*". In our analysis, we will therefore try to evaluate whether these elements can all be positively connected with the ESG model. That is, we ask ourselves whether the optimization of the ESG model can be compatible with the simultaneous increase in energy efficiency, reduction of climate risk and increase in banking stability.

2.1. Estimation of the Value of Energy Efficiency within the ESG Model

In the following analysis, we take into consideration the relationship between the value of energy efficiency in the ESG context. In this regard, three different econometric models will be proposed to evaluate the connection between energy efficiency and each of the three components of the ESG model i.e.: E-Environment, S-Social and G-Governance. We will therefore first highlight the relationships of energy efficiency with each of the components of the ESG model and then give an overall opinion on the impact of the ESG model on energy efficiency.

2.1.1. Estimation of Value of Energy Efficiency with Respect to the E-Environmental Dimension in the ESG Model

Specifically we have estimated the following equation:

$$EE_{it} \cong -EIL_{it} = \alpha + \beta_1(CDD)_{it} + \beta_2(SNFD)_{it} + \beta_3(ME)_{it} + \beta_4(FA)_{it} + \beta_5(FFEC)_{it} + \beta_6(TMPA)_{it} + \beta_7(ASNRD)_{it} + \beta_8(GHG)_{it} \quad (1)$$

where: i = 193 and t = [2011;2022].

Table 1. Estimation of the relationship between energy efficiency and environment within the ESG model

Estimation of the relationship between energy efficiency and environment within the ESG-model								
	WLS				Pooled OLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
Const	-0.47	0.12	<0.0001	***	-494.477	0.902852	<0.0001	***
ASNRD	-0.10	0.02	<0.0001	***	-0.4571	0.067838	<0.0001	***
SNFD	1.45	0.10	<0.0001	***	414.616	0.212706	<0.0001	***
CDD	16.50	3.15	<0.0001	***	28.799	339.569	<0.0001	***
FA	0.03	0.00	<0.0001	***	0.100057	0.019313	<0.0001	***
FFEC	0.04	0.00	<0.0001	***	0.047306	0.014386	0.001	***
GHG	-9.00	2.04	<0.0001	***	-738.673	194.135	0.0001	***
ME	1.05	0.06	<0.0001	***	257.446	0.170223	<0.0001	***
TMPA	-0.09	0.00	<0.0001	***	-0.120902	0.05082	0.0175	**
	Fixed-effects				Random-effects			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
Const	-921.413	28.802	<0.0001	***	-807.849	735.851	<0.0001	***
ASNRD	-0.778452	0.0977195	<0.0001	***	-0.746405	0.09558	<0.0001	***
SNFD	311.117	0.349044	<0.0001	***	328.237	0.342084	<0.0001	***
CDD	377.793	233.859	<0.0001	***	272.184	199.824	<0.0001	***
FA	274.472	0.0872986	<0.0001	***	241.499	0.081217	<0.0001	***
FFEC	0.0421787	0.0126895	0.0009	***	0.040211	0.012495	0.0013	***
GHG	-144.629	174.035	<0.0001	***	-153.935	170.602	<0.0001	***
ME	231.695	0.263794	<0.0001	***	241.781	0.258789	<0.0001	***
TMPA	-0.134624	0.0432566	0.0019	***	-0.138262	0.04261	0.0012	***

We found that EIL is positively associated to:

- CDD: is a measurement designed to track energy use. It is the number of degrees that a day's average temperature is above 18°C (65°F). Daily degree days are accumulated to obtain annual values. There is a positive relationship between the value of EIL and the value of CDD;
- SNFD: is calculated as the product of unit resource rents and the excess of roundwood harvest over natural growth. There is a positive relationship between the value of SNFD and the value of EIL;
- ME: are those stemming from human activities such as agriculture and from industrial methane production. There is a positive relationship between the value of ME and the value of EIL;
- FA: is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens. There is a positive relationship between the value of FA and the value of EIL;
- FFEC: comprises coal, oil, petroleum, and natural gas products. There is a positive relationship between the value of FEEC and the value of EIL. There is a positive relationship between the value of FFEC and the value of EIL.

We found that EIL is negatively associated to:

- TMPA: are totally or partially protected areas of at least 1,000 hectares that are designated by national authorities as scientific reserves with limited public access, national parks, natural monuments, nature reserves or wildlife sanctuaries, protected landscapes, and areas managed mainly for sustainable use. Marine protected areas are areas of intertidal or subtidal terrain - and overlying water and associated flora and fauna and historical and cultural features--that have been reserved by law or other effective means to protect part or all of the enclosed environment. Sites protected under local or provincial law are excluded. There is a negative relationship between the value of TMPA and the value of EIL;

- ASNRD: is the sum of net forest depletion, energy depletion, and mineral depletion. Net forest depletion is unit resource rents times the excess of roundwood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. There is a negative relationship between the value of ASNRD and the value of EIL,
- GHG: refers to changes in atmospheric levels of all greenhouse gases attributable to forest and land-use change activities, including but not limited to (1) emissions and removals of CO2 from decreases or increases in biomass stocks due to forest management, logging, fuelwood collection, etc.; (2) conversion of existing forests and natural grasslands to other land uses; (3) removal of CO2 from the abandonment of formerly managed lands (e.g. croplands and pastures); and (4) emissions and removals of CO2 in soil associated with land-use change and management. For Annex-I countries under the UNFCCC, these data are drawn from the annual GHG inventories submitted to the UNFCCC by each country; for non-Annex-I countries, data are drawn from the most recently submitted National Communication where available. Because of differences in reporting years and methodologies, these data are not generally considered comparable across countries. Data are in million metric tons. There is a negative relationship between the value of GHG and the value of EIL.

We can see that in a broad sense the value of EIL tends to be positively connected with the E-Environment component within the ESG context. However, EIL growth should be considered as negatively associated with energy efficiency. That is, the growth of EIL indicates the presence of low energy efficiency. It therefore follows that the positive relationship between EIL and E-Environment means that there is a negative relationship between energy efficiency and E-Environment value in the context of the ESG model.

2.1.2. Estimation of the Value of Energy Efficiency with Respect to the S-Social Dimension in the ESG Model

Specifically, we have estimated the following equation:

$$EE_{it} \cong -EIL_{it} = \alpha + \beta_1(PUSMS)_{it} + \beta_2(PO)_{it} + \beta_3(MR)_{it} + \beta_4(AE)_{it} + \beta_5(ACFTC)_{it} + \beta_6(AGRR)_{it} + \beta_7(PA65)_{it} \quad (2)$$

where: i =193 and t = [2011;2022].

Table 2. Estimations of the relationship between energy efficiency and the S-Social Dimension within the ESG model

Estimations of the relationship between energy efficiency and s-social within ESG model								
	Pooled OLS				Fixed-effects			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
Const	0.53236	1.09699	0.6275		103.215	8.67383	<0.0001	***
ACFTC	-0.0463615	0.0193198	0.0165	**	-0.173796	0.026761	<0.0001	***
AE	-0.0464934	0.0147595	0.0017	***	-0.068804	0.0171408	<0.0001	***
AGRR	-2.04884	0.3252	<0.0001	***	-1.38104	0.322814	<0.0001	***
MR	-0.0045044	0.0005689	<0.0001	***	-0.002617	0.0005328	<0.0001	***
PUSMS	-0.057072	0.0134468	<0.0001	***	0.802408	0.104789	<0.0001	***
PA65	0.770667	0.0324978	<0.0001	***	-13.7744	0.823556	<0.0001	***
PO	0.146085	0.028703	<0.0001	***	0.136609	0.037295	0.0003	***
	Random-effects				WLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
Const	55.2039	18.2703	0.0025	***	0.454106	0.15861	0.0042	***
ACFTC	-0.124912	0.0257646	<0.0001	***	-0.00914	0.0025234	0.0003	***
AE	-0.0456983	0.0166261	0.006	***	-0.010468	0.0016997	<0.0001	***
AGRR	-1.50971	0.315671	<0.0001	***	-0.353382	0.104368	0.0007	***
MR	-0.0028992	0.0005207	<0.0001	***	0.0138337	0.0016242	<0.0001	***
PUSMS	0.786758	0.10022	<0.0001	***	-0.006732	0.0023471	0.0042	***
PA65	-8.63191	0.643944	<0.0001	***	0.0622182	0.0185409	0.0008	***
PO	0.146047	0.0364757	<0.0001	***	0.0815035	0.0036642	<0.0001	***

We found that the level of energy efficiency is positively associated with:

- PUSMS: is the percentage of people using improved sanitation facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines: ventilated improved pit latrines, compositing toilets or pit latrines with slabs. There is a positive relationship between the value of PUSMS and EIL;
- PO: is the percentage of adults ages 18 and over whose Body Mass Index (BMI) is 30 kg/m² or higher. Body Mass Index (BMI) is a simple index of weight-for-height, or the weight in kilograms divided by the square of the height in meters. There is a positive relationship between the value of PO and EIL;
- MR: is the probability per 1,000 that a new-born baby will die before reaching age five, if subject to age-specific mortality rates of the specified year. There is a positive relationship between the value of MR and EIL.

We also find that the level of energy efficiency is negatively associated with:

- AE: is the percentage of population with access to electricity. Electrification data are collected from industry, national surveys and international sources. There is a negative relationship between the value of AE and EIL;
- ACFTC: is the proportion of total population primarily using clean cooking fuels and technologies for cooking. Under WHO guidelines, kerosene is excluded from clean cooking fuels. There is a negative relationship between the value of ACFTC and EIL;
- AGRR: is computed as the annualized average growth rate in per capita real consumption or income of the bottom 40% of the population in the income distribution in a country from household surveys over a roughly 5-year period. There is a negative relationship between the value of AGRR and EIL;
- PA65: is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. There is a negative relationship between the value of PA65 and EIL.

We can see that the value of EIL tends to be negatively correlated with the value of S-Social within the ESG model. However, since the increase in EIL tends to reduce energy efficiency then we can deduce that there is a positive relationship between energy efficiency and the value of the S-Social component. That is, in countries where the value of the S-Social component tends to grow, there is also a growth in energy efficiency measured as a reduction in the EIL value.

2.1.3. Estimation of the Value of Energy Efficiency with Respect to the G-Governance Dimension in the ESG Model

Specifically, we have estimated the following equation:

$$EE_{it} \cong -EIL_{it} = \alpha + \beta_1(GDPG)_{it} + \beta_2(GE)_{it} + \beta_3(RQ)_{it} + \beta_4(RDE)_{it} + \beta_5(SEPS)_{it} \quad (3)$$

where: i = 193 and t = [2011;2022]

Table 3. Estimations of the relationship between energy efficiency and the G-Governance dimension within the ESG model

Estimations of the relationship between energy efficiency and g-governance within ESG model								
	Random Effects				WLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	4.20486	1.05967	<0.0001	***	2.01651	0.096783	<0.0001	***
GDPG	-0.18085	0.04967	0.0003	***	0.077596	0.013934	<0.0001	***
GE	-5.96931	0.388357	<0.0001	***	-1.48558	0.175804	<0.0001	***
RQ	3.86901	0.093556	<0.0001	***	0.751533	0.163579	<0.0001	***
RDE	2.63403	0.302844	<0.0001	***	0.759216	0.083698	<0.0001	***
SEPS	-2.26433	0.09711	<0.0001	***	-0.346267	0.108952	0.0015	***
	Fixed Effects				Pooled OLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	4.42264	0.417481	<0.0001	***	4.70064	0.411515	<0.0001	***
GDPG	-0.17367	0.051146	0.0007	***	-0.238789	0.053751	<0.0001	***
GE	-6.27513	0.431551	<0.0001	***	-6.83889	0.304034	<0.0001	***
RQ	3.68409	0.100121	<0.0001	***	4.61383	0.095642	<0.0001	***
RDE	3.84708	0.366069	<0.0001	***	0.604542	0.191135	0.0016	***
SEPS	-2.64404	0.126169	<0.0001	***	-2.15656	0.081863	<0.0001	***

We found that the level of EIL is positively associated to:

- RQ: captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5. There is a positive relationship between the value of RQ and EIL.
- RDE: includes both capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education and Private non-profit. R&D covers basic research, applied research, and experimental development. There is a positive relationship between the value of RDE and EIL.

We also found that the level of EIL is negatively associated to:

- GDPG: is the annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2015 prices, expressed in U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. There is a negative relationship between the value of GDPG and EIL.
- GE: captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e., ranging from approximately -2.5 to 2.5. There is a negative relationship between the value of GE and EIL.
- SEPS: is the gender parity index for gross enrolment ratio in primary and secondary education is the ratio of girls to boys enrolled at primary and secondary levels in public and private schools. There is a negative relationship between the value of SEPS and EIL.

We can see that the value of EIL tends to be negatively correlated with the value of G-Governance within the ESG model. However, since the increase in EIL tends to reduce energy efficiency then we can deduce that there is a positive relationship between energy efficiency and the value of the G-Governance component. That is, in countries where the value of the G-Governance component tends to grow, there is also a growth in energy efficiency measured as a reduction in the EIL value.

2.2. Estimation of the Banking Stability in the ESG Framework

In the following analysis, we take into consideration the relationship between the value of banking stability in the ESG context. In this regard, three different econometric models will be proposed to evaluate the connection between banking stability and each of the three components of the ESG model i.e.: E-Environment, S-Social and G-Governance. We will therefore first highlight the relationships of banking stability with each of the components of the ESG model and then give an overall opinion on the impact of the ESG model on banking stability. We approximate the value of banking stability using the bank nonperforming loans to total gross loans (%).

2.2.1. Estimation of Value of Banking Stability with Respect to the E-Environmental Dimension in the ESG Model

Specifically, we have estimated the following equation:

$$BS_{it} \cong BNPL_{it} = \alpha + \beta_1(NRD)_{it} + \beta_2(AFF)_{it} + \beta_3(EIL)_{it} \quad (4)$$

where: i = 137 and t = [2010;2022].

We found that BS is positively associated with

- AFF: corresponds to ISIC divisions 1-3 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 4. Note: For VAB countries, gross value added at factor cost is used as the denominator. There is a positive relationship between BS and AFF.
- EIL: is the ratio between energy supply and gross domestic product measured at purchasing power parity. Energy intensity is an indication of how much energy is used to produce one unit of economic output. Lower ratio indicates that less energy is used to produce one unit of output. There is a positive relationship between EIL and BS.

Table 4. Banking stability and the E-Environmental component within the ESG model

Banking stability and the e-environmental component within the ESG model								
	Pooled OLS				Fixed-effects			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
Const	5.59265	0.434368	<0.0001	***	-0.8877	1.44434	0.5389	
NRD	0.163599	0.035938	<0.0001	***	-0.3089	0.05675	<0.0001	***
AFF	0.173171	0.022669	<0.0001	***	0.40317	0.0937	<0.0001	***
EIL	-0.19383	0.083836	0.0209	**	1.07874	0.24883	<0.0001	***
	Random-effects				WLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	2.67211	1.19556	0.0254	**	4.37442	0.12618	<0.0001	***
NRD	-0.24655	0.051501	<0.0001	***	0.13183	0.02081	<0.0001	***
AFF	0.247835	0.059274	<0.0001	***	0.18046	0.00894	<0.0001	***
EIL	0.54826	0.185698	0.0032	***	-0.1074	0.02099	<0.0001	***

We also found that BS is negatively associated with:

- NRD: is the sum of net forest depletion, energy depletion, and mineral depletion. Net forest depletion is unit resource rents times the excess of roundwood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. There is a negative relationship between NRD and BS.

We found that BS tends to be positively associated to the E component of the ESG model. That is, countries that perform well in environmental terms tend to also perform well in terms of banking stability. This relationship could be a manifestation of the Environmental Kuznets Curve-EKC, that is, that particular rule of thumb that states that countries with high per capita income are more likely to successfully implement sustainable economic policies than countries with low per capita income. Countries with high per capita income also tend to have high levels of banking stability.

2.2.2. Estimation of the Value of Banking Stability with Respect to the S-Social Dimension in the ESG Model

Specifically, we have estimated the following equation:

$$BS_{it} \cong BNPL_{it} = \alpha + \beta_1 (PUSM)_{it} + \beta_2 (SEP)_{it} + \beta_3 (UT)_{it} \tag{5}$$

where: i = 137 and t = [2010;2022].

Table 5. Banking stability and the S-Social component within the ESG model

Banking stability and the s-social component within the ESG model								
	WLS				Random-effects			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
Const	20.5554	1.07044	<0.0001	***	18.4641	4.0994	<0.0001	***
PUSM	-0.051933	0.0029742	<0.0001	***	-0.073032	0.0226393	0.0013	***
SEP	-0.143225	0.00975852	<0.0001	***	-0.123046	0.0340138	0.0003	***
UT	0.394994	0.0253021	<0.0001	***	0.773315	0.0635002	<0.0001	***
	Fixed-effects				Pooled OLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
Const.	226.934	637.7	0.0004	***	22.9878	2.68906	<0.0001	***
PUSM	-0.145276	0.0615694	0.0185	**	-0.053223	0.00831528	<0.0001	***
SEP	-0.117307	0.0382153	0.0022	***	-0.159164	0.0243716	<0.0001	***
UT	0.842292	0.0709012	<0.0001	***	0.477631	0.0454143	<0.0001	***

We found that BS is positively associated to:

- UT: refers to the share of the labour force that is without work but available for and seeking employment. There is a positive relationship between UT and BS.

We also find that BS is negatively associated to:

- PUSM: is the percentage of people using drinking water from an improved source that is accessible on premises, available when needed and free from faecal and priority chemical contamination. Improved water sources include piped water, boreholes or tubewells, protected dug wells, protected springs, and packaged or delivered water. There is a negative relationship between PUSM and BS.
- SEP: is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Primary education provides children with basic reading, writing, and mathematics skills along with an elementary understanding of such subjects as history, geography, natural Environmental, Social and Governance We found that BS is positively associated with the S component of the ESG model. That is, countries that have a greater orientation towards social policies, inclusion, removal of inequality and fight against poverty also tend to have better results in terms of banking stability. This relationship may be because generally the level of social inclusiveness and well-being tends to grow with per capita income together with banking stability.

2.2.3. Estimation of the Value of Banking Stability with Respect to the G-Governance Dimension in the ESG Model

Specifically we have estimated the following equation:

$$BS_{it} \cong BNPL_{it} = \alpha + \beta_1(LFPR)_{it} + \beta_2(NM)_{it} + \beta_3(PS)_{it} \quad (6)$$

where: i = 137 and t = [2010;2022].

Table 6. Estimation of the relationship between banking stability and G-Governance dimension within the ESG model.

Estimation of the relationship between Banking Stability and G-Governance								
	Fixed-effects				Random-effects			
	Coefficient	*Std. Error*	p-value		Coefficient	Std. Error	p-value	
const	47.5913	5.34094	<0.0001	***	28.5893	3.63336	<0.0001	***
LFPR	-0.603977	0.0792168	<0.0001	***	-0.324525	0.0528813	<0.0001	***
NM	-2.77E-06	1.32E-06	0.0358	**	-2.23E-06	1.23E-06	0.0701	*
PS	-2.69162	0.603103	<0.0001	***	-1.76267	0.489933	0.0003	***
	WLS				Pooled OLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	15.1992	0.705438	<0.0001	***	15.6553	1.45026	<0.0001	***
LFPR	-0.141751	0.010206	<0.0001	***	-0.129896	0.0212864	<0.0001	***
NM	-2.42E-06	3.77E-07	<0.0001	***	-1.95E-06	1.00E-06	0.0523	*
PS	-0.933208	0.115679	<0.0001	***	-1.38816	0.256159	<0.0001	***

Specifically, we found that the level of BS is negatively associated with:

- LFRP: is the proportion of the population ages 15 and older that is economically active: all people who supply labour for the production of goods and services during a specified period. There is a negative relationship between LFRP and BS.
- NM: is the net total of migrants during the period, that is, the number of immigrants minus the number of emigrants, including both citizens and noncitizens. There is a negative relationship between NM and BS.
- PS: measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5. There is a negative relationship between PS and BS.

Results show that the level of BS is negatively associated with the level of the G-Governance component in the context of the ESG model. This result may appear paradoxical. However, we must consider that not all high per capita income countries that generally perform well in terms of BS also perform well in terms of governance. For example, the USA has less than excellent values in terms of Political Stability and other essential indicators for evaluating governance within ESG models.

2.3. Estimate the Value of Climate Risk in the ESG Framework

In the following analysis, we take into consideration the relationship between the value of climate risk in the ESG context. In this regard, three different econometric models will be proposed to evaluate the connection between climate risk and each of the three components of the ESG model i.e.: E-Environment, S-Social and G-Governance. We will therefore first highlight the relationships of climate risk with each of the components of the ESG model and then give an overall opinion on the impact of the ESG model on climate risk. We approximate the value of climate risk using the Land Surface Temperature-LST.

2.3.1. Estimation of the Value of Climate Risk with Respect to the E-Environment Dimension in the ESG Model

Specifically we have estimated the following equation:

$$CR_{it} \cong LST_{it} = \alpha + \beta_1(NFD)_{it} + \beta_2(CDD)_{it} + \beta_3(EIL)_{it} + \beta_4(PM2.5)_{it} \quad (6)$$

where: *i* = 193 and *t* = [2011; 2022].

Table 7. Estimation of the Relationship between Climate Risk and E-Environment.

Estimation of the Relationship between Climate Risk and E-Environment								
	Pooled OLS				Fixed-effects			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	14.2027	0.354035	<0.0001	***	21.2648	0.45118	<0.0001	***
ASNRD	0.32937	0.0510244	<0.0001	***	0.07276	0.02678	0.0067	***
CDD	0.00313	7.04E-05	<0.0001	***	0.00196	0.00013	<0.0001	***
EIL	-0.3121	0.0543984	<0.0001	***	-0.2927	0.03675	<0.0001	***
PM2.5	0.09606	0.0091004	<0.0001	***	-0.0459	0.00956	<0.0001	***
	Random Effects				WLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	20.1822	0.723282	<0.0001	***	14.3053	0.08714	<0.0001	***
ASNRD	0.07744	0.026382	0.0033	***	0.35292	0.01996	<0.0001	***
CDD	0.00223	0.0001136	<0.0001	***	0.0031	1.85E-05	<0.0001	***
EIL	-0.2948	0.0360074	<0.0001	***	-0.311	0.00596	<0.0001	***
PM2.5	-0.0326	0.0091684	0.0004	***	0.09547	0.00195	<0.0001	***

We found that the level of CR is positively associated to:

- NFD: is calculated as the product of unit resource rents and the excess of roundwood harvest over natural growth. There is a positive relationship between CR and NFD.
- CDD: is a measurement designed to track energy use. It is the number of degrees that a day's average temperature is above 18°C (65°F). Daily degree days are accumulated to obtain annual values. There is a positive relationship between CDD and NFD.
- PM2.5: is the percent of population exposed to ambient concentrations of PM2.5 that exceed the WHO guideline value is defined as the portion of a country's population living in places where mean annual concentrations of PM2.5 are greater than 10 micrograms per cubic meter, the guideline value recommended by the World Health Organization as the lower end of the range of concentrations over which adverse health effects due to PM2.5 exposure have been observed. There is a positive relationship between PM2.5 and CR.

We also find that the level of CR is negatively associated to:

- EIL: is the ratio between energy supply and gross domestic product measured at purchasing power parity. Energy intensity is an indication of how much energy is used to produce one unit of economic output. Lower ratio indicates that less energy is used to produce one unit of output. There is a poso

We find that the level of CR is negatively associated with the E-Environmental component within the ESG model. The level of CR increases with the reduction of the E-Environmental component.

2.3.2. Estimation of the Value of Climate Risk with Respect to the S-Social Dimension in the ESG Model

Specifically, we have estimated the following equation:

$$CR_{it} \cong LST_{it} = \alpha + \beta_1 (LEB)_{it} + \beta_2 (PA65)_{it} + \beta_3 (SEPS)_{it} \quad (7)$$

where i = 193 and t = [2011; 2022].

Table 8. Estimation of the relationship between Climate Risk and S-Social dimension within the ESG model

Estimation of the relationship between Climate Risk and S-Social dimension within the ESG model								
	Fixed-effects				Random-effects			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	-5.96593	4.17507	0.1536		2.26568	4.13443	0.5837	
GI	0.044678	0.024275	0.0662	*	0.051429	0.023728	0.0302	**
LEB	0.161534	0.045345	0.0004	***	0.114337	0.043663	0.0088	***
PA65	0.343516	0.040977	<0.0001	***	0.325633	0.040088	<0.0001	***
SEPS	6.91337	2.59966	0.0081	***	6.71236	2.54798	0.0084	***
	Pooled OLS				WLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	38.9013	6.74975	<0.0001	***	35.0053	2.92372	<0.0001	***
GI	0.527093	0.040164	<0.0001	***	0.511654	0.014305	<0.0001	***
LEB	-0.129547	0.064497	0.045	**	-0.148606	0.018851	<0.0001	***
PA65	-0.392095	0.069254	<0.0001	***	-0.357344	0.0213	<0.0001	***
SEPS	-23.1713	7.16983	0.0013	***	-17.5547	3.45928	<0.0001	***

We found that the level of CR is positively associated with:

- GI: measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus, a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality. There is a positive relationship between CR and GI.

We also found that the level of CR is negatively associated with:

- LEB: indicates the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. There is a negative relationship between LEB and CR.
- PA65: is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. There is a negative relationship between PA65 and CR.
- SEPS: is the gender parity index for gross enrolment ratio in primary and secondary education is the ratio of girls to boys enrolled at primary and secondary levels in public and private schools. There is a negative relationship between SEPS and CR.

Results suggest that the level of CR is negatively associated with the E-Environmental component within the ESG-Model.

2.3.3. Estimation of the Value of Climate Risk with Respect to the G-Governance Dimension in the ESG Model

Specifically, we have estimated the following equation:

$$CR_{it} \cong LST_{it} = \alpha + \beta_1 (ESRP)_{it} + \beta_2 (PS)_{it} + \beta_3 (PSHW)_{it} \quad (8)$$

where: i = 193 and t = [2011;2022].

We found that the level of CR is negatively associated to:

- ESRP: Economic and social human rights ensure that all people have access to the basic goods, services, and opportunities necessary to survive and thrive.
- PS: Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.
- PSHW: Women in parliaments are % of parliamentary seats in a single or lower chamber held by women.

Table 9. Estimation of the relationship between climate risk and G-Governance

Estimation of the relationship between climate risk and G-Governance								
	Pooled OLS				Fixed-effects			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	53.9111	1.89945	<0.0001	***	17.1964	1.26109	<0.0001	***
ESRP	-12.5277	0.864124	<0.0001	***	2.84463	0.576148	<0.0001	***
PS	-2.48009	0.254635	<0.0001	***	-0.386083	0.108446	0.0004	***
PSHW	-0.104053	0.0181081	<0.0001	***	0.0196881	0.00581146	0.0007	***
	Random-effects				WLS			
	Coefficient	Std. Error	p-value		Coefficient	Std. Error	p-value	
const	18.803	1.48365	<0.0001	***	55.2933	0.714815	<0.0001	***
ESRP	2.19236	0.562156	<0.0001	***	-13.2819	0.339867	<0.0001	***
PS	-0.44747	0.106892	<0.0001	***	-2.14692	0.104095	<0.0001	***
PSHW	0.0194436	0.00575138	0.0007	***	-0.091281	0.00667088	<0.0001	***

Finally, we found that the level of CR is negatively associated with the G-Governance component within the ESG model.

2.4. Can We Solve the Trilemma? Relationship between the Value of Banking Stability, Energy Efficiency and Climate Risk in the Context of the ESG Model

Below we summarize the equations that we estimated with our model with an indication of the effects for both the individual E, S and G components and the overall impact on the ESG model.

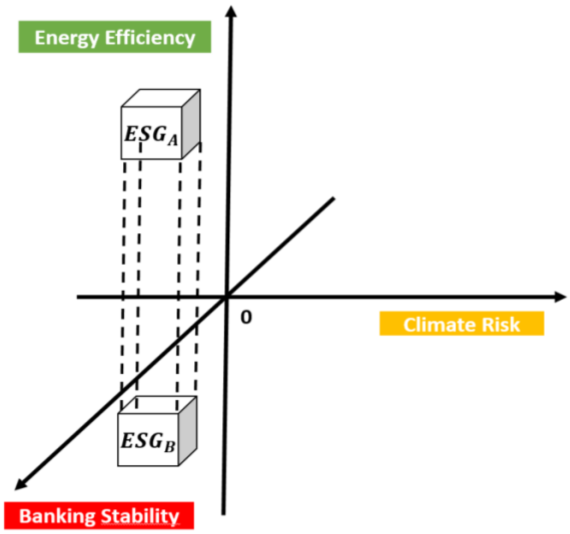
The analysis therefore demonstrates the impossibility of solving the Green Trilemma. In fact, by implementing the ESG model in the countries considered it is possible to obtain positive results in terms of increased banking stability and reduction of climate risk. However, energy efficiency tends to be negatively associated with value when applying the ESG model. It follows that the application of the ESG model does not allow the achievement of the three indicated objectives at the same time. The analysis also demonstrates that environmental sustainability issues should probably be addressed differently compared to energy issues. In fact, even countries that have an interest in realizing the environmental transition may still have problems in applying models that are sustainable from an energy point of view. The energy issue seems to be the element that risks derailing the application of ESG models on a large scale. Especially in the current international context characterized by Sino-American tension, the Russian-Ukrainian war and Israel's war against Hamas in Gaza.

Indeed, in this context we are witnessing significant pressure in the energy markets. Furthermore, the energy question becomes even more decisive, especially in light of the decisions of the USA and the European Union to apply reindustrialisation. The investment in reindustrialization made by both the American administration led by Biden and desired by the European Commission risks creating greater demand for energy in Europe. Furthermore, the need to support Ukraine against Russia through the growth of the military industry could further increase the use of energy for industrial purposes. Added to this significant growth in energy demand in the USA and Europe is also the choice to focus on electric cars, which could require further energy consumption. In short, it seems that there is a contradiction between environmental sustainability and the energy issue that should be resolved through adequate industrial policies. Probably one way to resolve the issue could consist in the split between energy economic policies and environmental economic policies. In fact, it is necessary to consider that the energy sector is strategic for countries, especially in periods of growing political-military tension at an international level. In this sense, it seems very unlikely, at least in the short term, to be able to create an energy production system that is completely compatible with ESG principles, especially from an environmental point of view.

Table 10. Synthesis of equations applied to estimate relationships of EE, BS & CR in respect to components of ESG model

Synthesis of the equations and their relationships with either the individual ESG components or the overall ESG effect			
	Equations	Relationship	Overall ESG effect
Energy efficiency and environment	$\mathrm{EIL_{it}} = \alpha + \beta_1(\mathrm{CDD})_{it} + \beta_2(\mathrm{SNFD})_{it} + \beta_3(\mathrm{ME})_{it} + \beta_4(\mathrm{FA})_{it} + \beta_5(\mathrm{FFEC})_{it} + \beta_6(\mathrm{TMPA})_{it} + \beta_7(\mathrm{ASNRD})_{it} + \beta_8(\mathrm{GHG})_{it}$	Negative	NEGATIVE
Energy efficiency and social	$\mathrm{EIL_{it}} = \alpha + \beta_1(\mathrm{PUSMS})_{it} + \beta_2(\mathrm{PO})_{it} + \beta_3(\mathrm{MR})_{it} + \beta_4(\mathrm{AE})_{it} + \beta_5(\mathrm{ACFTC})_{it} + \beta_6(\mathrm{AGRR})_{it} + \beta_7(\mathrm{PA65})_{it}$	Positive	
Energy efficiency and governance	$\mathrm{EIL_{it}} = \alpha + \beta_1(\mathrm{GDPG})_{it} + \beta_2(\mathrm{GE})_{it} + \beta_3(\mathrm{RQ})_{it} + \beta_4(\mathrm{RDE})_{it} + \beta_5(\mathrm{SEPS})_{it}$	Positive	
Banking stability and environment	$\mathrm{BNPL_{it}} = \alpha + \beta_1(\mathrm{NRD})_{it} + \beta_2(\mathrm{AFF})_{it} + \beta_3(\mathrm{EIL})_{it}$	Positive	POSITIVE
Banking stability and social	$\mathrm{BNLP_{it}} = \alpha + \beta_1(\mathrm{PUSM})_{it} + \beta_2(\mathrm{SEP})_{it} + \beta_3(\mathrm{UT})_{it}$	Positive	
Banking stability and governance	$\mathrm{BNLP_{it}} = \alpha + \beta_1(\mathrm{LFPR})_{it} + \beta_2(\mathrm{NM})_{it} + \beta_3(\mathrm{PS})_{it}$	Negative	
Climate risk and environment	$\mathrm{LST_{it}} = \alpha + \beta_1(\mathrm{NFD})_{it} + \beta_2(\mathrm{CDD})_{it} + \beta_3(\mathrm{EIL})_{it} + \beta_4(\mathrm{PM2.5})_{it}$	Negative	NEGATIVE
Climate risk and social	$\mathrm{LST_{it}} = \alpha + \beta_1(\mathrm{LEB})_{it} + \beta_2(\mathrm{PA65})_{it} + \beta_3(\mathrm{SEPS})_{it}$	Negative	
Climate risk and governance	$SLT_{it} = \alpha + \beta_1(ESRP)_{it} + \beta_2(\mathrm{PS})_{it} + \beta_3(\mathrm{PSHW})_{it}$	Negative	

Figure 2. Relationship between energy efficiency, climate risk and banking stability



Solving the Green Trilemma in the ESG context

We define the green trilemma as the possibility of improving energy efficiency, reducing climate risk and increasing banking stability through the optimization of the ESG model.

We can see that in an optimal condition we would find ourselves in position $\boldsymbol{ESG_A}$. That is, in position $\boldsymbol{ESG_A}$ we would have high energy efficiency, low climate risk and a positive value of banking stability. In the $\boldsymbol{ESG_A}$ case it would have been possible to obtain a positive resolution of the green trilemma.

However, as demonstrated by the econometric analysis conducted, only two elements are positively connected with the ESG model, namely the reduction of climate risk and the growth of banking stability. On the contrary, energy efficiency appears to be negatively associated with the optimization of the ESG model. Therefore the green trilemma cannot be resolved within the ESG model. The equilibrium point is represented by the point $\boldsymbol{ESG_B}$.

Our analysis shows the impossibility of solving the green trilemma. Indeed, the implementation of the ESGF model tends to be negatively linked to the reduction of climate risk and the growth of banking stability. However, the application of the ESG model tends to be negatively associated with increasing energy efficiency

Conclusions

In this article we tried to verify whether it is possible to maximize energy efficiency, increase banking stability and reduce climate risk by implementing the ESG model globally. The results show that the application of ESG models allows increasing banking stability and reducing climate risk. However, through the application of the ESG model it is not also possible to increase energy efficiency. We therefore rejected the Green Trilemma hypothesis in connection with the application of ESG models. Our analysis suggests the need to separate energy issues from environmental questions within the ESGF model. In fact, the strategic role of the energy sector for the economic and political development of countries seems to be not completely compatible with the application of the ESG model.

Credit Authorship Contribution Statement

Conceptualization was jointly conducted by M. A. and A. L., laying the foundational ideas and framework for the study. Methodology development, including the design of procedures and approaches used in the research, was collaboratively executed by both authors. M. A. and A. L. also shared responsibilities for the development and application of the software necessary for data collection and analysis. The validation of results, ensuring the accuracy and reliability of the findings, was carried out by both M. A. and A. L. Supervision, overseeing the progress of the work and providing guidance, was a shared responsibility. Project administration, managing the project's execution and coordination, was jointly handled by both authors. Finally, funding acquisition, securing financial support for the research, was also a collaborative effort by M. A. and A. L. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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*** European Central Bank (2022): 2022 climate risk stress test, July

Appendix

List of Abbreviations	
Variables	Abbreviation
Access to clean fuels and technologies for cooking (% of population)	ACFTC
Access to electricity (% of population)	AE
Agriculture, forestry, and fishing, value added (% of GDP)	AFF
Annualized average growth rate in per capita real survey mean consumption or income, total population (%)	AGRR
Adjusted savings: natural resources depletion (% of GNI)	ASNRD
Bank nonperforming loans to total gross loans (%)	BNPL
Banking Stability	BS
Cooling Degree Days	CDD
Climate Risk	CR
Energy Efficiency	EE
Energy intensity level of primary energy (MJ/$2017 PPP GDP)	EIL
Economic and Social Rights Performance Score	ESRP
Forest area (% of land area)	FA
Fossil fuel energy consumption (% of total)	FFEC
GDP growth (annual %)	GDPG
Government Effectiveness: Estimate	GE
GHG net emissions/removals by LUCF (Mt of CO2 equivalent)	GHG
Gini index	GI
Life expectancy at birth, total (years)	LEB
Labour force participation rate, total (% of total population ages 15-6G) (modelled ILO estimate)	LFPR
Land Surface Temperature	LST
Methane emissions (metric tons of CO2 equivalent per capita)	ME
Mortality rate, under-5 (per 1,000 live births)	MR
Adjusted savings: net forest depletion (% of GNI)	NFD
Net migration	NM
Adjusted savings: natural resources depletion (% of GNI)	NRD
Population ages 65 and above (% of total population)	PA65
PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	PM2.5
Prevalence of overweight (% of adults)	PO
Political Stability and Absence of Violence/Terrorism: Estimate	PS
Proportion of seats held by women in national parliaments (%)	PSHW
People using safely managed drinking water services (% of population)	PUSM
People using safely managed sanitation services (% of population)	PUSMS
Research and development expenditure (% of GDP)	RDE
Regulatory Quality: Estimate	RQ
School enrolment, primary (% gross)	SEP
School enrolment, primary and secondary (gross), gender parity index (GPI)	SEPS
Adjusted savings: net forest depletion (% of GNI)	SNFD
Terrestrial and marine protected areas (% of total territorial area)	TMPA
Unemployment, total (% of total labour force) (modelled ILO estimate)	UT