# Green financial policies and banks' risk-taking behavior

**Tiago F. A. Matos**

University of the Azores, School of Business and Economics, Rua da Mãe de Deus, s/n, 9501-801 Ponta Delgada, Portugal

Centre of Applied Economics Studies of the Atlantic (CEEAplA), Rua da Mãe de Deus, s/n, 9501-801 Ponta Delgada, Portugal

*Corresponding author e-mail*: tiago.fa.matos@uac.pt / ORCID: 0000-0002-8371-0715

**João C. A. Teixeira**

University of the Azores, School of Business and Economics, Rua da Mãe de Deus, s/n, 9501-801 Ponta Delgada, Portugal

Centre of Applied Economics Studies of the Atlantic (CEEAplA), Rua da Mãe de Deus, s/n, 9501-801 Ponta Delgada, Portugal

E-mail: joao.ca.teixeira@uac.pt / ORCID ID: 0000-0003-4774-0236

**Tiago M. Dutra**

University of the Azores, School of Business and Economics, Rua da Mãe de Deus, s/n, 9501-801 Ponta Delgada, Portugal;

Business Research Unit (BRU-IUL), Avenida das Forças Armadas, 1649-026 Lisbon, Portugal.

E-mail: tiago.m.dutra@uac.pt / ORCID ID: 0000-0002-3501-9612

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**Abstract**

This study examines the impact of climate-related financial policies on banks' risk-taking behavior. Based on a sample of 614 banks across 37 countries from 2006 to 2020, we find that stronger green financial policies lead to a reduction in bank risk from a total risk perspective. Conversely, when examining credit risk, we find an inverse relationship in which higher levels of commitment to green policies induce an increase in non-performing loans, translating into higher credit risk. Finally, we complement this analysis by showing that the dampening effect of green policies on bank risk is stronger in developing countries and during crises. These results stand when using different proxies for bank risk and green financial policies.

*JEL Classification: G01, G21, G28, Q58.*

*Keywords:* Banks' risk, climate-related financial policies, green credit, sustainability.

## 1. Introduction

Climate change and environmental issues have garnered the attention of policymakers and researchers due to their impact on the overall economy, financial markets, and banking industry (Grippa et al., 2019; Shirai, 2023). This has urged the intervention of central banks and policymakers through the conception of financial regulations aimed at integrating sustainable practices in the financial industry (Carney, 2015; Shirai, 2023) and ensuring that banks incorporate climate-related factors in their risk assessment processes (Cigu et al., 2020). Since the banking sector plays a pivotal role in meeting the financial needs of the private sector by providing credit and private investments (Beck and Demirguc-Kunt 2006; Wang 2016; European Banking Federation, 2017; Scholtens and Klooster, 2019), it serves as a conduit for promoting private sustainable investments.

Many studies have analyzed the impact of green credit on bank performance and competitiveness (Luo et al. 2021; Galan and Tan, 2022), banks' non-performing loans (Cui et al., 2018; Al-Qudah et al., 2022), and the overall economy, with respect to carbon emissions (D'Orazio and Dirks, 2021) and other macroeconomic aspects (Allen et al., 2020). Overall, the existing literature demonstrates a positive relationship between banks' performance and their environmental commitment, attributing such dampening effect not only to reduced exposure to climate risks (Chavaz, 2016; Noth & Schüwer, 2023; Lee et al., 2024), but also to improved social reputation (Liu and Huang, 2022; Feng et al., 2024) and to reduced loan portfolio risk (Cui et al., 2018; Feridun and Güngör, 2020; Höck et al., 2020; Umar et al., 2021; Al-Qudah et al., 2023; An et al., 2023).

However, there is a notable gap in understanding how enforcing green policies might influence banks' risk-taking dynamics (Scholtens and Klooster, 2019; An et al., 2023). This study aims to fill this gap.

Using a sample of 614 banks across 37 countries from 2006 to 2020, we find that stronger climate-related financial policies result in a reduction in bank risk from a total risk perspective. Additionally, from a credit risk perspective, we find an inverse relationship in which higher levels of commitment to green policies induce an increase in the bank's non-performing loans, translating into higher credit risk.

Extending our analysis by evaluating this dampening effect across developed and developing countries, we demonstrate that this effect is stronger in the latter. Furthermore, we show that stronger green financial policies can induce a greater reduction in bank risk during crises, associating such effects with the bank's increased social reputation when lending to sustainable projects.

The contributions of this study are multifold. First, it contributes to the literature on how green financial policies influence banks' risk-taking behavior. Second, to the best of our knowledge, this is the first empirical study to analyze how this relationship might influence banks located in developing countries differently and how these policies might influence banks' risk-taking behavior during crises. While some studies focus on specific countries such as China (Feng et al., 2014; Cui et al., 2018; Zhou et al., 2022; Liu and Huang, 2022; An et al. 2023) or the United Arab Emirates (Al-Qudah et al., 2022), this paper goes one step further by analyzing how these policies can influence different countries according to their level of economic development. Finally, this study can help policymakers utilize green financial policies to reduce the banking system's exposure to environmental risks and even financial shocks, considering that our database contains many countries worldwide that are diversified both geographically and in terms of economic development. Further, it acts as a wake-up call considering the ramifications of these policies in terms of the exposure of the loan portfolio, which might prove to be fragile in times of economic uncertainty.

The remainder of this paper is organized as follows. Section 2 briefly reviews the literature examining how the implementation of green macroprudential policies can induce banks to increase their green credit allocation and examines its potential impact on banks’ risk-taking behavior. Section 3 describes the data and variables used and explains the empirical analysis. Section 4 discusses the results and presents additional robustness tests. Finally, Section 5 summarizes the conclusions.

## 2. Literature review and hypothesis development

### 2.1. The effect of climate-related financial policies on bank risk

Climate change can influence monetary policies and financial regulations (Batten et al., 2016; Coeuré, 2018) due to shocks in supply prices and market volatility as a consequence of inflationary pressure on spreads, saving rates, and real interest rates arising from uncertainty (Pfister and Valla, 2021; D'Orazio and Popoyan, 2022). Since banks are as vulnerable as any other company (Thompson and Cowton, 2004), policymakers have started implementing a green prudential framework, aiming at increasing banks' green credit allocation to safeguard against any environmental or climate-related risks within the economy and financial system.

In this context, the literature refers to climate-related financial policies or green prudential policies as the guidelines or policies implemented by policymakers to promote sustainable and environmentally friendly practices in the banking sector (Chen et al., 2023), and increase green credit, that is, loans toward businesses or projects focusing on green, clean energy or environmental sustainability, including upgrades from traditional industries (Aizawa and Yang, 2010; Akomea-Frimpong et al., 2022).

The impact of climate change on the banking industry can materialize through two primary risks: physical risk, channeled through damage to property and infrastructure caused by natural disasters (Batten et al, 2016; Prudential Regulation Authority, 2018; Grippa et al., 2019; European Parliament, 2021); and transitional risk arising from regulatory changes, through which the late adaptation to a green policy framework can lead to greater risk due to increased consumer consciousness and market sentiment (Grippa et al., 2019; European Parliament, 2021) and, consequently, a decrease in the value of some assets (Prudential Regulation Authority, 2018; European Parliament, 2021). Furthermore, stranded assets, arising from transitional risk, can cause a “Minsky” moment, where a sudden collapse of the assets’ value can lead to financial instability, potentially causing a cascade effect throughout the entire financial system (Minsky, 1982; Carney, 2015; European Systemic Risk Board, 2016; Battiston et al., 2017).

The literature supports the idea that implementing green prudential policies and increasing banks’ green credit allocation can effectively reduce bank risk (Feridun and Güngör, 2020; Neitzert and Petras, 2022; Vanishvili and Katsadze, 2022). This theory is based on the portfolio diversification theory, which states that banks can reduce their loan portfolio risk by diversifying toward green, renewable, and low-carbon industries, thus reducing the weight of common and traditional investments in their loan portfolios (Luo et al., 2021). Since these traditional investments have a higher environmental risk, banks can reduce their exposure and improve their asset quality (An et al., 2023) by increasing green lending.

On this matter, studies by Cui et al. (2018), Umar et al. (2021), Al-Qudah et al. (2023) and Pyka and Nocon (2023) show that banks with higher green loan allocation have reduced non-performing loans and, consequently, improved credit quality. This effect is attributed to the lower volatility of the borrower’s earnings (Umar et al., 2021) and to the diversification theory aforementioned. This influence is also observed on a macro level, as Choudhury et al. (2023a) show that banks have lower default probability in countries with a larger share of renewable energy to their total energy supply.

Market sentiment also contributes to this dampening effect. In the past few years, investor interest in sustainability factors has increased, in addition to the traditional triad investment factors, that is, profitability, risk, and liquidity (Ambec and Lanoie, 2008; Rhodes, 2010). Therefore, by utilizing this growing public awareness of environmental issues, banks can attract deposits and investments from environmentally conscious investors by increasing their green credit allocation (Lingnau et al., 2022; Huang et al., 2023; Choudhury et al., 2023b; Mirza et al., 2023). The empirical findings of Liu and Huang (2022), Nietzert and Petras (2022) and Feng et al. (2024) also verify this effect by showing that an increase in banks' activity with respect to green credit leads to an improvement in their social reputation and operating performance, as it enhances their financial risk management capabilities. Additionally, Wu and Shen (2013) and Ciciretti et al. (2014) show that higher levels of green credit allocation allow banks to reduce their funding costs for both debt and equity. Moreover, Jing et al. (2022) show that during the COVID-19 pandemic, companies with better sustainability levels were more resilient to shocks, associating this effect with increased stakeholder confidence. On this matter, the empirical findings of Jing et al. (2022) demonstrate that banks can take advantage of their increased social reputation to decrease their market volatility during periods of distress.

Since banks' performance depends on the financial health of their clients (Zhou et al., 2022), banks can reduce their credit risk in the long run by increasing green lending. This theory is based on the fact that some firms struggle to adapt sustainability activities and face a higher risk of default (Belloni et al., 2022). Therefore, although these difficulties might increase short-term bank risk (Godfrey, 2008), the surviving firms will eventually have better environmental performance, higher operational efficiency, innovation, and, consequently, better financial performance (Zhou et al., 2022), thus reducing the banks' credit risk associated with such lenders. Moreover, Alogoskoufis et al. (2021) show that these short-term costs, which ultimately reduce the impact of transitional risk, are outweighed by the potential losses derived from sluggish implementation because it would imply an increase in physical risk in the long run as physical events causing these risks would become recurrent (Belloni et al., 2022).

However, this risk reduction effect is not linear across countries or even across banks in the same country. According to Weber et al. (2008), it is critical that banks include environmental and social risks in their credit risk assessments to avoid non-performing loans arising from green credit. Furthermore, experience and information asymmetries between banks can also explain why green credit influence banks differently, as suggested by Zhou et al. (2022). Therefore, the effect of implementing climate-related policies aiming at increasing green credit may not have a linear effect across all banks.

Finally, Lee et al. (2024) analyze how stricter environmental policies may impact banks' risk and find that stricter policies lead to reduced bank risk through the development of a greener economy. This effect is explained by the reduction in climate risks in greener economies, considered in the literature as a threat for financial stability and performance (Chavaz, 2016; Noth & Schüwer, 2023).

Hence, we test the hypothesis that the early implementation of green macroprudential policies, triggering an increase in banks' green credit allocation, results in banks' asset risk reduction, channeled through not only improved portfolio risk management but also enhanced social and market reputation, leading to an increase in deposits and, consequently, lowering funding costs.

### 2.2. The dark side of green financial policies

Another strand of the literature suggests that an increase in lending toward sustainable projects, due to the implementation of a green prudential framework, could lead to an increase in bank risk. According to Steckel et al. (2016) and Akomea-Frimpong et al. (2022), a lack of standardization in these industries can cause information asymmetry issues, which may cause banks to struggle to assess the risk of investing in such projects.

Furthermore, Chen et al. (2023) show that banks can deteriorate their credit quality by investing in green credit projects, as they are prone to environmental risks, thus impacting the banks’ earnings and, consequently, increasing the risk of withholding loan repayments. The findings of Park and Kim (2020) also support this theory that increased green lending leads to banks taking more risks, from a credit risk perspective.

The empirical findings of Zhou et al. (2022) also support the damaging effects of an increase in banks’ credit portfolio toward sustainable projects. They show that green projects require higher capital investments and increased human resources, leading to an increase in operating costs and, consequently, reduced profitability. This increases the risk of default of these projects, thereby resulting in increased non-performing loans for banks.

On this matter, we might expect that implementing green policies and leading banks to increase lending towards sustainable projects to cause a deterioration in the banks’ loan portfolio quality, through increased non-performing loans, which ultimately translates into higher credit risk.

Therefore, we analyze the hypothesis that enforcing green macroprudential policies can lead to a higher credit risk.

## 3. Variables and methodology

### *3.1.Data and sample*

To conduct our analysis, we combined data from numerous sources. We focused on publicly listed commercial banks and bank-holding companies, gathering data on 614 banks between 2006 and 2020 from the BankFocus database provided by Bureau van

Dijk. For country-level variables, we collected data using DataStream, a financial time series database by Refinitiv.

Table 1 presents details of the sample distribution by country and year.

**[PLEASE INSERT TABLE 1 ABOUT HERE]**

Table 1 shows that the sample has an unbalanced panel data format. This is because not all of the 614 banks sampled were active during the sample period. Furthermore, this unbalanced format was caused by the fact that we dealt with outliers by winsorizing the final sample at the 1% and 99% percentiles of the bank-level data and by excluding banks with negative equity.

### *3.2.Dependent variable*

In line with the existing research, this study used banks' asset risk as the primary measure of their individual risk. Following Gropp and Heider (2010), Claessens et al. (2014), Teixeira et al. (2020), and Dutra et al. (2023a), we calculated the asset risk of a bank by the standard deviation of asset returns, which reflects the yearly standard deviation based on the daily stock price returns, multiplied by the total market value of the bank's equity, over the total market value of the bank's assets. The market value of the bank's equity is computed as the stock price multiplied by the number of the bank's outstanding shares, while the total market value of the bank's assets is calculated as the sum of the market value of the banks' equity and the book value of the bank's liabilities.

This approach allowed us to capture two distinct components of risk, idiosyncratic risk and market risk, thus measuring the market effect on bank risk arising from a changing climate-related prudential framework, since the literature considers the market reaction as a channel through which green policies can influence banks' risk.

Furthermore, following Kato (2021), Al-Qudah et al. (2022), Matos et al. (2023) and Saliba et al. (2023), we used the bank's credit risk, measured by the ratio of loan loss provisions to total loans, to capture the effects of climate-related financial policies on the bank's loan portfolio. Finally, following existing research (Zhou et al., 2022; An et al., 2023; Dutra et al., 2023b; Matos et al., 2024a), we used the Z-score as a proxy for total bank risk as a robustness check, as this allows us to test whether our findings hold when the market influence is excluded.

### *3.3.Green macroprudential policies*

As a measure of countries' engagement in implementing climate-related policies, we used the Climate-Related Financial Policy (CRFP) index obtained from the novel database provided by D'Orazio (2023). This index measures five key areas: green prudential regulations, credit allocation policies, green financial principles, other disclosure requirements, and green bond taxonomy and issuing. It assigns a score based on the country's commitment and bindingness to the policies contained in these areas. This database presents four different specifications, in which D'Orazio (2023) assigns different weights to policy areas and considers the level of commitment. We chose to use index number one, where the policy areas are equally weighted, and the level of commitment to each policy is considered. In the robustness checks, we use index number 2, where the green prudential regulation and credit allocation areas have different weights. Overall, a higher score on both indexes indicates a higher commitment to climate-related policies.

To confirm the results, we rely on an alternative measurement for the green financial policies obtained from the Organisation for Economic Co-operation and

Development (OECD) Environment Statistics database, namely the environmental policy stringency (EPS) index. This variable is an internationally comparable measure of the degree of explicit or implicit price on polluting or environmentally damaging behavior considered in environmental policies. This index is widely used in the literature, as in Chen et al. (2022), Lee et al. (2024) and Fatima et al. (2024), as it is considered a credible measure of the effectiveness and robustness of environmental policies in place (Adai et al., 2022).

Overall, these variables provide us with comprehensive and standardized measures that can be used to assess banks' risk response to the level of engagement in each country.

*3.4.Country- and bank-level control variables*

The literature identifies bank-specific characteristics and macroeconomic variables as important determinants of banks' risk-taking behavior. Therefore, we included a set of bank-specific and macroeconomic variables to capture the time-invariant bank or country fixed effects that impact bank risk through different channels. The bank control variables include banks' profitability, leverage, size, operational efficiency (measured by the inverse of the cost-to-income ratio), income diversity, and asset diversity. As country control variables, we included the gross domestic product (GDP) growth rate, inflation rate, the macroprudential policies adjustments index and the level and slope of interest rates.

The source and definition of all these variables are summarized in Appendix I and their expected effects and respective empirical theory are presented in Appendix II.

*3.5.Empirical strategy*

We assess whether implementing climate-related financial policies can reduce bank risk. To achieve this, we use the following empirical specifications:

$$Risk_{i,j,t} = \alpha + \beta_1 Risk_{i,j,t-1} + \beta_2 CRFP_{j,t} + \beta_3 BankControl_{i,t} + \beta_4 CountryControl_{j,t} + Year_t + \varepsilon_{i,j,t} \ , \quad (1)$$

where the dependent variable $Risk_{i,j,t}$ indicates risk for bank *i*, located in country *j* in year *t*; *and CRFP* is an index of climate-related financial policies for country *j* in year *t*. *BankControl* and *CountryControl* are sets of idiosyncratic bank characteristics and macroeconomic/external variables, respectively, which are typically used as control variables in the literature. The variable $Year_t$ captures time-specific fixed effects, allowing us to control for the exogenous impact on the dependent variable not attributed to the endogenous variables. Finally, since we use a dynamic model, the one-period lagged dependent variable is included to measure banks' risk persistence over time due to inter-temporal risk smoothing and competition and to capture the response to banking regulations, as proposed by Delis and Kouretas (2011).

Dynamic panel data specifications may face endogeneity issues. Furthermore, commonly used models such as ordinary least squares (OLS) or maximum likelihood estimation (MLE) only remain consistent when the sample comprises a large number of observations. We address these challenges by employing an autoregressive model, namely the system generalized method of moments (sGMM)[1]. This model differs from other approaches in that it focuses on specific moments, known as moment conditions, of random variables, instead of making assumptions about the entire distribution.

[1] We also conducted additional analyses using Random Effects (RE) and Fixed Effects (FE) models, in addition to a Two-Stage Least Squares (2SLS) estimation to account for endogeneity. The results of these robustness checks, which support the main findings, are available upon request.

Additionally, this approach is particularly effective in scenarios with a large N and a short T timeframe (Blundell and Bond, 1998; Roodman, 2009). To assess the consistency of the sGMM estimator, we examine two key assumptions: the absence of serial correlation among errors and the absence of instrument proliferation. To do so, we rely on two diagnostic tests: the Hansen test of overidentifying restrictions and the autoregressive test. The first test evaluates the global validity of the instruments by analyzing the specified moment conditions, while the second test, proposed by Arellano and Bond (1991), checks for serial correlation in the error term, ε.

Finally, to evaluate whether the effects of green financial policies are consistent regardless of a country's economic development, we divide the sample according to the level of economic development of the country, following Alam et al. (2019), and use the following interaction model:

$$\begin{aligned} Risk_{i,j,t} &= \alpha + \beta_1 Risk_{i,j,t-1} + \beta_2 CRFP_{j,t} + \beta_3 EMDE\_Dummy_{j,t} + \\ &\beta_4 (CRFP \times EMDE\_Dummy)_{j,t} + \beta_5 BankControl_{i,t} + \\ &\beta_6 CountryControl_{j,t} + Year_t + \varepsilon_{i,j,t} \, . \end{aligned} \tag{3}$$

The *EMDE Dummy* variable, considered in Equation 3, is a dummy variable that takes the value of 1 if the bank is located in an emerging market/developing economy and 0 otherwise. This specification allows us to verify whether the impact of green financial policies depends on whether banks are located in developed or developing countries using the interaction term *CRFP*×*EMDE_Dummy*. This impact can be analyzed as follows:

$$\frac{\partial Risk_{i,j,t}}{\partial EMDE\_Dummy_{j,t}} = \beta_3 + \beta_4 CRFP_{j,t} \, . \tag{4}$$

This same approach is also adopted when we analyze the effect of green financial policies during systemic crises, by replacing the EMDE dummy variable with a crisis dummy variable that assumes a value of 1 in years of a systemic crisis and 0 otherwise, as follows:

$$Risk_{i,j,t} = \alpha + \beta_1 Risk_{i,j,t-1} + \beta_2 CRFP_{j,t} + \beta_3 Crisis_{j,t} + \beta_4 (CRFP \times Crisis)_{j,t} + \beta_5 BankControl_{i,t} + \beta_6 CountryControl_{j,t} + Year_t + \varepsilon_{i,j,t} \; . \tag{5}$$

In this specification, the *Crisis* variable is a dummy variable that assumes the value 1 in the years of the systemic banking crisis and 0 otherwise.

### *3.6.Descriptive statistics*

Table 2 reports the descriptive statistics for the main variables. Overall, the average bank in the sample presents a bank risk of 5.171% with profitability of 1.506% and leverage of 87.215%. The average country has a GDP growth of 1.640% and a 1.921% inflation.

**[PLEASE INSERT TABLE 2 ABOUT HERE]**

Figure 1 graphically represents the average bank risk for a preliminary analysis of the evolution of bank risk over the study period. Overall, bank risk presents a higher average in the 2007-08 years of the great financial crisis, whereas this average is lower in the year prior to this crisis, albeit increasing in the years of global uncertainty in the financial markets, such as Brexit and the US-China tariff war in 2016 and the COVID-19 pandemic in 2020.

**[PLEASE INSERT FIGURE 1 ABOUT HERE]**

Next, we explore the evolution of the CRFP index, as shown in Figure 2. The early evolution of this variable shows that green policies have been increasingly adopted over the past two decades, as shown in Panel A.

**[PLEASE INSERT FIGURE 2 ABOUT HERE]**

We further examined this variable by decomposing the sample according to the level of economic development of a country, that is, emerging markets and developing economies (EMDE) and advanced economies (AE), as graphically depicted in Panel B. From the figure, both groups of countries showed similar behavior regarding the growing implementation of climate-related financial policies in the 2006-2010 period. However, in 2008, the level of engagement with these policies decreased. This might be attributed to the focus of policymakers on addressing immediate financial stability problems arising from the Great Financial Crisis rather than focusing on the climate aspect, which also occurred during the COVID-19 Pandemic (Quatrini, 2021).

Furthermore, since 2010, EMDE countries have increased the implementation of these policies beyond the levels of AE countries. This behavior is consistent with the empirical evidence of the Organization for Economic Cooperation and Development (OECD, 2018) and D'Orazio (2022), who pointed out that after the 16$^{th}$ Conference of the Parties to the United Nations Framework Convention on Climate Change (COP16) in 2010, national funds have been flowing from developed countries to developing economies to enhance the engagement of the latter in policies aimed at tackling climate change. Therefore, we expect a boost in developing countries' engagement with climate-related financial policies after 2010.

## 4. Empirical Findings

We start by analyzing how adopting climate-related financial policies can influence bank risk. We then develop this analysis by specifying the effects according to the level of economic development of a country and by checking whether these effects are transversal to years of crises and regular years. Finally, we check the robustness of the results using different proxies for bank risk, namely the Z-score, and for the climate-related financial policies.

### 4.1. *The impact of green macroprudential policies on bank risk*

Table 3 presents the benchmark regressions used to analyze the effect of climate-related financial policies on bank risk.

**[PLEASE INSERT TABLE 3 ABOUT HERE]**

The first conclusion considers the statistical significance of all variables at the 1% level. Furthermore, the results show that bank risk tends to persist over time, because the lagged dependent variable is statistically significant, supporting the empirical findings of Delis and Kouretas (2011), Castro (2013), and Baselga-Pascual et al. (2015).

Focusing on the effects of climate-related financial policies on bank risk, we find that greater engagement in green financial policies leads banks to reduce their risk. Specifically, for each increase in the climate-related financial policies index of 10 basis points, there is a reduction in banks' asset risk of about 0.45%. This effect is supported by the theory of Luo et al. (2021), according to which banks can reduce their portfolio risk and exposure to physical risks in the long run by diversifying their loan portfolios toward green projects and reducing the weight of common investments.

Furthermore, since our measure of bank risk captures market risk, we can conclude that market sentiment affects how green policies influence bank risk. In other words, when banks increase their green credit allocation, they can boost their social reputation (Huang et al., 2023; Feng et al., 2024), attract environmentally conscious investors (Lingnau et al., 2022; Huang et al., 2023; Mirza et al., 2023), thereby reducing their debt and equity funding costs (Ciciretti et al., 2014).

## 4.2. *Additional analyses*

### 4.2.1. *The effect of climate-related financial policies on banks' credit risk*

Based on these conclusions, it is important to evaluate whether adopting climate-related financial policies can influence bank credit quality. We repeat the same regression using banks' credit risk as the dependent variable. The results are presented in Model 2 in Table 3.

As we can see, all variables remain statistically significant except for the banks' asset diversity. Furthermore, we can again visualize risk persistence over time because the lagged dependent variable remains statistically significant, thus further validating the choice of this model.

By examining the CRFP index, we find that when countries increase their engagement in green policies, especially when increasing the level of enforcement of such policies, banks' credit risk increase, materialized through an increase in their loan loss provisions. In other words, for each increase in the green policies index of 10 basis points, there is an increase in the banks' credit risk of 0.51% These results are consistent with the evidence presented by Godfrey (2008), Park and Kim (2020), and Chen et al. (2023) that an increase in green credit allocation can lead to an increase in banks' short-term credit risk. However, this effect is expected to be countered in the long term because the surviving firms will have higher operational efficiency and financial performance (Zhou et al., 2022), reflecting a reduction in credit risk.

#### 4.2.2. *The effect of the economic development level of a country: advanced economies vs emerging markets and developing countries*

The empirical literature indicates that engagement in global green policies varies from country to country (Network for Greening the Financial System, 2019; Official Monetary and Financial Institutions Forum, 2020; D'Orazio and Popoyan, 2022). Meanwhile, Pauw and Pegels (2013) and La Rovere et al. (2018) show that the public initiatives of developing countries toward green finance is very poor due to the low returns associated with these investments, although they increased substantially in the past decade due to the pledge made by the countries at COP16 (Organization for Economic Cooperation and Development, 2018). Therefore, it is important to evaluate whether these effects are transverse between these two groups of countries.

To do so, we estimated the previous model by applying the specification presented in Equation 3 and interacting the green financial policy index with the dummy variable related to developing economies (EMDE Dummy). The results are presented in Model 3 in Table 4 and graphically depicted in Figure 3.

**[PLEASE INSERT TABLE 4 ABOUT HERE]**

**[PLEASE INSERT FIGURE 3 ABOUT HERE]**

The results show that this effect is stronger in developing countries than in developed countries. This effect is validated by Mua (2017), who points out that green financial policies are particularly effective in developing countries because they reduce their exposure to international financial shocks, which are considered their main vulnerability (Alam et al., 2019). Furthermore, in Figure 3, we find an interesting pattern in which higher levels of engagement in green financial policies for EMDE countries amplify the effectiveness of these policies in reducing bank risk.

#### 4.2.3. *The effect of the crisis: the systemic crisis vs the COVID-19 pandemic*

During the recent COVID-19 pandemic in 2020, investments in the green economy were overlooked, and public interest in these investments decreased (Quatrini, 2021; Nguyen et al., 2023). It is therefore important to assess whether these effects persist during periods of economic uncertainty. To do so, we applied the specification presented in Equation 5 where we interact the green financial policies index with the dummy variable that takes the value of one in years of systemic crises. The results are displayed in Model 4 in Table 4 and illustrated in Figure 4.

**[PLEASE INSERT FIGURE 4 ABOUT HERE]**

Overall, all variables remained statistically significant. Furthermore, using Figure 4, we find that during crises, higher levels of engagement in green financial policies lead to a greater reduction in bank risk. From Table 5, which reports the marginal effects of this model through the delta method, this effect is only visible in countries with higher levels of green financial policy adoption, whereas countries below the turning point (*i.e.*, with a CRFP index below 30.39%) experience the opposite effect.

**[PLEASE INSERT TABLE 5 ABOUT HERE]**

These results are consistent with the empirical findings of Jing et al. (2022), who found that during the COVID-19 pandemic, companies with higher sustainability performance (*i.e.*, green firms) performed better and were more resilient than companies operating in traditional industries. This effect is associated with stakeholder theory, in which higher engagement in sustainable investments can lead to increased stakeholder confidence and reduced company risk (Dhaliwal et al., 2011; El Ghoul et al., 2011).

### 4.3. *Robustness checks*

#### 4.3.1. *Z-Score as the dependent variable*

To further confirm our results, following Bhagat et al. (2015), Danisman and Tarazi (2020), Lee et al. (2024), and Matos et al. (2024b), we used a different measure of bank risk, namely, the Z-score. This variable measures the variability in banks' returns that can be absorbed by banks' capital without such bank becoming insolvent. Therefore, higher values indicate less risky banks. We repeat Model 1 and present the results in Table 6.

**[PLEASE INSERT TABLE 6 ABOUT HERE]**

Overall, Model 5 validates our previous results, where higher levels of engagement in climate-related financial policies lead to an increase in banks' Z-score, thus reducing bank risk.

#### 4.3.2. *Different weighting for the policy areas*

Since the database introduced by D'Orazio (2023) provides three additional differentiated indexes[2] where the policy areas are differently weighted, we used index

[2] We conduct additional robustness checks by regressing Model 1 against the two remaining CRFP indexes presented by D'Orazio (2023). The results of these models validate our previous findings. Therefore, for simplification purposes, we do not present these regressions in this paper.

number two, where the prudential and credit allocation areas are differently weighted. This approach allowed us to test the sensitivity of our results to the weighting of each of the policy areas considered. The results are presented in Model 6 in Table 5.

Again, Model 6 confirms our earlier findings, indicating that higher levels of engagement in climate-related financial policies result in reduced bank risk.

#### 4.3.3. *The environmental policy stringency as a proxy for climate financial policies*

Finally, to validate our results, we proxy the green policies by using the environmental policy stringency variable applied to a sample solely composed by banks located in OECD countries. The results are presented in Models 7 and 8 in Table 7.

**[PLEASE INSERT TABLE 7 ABOUT HERE]**

Overall, the results support our previous findings. While a more stringent green framework leads to a reduction in banks' risk from the banks' asset risk perspective, visible by the negative estimated coefficient associated with this variable in Model 7, it also causes a deterioration in the banks' credit quality, materializing in an increase on banks' credit risk (Model 8).

## 5. Conclusion

The banking sector plays a vital role in the transition to a greener economy by providing capital to all economic sectors and bridging supply and demand. Therefore, policymakers have focused on implementing prudential policies aimed at increasing investments in green and sustainable projects. The existing literature has analyzed the effects of climate policies on the overall economy. Regarding the influence of these policies on bank risk, the empirical literature points out to contradictory effects, which makes this study relevant on understanding them.

The results provide evidence that the effects of implementing green financial policies are twofold. First, from an asset risk perspective, it causes a decline in bank risk since banks that have a higher share of green credit in their loan portfolio can boost their social reputations, exploit market sentiment, attract environmentally conscious investors, and reduce their debt and equity funding costs.

Second, from a credit risk perspective, adopting green financial policies and encouraging banks to invest in greener projects can increase banks' credit risk. This is channeled through increased lending to sustainable investments, as the empirical literature shows that these are traditionally riskier in the short term and less profitable, leading to an increase in banks' loan loss provisions.

In terms of the implications of these effects, the risk-dampening effect is found to be more expressive in developing countries, associating these results with the fact that an increase in banks' green lending can reduce exposure to international financial shocks, which is considered the main cause of concern in such countries.

Moreover, we find evidence that during crises, tightening green prudential policies can reduce bank risk. This effect can be achieved through the above-mentioned stakeholder theory, where banks that lend to green firms are considered less risky by investors and, therefore, can take advantage of increased stakeholder confidence and reduce their exposure to shocks and funding costs.

These results hold when we use the Z-score as the dependent variable, when we apply a different proxy to measure green policies, and also when we consider an index where these areas are differently weighted.

Our research has vital implications for policymakers and banks as it shows the dark side of green financial policies, where a larger share of green credit can introduce fragilities in terms of non-performing loans, which can be damaging during crises. While this fact does not constitute an impediment to the development of financial policies, it shows what policymakers should consider when analyzing the effectiveness of these policies. Nonetheless, to address this fragility, banks should diversify their green portfolios across multiple sectors to mitigate sector-specific risks and reduce their exposure to any single type of sustainable investment.

Moreover, the key implication that social reputation can motivate banks to engage in green lending to lower their fundings costs should also be considered by policymakers. On this matter, policymakers should implement more transparent and standardized reporting standards regarding the banks' green investments and their associated risk to provide investors with relevant, comprehensive and, more importantly, comparable information. This not only can help banks enhance their credibility but also help investors make informed decisions. In fact, this lack of standardization and the information asymmetries arising from it has been regarded in the literature as an important reason to explain the differences amongst different banks.

Furthermore, given that the risk-dampening effects of these policies are particularly pronounced in developing countries, policymakers in these countries should prioritize policies that incentivize green lending, as this would be beneficial not only from a financial stability perspective, but also from an environmental point of view.

However, notably, we do not consider the level of green loans in the individual banks' loan portfolios, which is an important limitation of this study. Thus, in future research, it would be important to evaluate whether the level of green loans in bank portfolios is a driver of bank risk, both during normal years and, more importantly, during crises, as implementing green financial policies might introduce unexpected fragilities in the banking system. While our study focuses on the short-term effects of implementing climate-related financial policies, future developments should focus on monitoring the effects of these policies over time, as this would provide policymakers with relevant information to adapt such policies.

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## Table 1.
**Sample distribution by country and year.**

Distribution of the sample by country, year and by the level of economic development, following the distribution presented by Alam et al. (2019). Each pair country/year presents the number of banks considered in the sample, as well as the total observations by country.

| Country | Type of country | Year | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | |
| Austria | AE | | | 4 | 4 | 4 | | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 7 | **62** |
| Belgium | AE | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | **11** |
| Brazil | EMDE | | | | | 2 | | 10 | | 11 | 8 | 8 | 10 | 9 | 12 | 13 | **83** |
| Bulgaria | EMDE | | | | | | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | **27** |
| Chile | EMDE | | | | | 2 | 2 | | | | | | | | 2 | | **6** |
| China | EMDE | | 5 | | 7 | | 9 | 8 | 9 | 15 | | | | | | | **53** |
| Colombia | EMDE | | | 2 | 2 | 1 | | 3 | 3 | 3 | 3 | | 3 | 2 | 2 | 2 | **26** |
| Cyprus | AE | | | | | 1 | | | | | | | | 1 | | | **2** |
| Czech Republic | AE | | | | 1 | 1 | 1 | 1 | | | | 1 | 2 | 2 | 1 | 1 | **11** |
| Denmark | AE | 2 | 3 | | 4 | 4 | 10 | 11 | 13 | 12 | | | | | 14 | 13 | **86** |
| Finland | AE | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 4 | 4 | **19** |
| France | AE | 3 | 3 | 5 | 6 | 4 | 4 | 5 | 5 | 6 | 5 | 5 | 4 | 5 | 5 | 5 | **70** |
| Germany | AE | 2 | 3 | 3 | 3 | 3 | 5 | 5 | 6 | 8 | 7 | 7 | 6 | 6 | 7 | 8 | **79** |
| Greece | AE | | 1 | | 1 | | 1 | | | | | 5 | | 5 | 5 | | **18** |
| Hungary | EMDE | | | | | | | | | | | | 1 | 1 | | 1 | **3** |
| India | EMDE | 5 | 6 | 7 | 6 | 9 | 10 | 10 | 12 | 11 | 15 | 18 | | 19 | 23 | 17 | **168** |
| Indonesia | EMDE | | 6 | 5 | 5 | 4 | 12 | 10 | 13 | 16 | 18 | 25 | 25 | | | | **139** |
| Ireland | AE | | | | | | | | 1 | 1 | | 1 | 4 | 4 | 4 | 4 | **19** |
| Italy | AE | 2 | 3 | 3 | 4 | 2 | 6 | 6 | 5 | 5 | 6 | 6 | 5 | 8 | 11 | 14 | **86** |
| Japan | AE | 17 | 20 | 16 | 31 | 21 | 22 | 25 | 18 | 20 | 17 | 20 | 26 | 22 | 19 | 21 | **315** |
| Lithuania | AE | | | | | | | 1 | 1 | | | | 1 | | 1 | 1 | **5** |
| Mexico | EMDE | | 2 | 2 | 2 | | 8 | | | | 9 | | | | | | **23** |
| Netherlands | AE | | 1 | 1 | 1 | 1 | 1 | | | 1 | | 1 | 2 | | | 2 | **11** |
| Norway | AE | | | | | | | 7 | 11 | 11 | | | | | | 23 | **52** |
| Peru | EMDE | | | | | | | 1 | | | | 4 | | | 1 | | **6** |
| Philippines | EMDE | 3 | 5 | 4 | 2 | | | | | 9 | 9 | | | | 11 | | **43** |
| Poland | EMDE | 1 | 1 | 1 | 4 | | | 4 | 5 | 4 | 3 | 5 | 4 | 5 | 4 | 5 | **46** |
| Portugal | AE | | | | | | | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | **10** |
| Russian Federation | EMDE | | | 1 | | | | | | | | | 9 | 9 | 8 | | **27** |
| Spain | AE | 4 | 4 | 5 | 5 | 5 | 4 | 5 | 6 | 5 | 5 | 6 | 6 | 6 | 6 | 5 | **77** |
| Sweden | AE | | | 3 | 3 | | | 3 | 3 | 3 | | | | | | 6 | **21** |
| Switzerland | AE | | | | | | | 6 | 5 | 6 | 6 | 6 | 5 | 6 | 7 | 6 | **53** |
| Thailand | EMDE | 2 | 2 | | | | | | | | | | | | | | **4** |
| Turkey | EMDE | 2 | | 2 | 5 | | | | | | | | | | | | **9** |
| Ukraine | EMDE | | | | | | | 2 | | | | | | 1 | 3 | 2 | **8** |
| United Kingdom | AE | 6 | 7 | 9 | | 9 | | 7 | | 7 | 8 | | | 15 | 15 | | **83** |
| United States of America | AE | | | 142 | 151 | 157 | 169 | 193 | 196 | 209 | 213 | 216 | 224 | 222 | 229 | 228 | **2 549** |
| **Total** | | **50** | **73** | **216** | **247** | **231** | **267** | **332** | **322** | **374** | **343** | **344** | **348** | **365** | **406** | **392** | **4 310** |

**Table 2.**
**Descriptive Statistics.**

| | N | Mean | St. Dev. | Min. | Max. | Distribution | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | **10th** | **50th** | **90th** |
| ***Banks' risk*** | | | | | | | | |
| Asset Risk | 4 310 | 5.171 | 10.476 | .000 | 79.802 | .311 | 1.700 | 11.982 |
| Credit Risk | 4 310 | 2.493 | 3.959 | .069 | 81.664 | .546 | 1.381 | 5.102 |
| Z-Score | 4 310 | .016 | .939 | -3.274 | 3.228 | -1.191 | .129 | 1.112 |
| ***Climate-related Financial Policy Indexes*** | | | | | | | | |
| CRFPI 1 | 4 310 | 27.454 | 17.243 | .000 | 86.667 | .000 | 33.333 | 46.667 |
| CRFPI 2 | 4 310 | 19.840 | 18.252 | .000 | 92.500 | .000 | 18.500 | 44.400 |
| EPS | 4 160 | 2.678 | .752 | .222 | 4.889 | 1.889 | 2.875 | 3.722 |
| ***Bank specific variables*** | | | | | | | | |
| Profitability (%) | 4 310 | 1.506 | 2.839 | -16.936 | 72.844 | .218 | 1.323 | 2.610 |
| Leverage (%) | 4 310 | 87.215 | 10.142 | 6.320 | 99.635 | 78.493 | 88.445 | 97.046 |
| LOG Size | 4 310 | 9,287 | 2.149 | .047 | 14.854 | 6.972 | 8.896 | 12.535 |
| Cost-income ratio | 4 310 | 63.358 | 14.843 | 3.743 | 141.282 | 45.798 | 62.979 | 80.908 |
| Asset diversity | 4 310 | .656 | .395 | .000 | 1.999 | .278 | .559 | 1.195 |
| Income diversity | 4 310 | .677 | .465 | -.219 | 2.450 | .204 | .564 | 1.363 |
| ***Macroeconomic variables*** | | | | | | | | |
| GDP Growth | 4 310 | 1.640 | 2.410 | -11.182 | 13.900 | -2.300 | 2.000 | 3.282 |
| Inflation | 4 310 | 1.921 | 1.641 | -1.700 | 13.300 | .200 | 1.741 | 3.103 |
| Macroprudential policies index | 4 310 | .819 | 2.190 | -9 | 13 | -1 | 1 | 3 |
| Level of interest rates (%) | 4 310 | 1.337 | 4.610 | -294.075 | 5.087 | .148 | 1.603 | 2.915 |
| Slope of interest rates (%) | 4 310 | 2.741 | 2.202 | -.579 | 31.313 | .786 | 2.270 | 5.865 |
| Concentration | 4 310 | 43.261 | 17.848 | .000 | 100 | 34.420 | 35.313 | 77.864 |
| Crisis | 4 310 | .171 | .376 | 0 | 1 | 0 | 0 | 1 |

## Table 3.

**Banks' risk models with the climate-related financial policies.**

Model 1 presents the effect of the climate-related financial policies on the banks' risk as measured by the bank's asset risk, calculated as the annualized standard deviation of daily stock price returns times the market value of equity over the market value of the bank. Model 2 represents the effect of climate-related financial policies over the banks' risk, as measured by its' credit risk. The banks' credit risk is measured as the loan loss provisions to the total loans ratio. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. The null hypothesis of the Hansen test states that all instruments are jointly exogenous and that the instruments used are not correlated with residuals. The null hypothesis of the autoregressive (AR) test states that there is no second-order serial correlation in the error term.

| | **Model 1** | **Model 2** |
|---|---|---|
| **Dependent variable** | **Asset Risk** | **Credit Risk** |
| Lagged dependent variable | .586*** | .218*** |
| | (.010) | (.007) |
| **Climate-related financial policies index** | | |
| CRFPI 1 | -.045*** | .051*** |
| | (.004) | (.002) |
| **Bank-specific variables** | | |
| Profitability | -.342*** | -.068*** |
| | (.046) | (.004) |
| Leverage | -.092*** | -.023*** |
| | (.014) | (.003) |
| LOG Size | -.759*** | -.380*** |
| | (.094) | (.014) |
| Cost-income ratio | -.021*** | -.032*** |
| | (.006) | (.002) |
| Asset Diversity | 2.898*** | .094 |
| | (.464) | (.091) |
| Income Diversity | 1.430*** | 1.348*** |
| | (.247) | (.074) |
| **Macroeconomic variables** | | |
| GDP Growth | .756*** | .609*** |
| | (.022) | (.007) |
| Inflation | .035*** | .211*** |
| | (.004) | (.016) |
| Concentration | -.031*** | -.054*** |
| | (.004) | (.001) |
| Macroprudential Policies Index | -.148*** | -.099*** |
| | (.025) | (.011) |
| Level of interest rates | -1.434*** | -1.156*** |
| | (.058) | (.017) |
| Slope of interest rates | .633*** | .775*** |
| | (.053) | (.016) |
| Crisis | .706*** | .717*** |
| | (.146) | (.039) |
| Year dummies | Yes | Yes |
| **Pre-validation tests** | | |
| Sargan-Hansen test | .370 | .272 |
| Arellano-Bond test for AR (2) | .210 | .175 |

## Table 4.

**Banks' risk models with the climate-related financial policies and the EMDE and Crisis dummy variables.**

The dependent variable, the bank's asset risk, is given by the annualized standard deviation of daily stock price returns times the market value of equity over the market value of the bank. Models 3 and 4 include the interaction term between the climate-related financial policies index and the EMDE and systemic crisis dummy variables, respectively. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. The null hypothesis of the Hansen test states that all instruments are jointly exogenous and that the instruments used are not correlated with residuals. The null hypothesis of the autoregressive (AR) test states that there is no second-order serial correlation in the error term.

| Dependent Variable: Asset Risk | Model 3 | Model 4 |
|---|---|---|
| Lagged dependent variable | .747*** | .749*** |
| | (.001) | (.001) |
| **Climate-related financial policies index** | | |
| CRFP 1 | -.003*** | .006*** |
| | (.001) | (.001) |
| **Interaction variable** | | |
| EMDE Dummy x CRFP 1 | -.006*** | |
| | (.001) | |
| Crisis Dummy x CRFP 1 | | -.031*** |
| | | (.001) |
| **Bank-specific variables** | | |
| Profitability | -.073*** | -.063*** |
| | (.003) | (.002) |
| Leverage | -.021*** | -.025*** |
| | (.002) | (.001) |
| Size | -.054*** | -.056*** |
| | (.009) | (.006) |
| Cost-income ratio | -.034*** | -.038*** |
| | (.001) | (.001) |
| Asset Diversity | -.488*** | -.141*** |
| | (.052) | (.033) |
| Income Diversity | 2.061*** | 1.703*** |
| | (.043) | (.037) |
| **Macroeconomic variables** | | |
| GDP Growth | .423*** | .375*** |
| | (.006) | (.004) |
| Inflation | -.010* | -.590*** |
| | (.005) | (.010) |
| Macroprudential policies index | -.067*** | -.138*** |
| | (.006) | (.007) |
| Level of interest rates | -.582*** | -.590*** |
| | (.012) | (.010) |
| Slope of interest rates | .307*** | .260*** |
| | (.007) | (.006) |
| Concentration | -.027*** | -.026*** |
| | (.001) | (.001) |
| Crisis | .177*** | .942*** |
| | (.021) | (.038) |
| EMDE Dummy | .386*** | |
| | (.062) | |
| **Pre-validation tests** | | |
| Sargan-Hansen test | .466 | .517 |
| Arellano-Bond test for AR (2) | .310 | .234 |

## Table 5.

**Average marginal effects of the interaction between the climate-related financial policies index and the systemic crisis dummy variable, considering the Asset risk as the dependent variable.**

Average marginal effects of Model 4 (Table 4), with standard errors obtained by the Delta method. The first column reports the values of the climate-related financial policies index, from the minimum, 0, to the maximum observed, 90, in increments of 10. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

| **c (CRFP Index)** | **Climate-related financial policies index (Model 4)** | |
|---|---|---|
| | dy/dx at CRFP=c | Delta Method Standard Error |
| **0** | .942*** | .038 |
| **10** | .631*** | .027 |
| **20** | .320*** | .018 |
| **30** | .009 | .016 |
| **40** | -.302*** | .023 |
| **50** | -.613*** | .033 |
| **60** | -.924*** | .045 |
| **70** | -1.235*** | .058 |
| **80** | -1.546*** | .070 |
| **90** | -1.857*** | .083 |

## Table 6.

**Robustness Check: Prior banks' risk model with the Z-Score as a proxy for banks' risk and with the climate-related financial policies index number two as alternative proxy for green financial policies.**

Estimation of the baseline model (Model 1) using as an alternative proxy for banks' risk: the Z-Score. Model 5 replicates Model 1, where we analyze the effect of the climate-related financial policies on banks' risk measured by its' Z-Score. Model 6 replicated Model 1 but considering an alternative index for green financial policies, where the policy areas are differently weighted. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

| | **Model 5** | **Model 6** |
|---|---|---|
| **Dependent variable** | **Z-Score** | **Asset Risk** |
| Lagged dependent variable | .193*** | .634*** |
| | (.014) | (.011) |
| **Climate-related financial policies index** | | |
| CRFPI 1 | .006*** | |
| | (.001) | |
| CRFPI 2 | | -.036*** |
| | | (.005) |
| **Bank-specific variables** | | |
| Profitability | .091*** | -.349*** |
| | (.011) | (.045) |
| Leverage | -.009*** | -.102*** |
| | (.002) | (.014) |
| Size | -.045*** | -.744*** |
| | (.013) | (.095) |
| Cost-income ratio | -.042*** | -.022*** |
| | (.002) | (.006) |
| Asset Diversity | -.193** | 3.040*** |
| | (.080) | (.452) |
| Income Diversity | .270*** | 1.342*** |
| | (.065) | (.252) |
| **Macroeconomic variables** | | |
| GDPGrowth | .027*** | .717*** |
| | (.008) | (.024) |
| Inflation | -.032*** | -.041* |
| | (.012) | (.024) |
| Macroprudential policies index | .028*** | -.157*** |
| | (.009) | (.021) |
| Concentration | .020*** | -.030*** |
| | (.001) | (.004) |
| Level of interest rates | -.103*** | -1.354*** |
| | (.016) | (.062) |
| Slope of interest rates | -.067*** | .545*** |
| | (.013) | (.052) |
| Crisis | -.394*** | .488*** |
| | (.060) | (.137) |
| **Pre-validation tests** | | |
| Sargan-Hansen test | .379 | .302 |
| Arellano-Bond test for AR (2) | .147 | .210 |

## Table 7.

**Robustness Checks: Prior Banks' risk models with the environmental policy stringency (EPS) variable as an alternative proxy for climate-related financial policies.**

Estimation of the baseline model (Model 1) using as an alternative proxy for the climate-related financial policies: the environmental policy stringency variable. Model 7 replicates Model 1, where we analyze the effect of the environmental policy stringency on the banks' risk as measured by the bank's asset risk. Model 8 replicates Model 2, where we analyze the effect of this same but considering the banks' credit risk as dependent variable. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

| | **Model 7** | **Model 8** |
|---|---|---|
| **Dependent variable** | **Asset Risk** | **Credit Risk** |
| Lagged dependent variable | .698*** | .989*** |
| | (.010) | (.004) |
| **Green financial policy variable** | | |
| Environmental Policy Stringency | -1.651*** | .514*** |
| | (.015) | (.033) |
| **Bank-specific variables** | | |
| Profitability | -.074*** | -.023*** |
| | (.002) | (.001) |
| Leverage | -.032*** | -.090*** |
| | (.001) | (.002) |
| LOG Size | -.204*** | -.732*** |
| | (.050) | (.090) |
| Cost-income ratio | -.028*** | -.010*** |
| | (.008) | (.001) |
| Asset Diversity | .885*** | .586*** |
| | (.039) | (.074) |
| Income Diversity | .707*** | .115*** |
| | (.036) | (.006) |
| **Macroeconomic variables** | | |
| GDP Growth | .520*** | .105* |
| | (.006) | (.080) |
| Inflation | .236*** | .189* |
| | (.008) | (.138) |
| Macroprudential policies index | -.052*** | -.060*** |
| | (.007) | (.001) |
| Concentration | -.031*** | -.027*** |
| | (.003) | (.001) |
| Level of interest rates | -.292*** | -.091*** |
| | (.008) | (.002) |
| Slope of interest rates | .356*** | .158*** |
| | (.007) | (.001) |
| Crisis | .732*** | .509*** |
| | (.028) | (.048) |
| Year dummies | Yes | Yes |
| **Pre-validation tests** | | |
| Sargan-Hansen test | .804 | .381 |
| Arellano-Bond test for AR (2) | .154 | .150 |

**Figure 1.**

**Banks' risk yearly mean for the 2006-2020 period.**

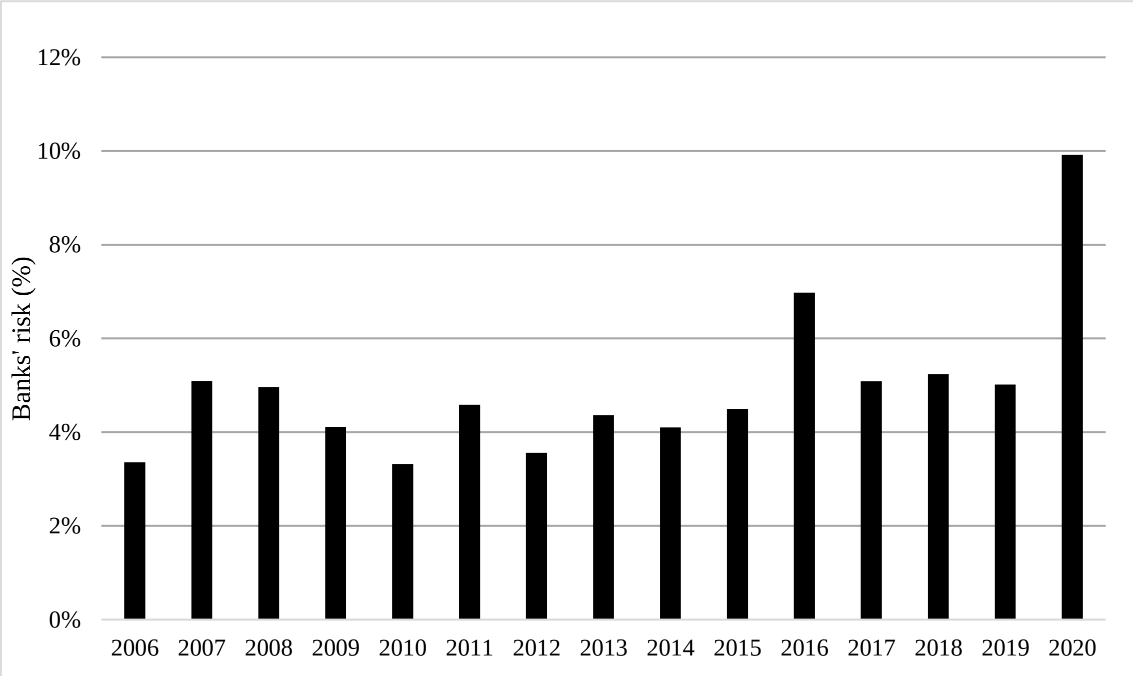
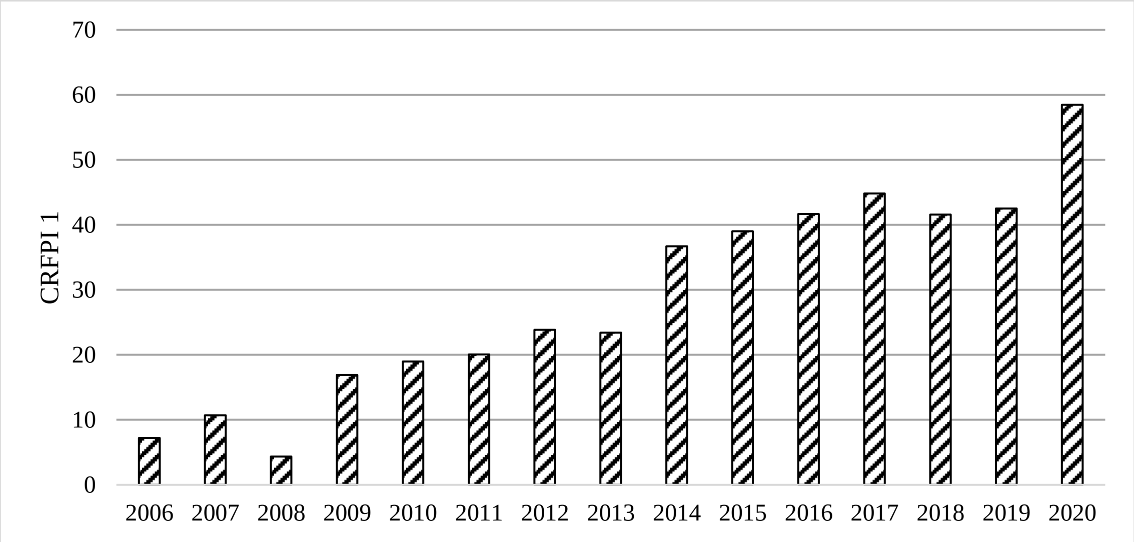


**Figure 2.**

**Climate-related financial policies index yearly mean for the 2006-2020 period.**

*Panel A – Climate-related financial policies index yearly mean, for the 2006-2020 period, for the whole sample.*




*Panel B – Climate-related financial policies index number 1 yearly mean, for the 2006-2020 period, divided by the AE and EMDE countries.*

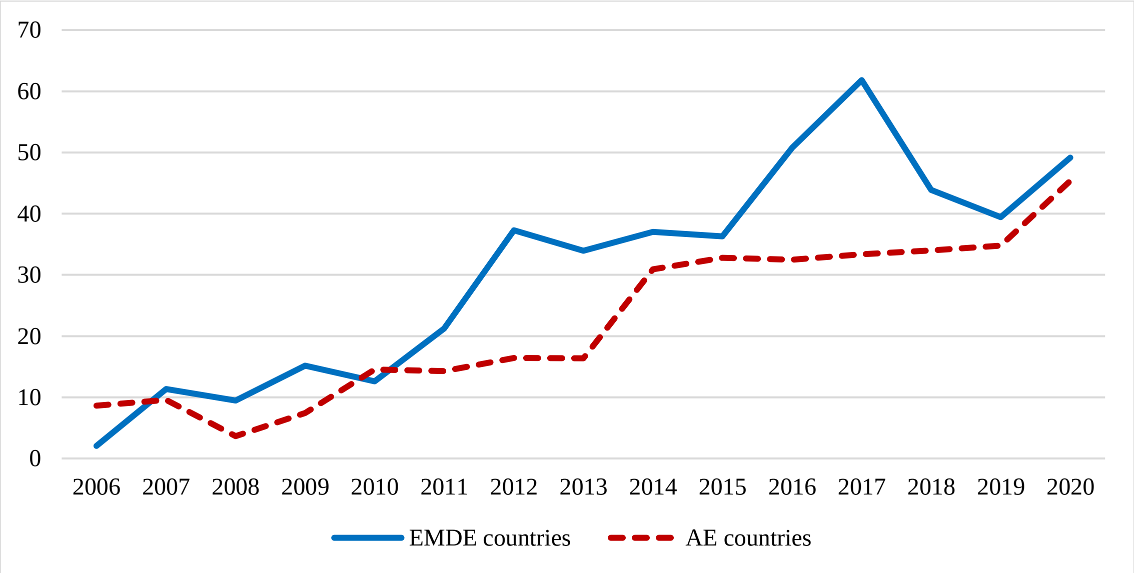


**Figure 3.**

**Marginal effects of the climate-related financial policies index on banks' risk, for the EMDE countries.**

Marginal effect of the climate-related financial policies index on banks' risk, for the EMDE countries. These results are calculated using the derivatives of Equation 3 along with Model 3, a methodology used by Brambor et al. (2006) and Berry et al. (2012). The dashed lines provide the 95% confidence intervals.

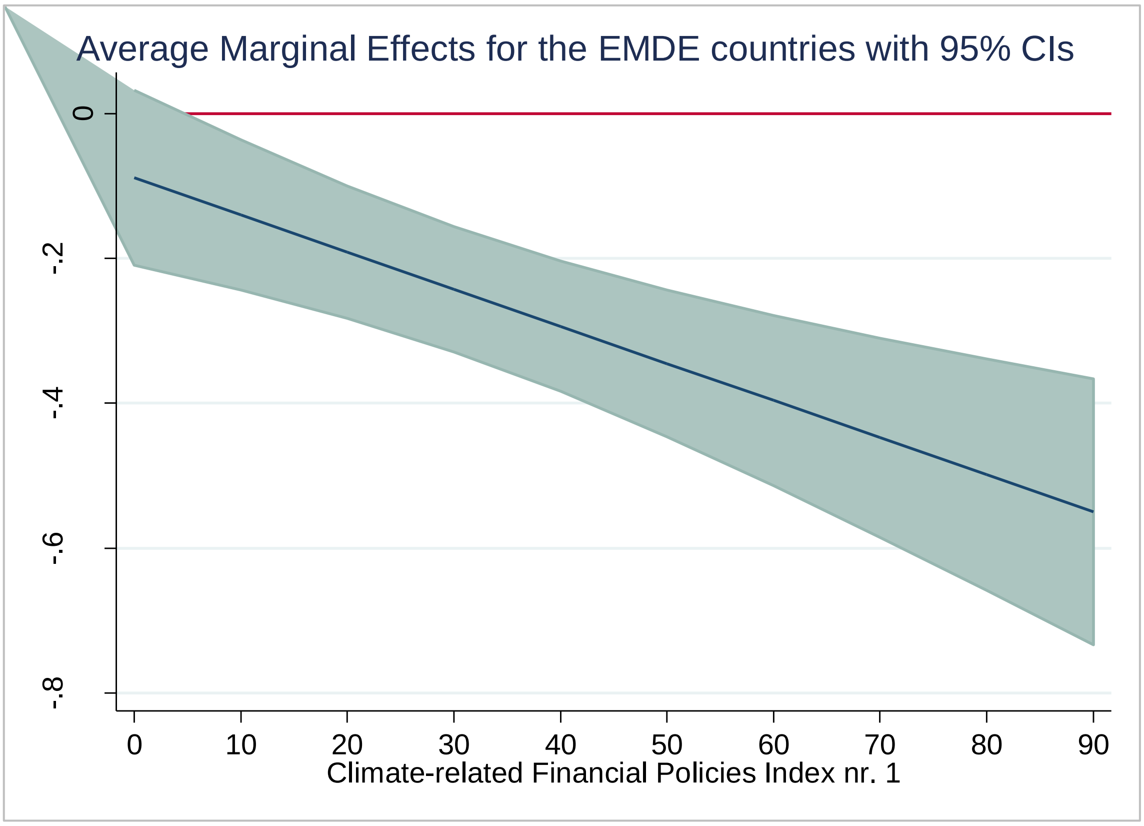
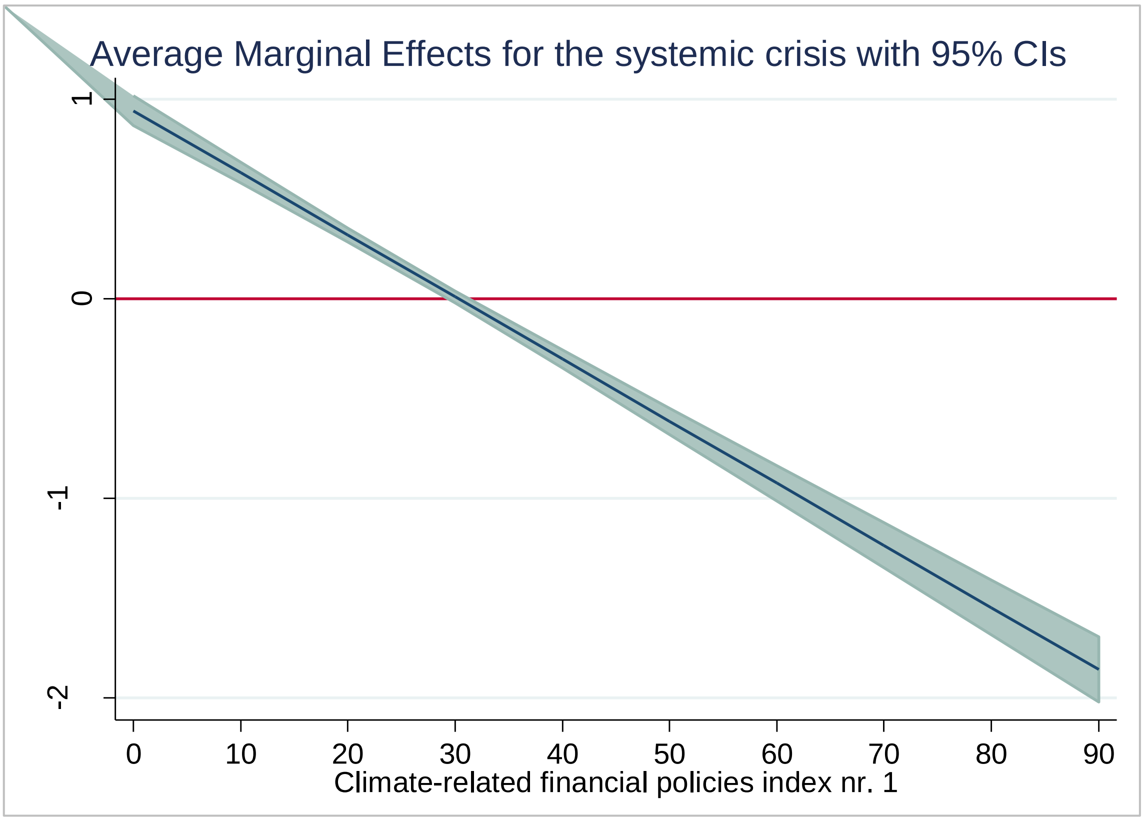


**Figure 4.**

**Marginal effects of the climate-related financial policies index on banks' risk, for the systemic crisis period.**

Marginal effect of the climate-related financial policies index on banks' risk, for the interaction with the systemic crisis dummy variable. These results are calculated using the derivatives of Equation 3 along with Model 4, a methodology used by Brambor et al. (2006) and Berry et al. (2012). The dashed lines provide the 95% confidence intervals.



## Appendix I.
### Variable sources and definitions.

| Variable | Description | Source |
| --- | --- | --- |
| *Banks' risk* | | |
| Asset Risk | Annualized standard deviation of daily stock price returns times the market value of equity over the total market value of the bank. | Thompson Reuters Datastream, Bankfocus database, and author's calculations |
| Credit risk | Provisions for loan losses to total loans ratio. | Bankfocus database, and author's calculations |
| Z-score | Natural logarithm of (ROA + E/A)/σ(ROA). ROA represents the rate of return on assets, E/A is the equity-to-assets ratio and σ (ROA) is the standard deviation of the rate of return on assets. A higher score suggests a lower probability of bank insolvency and, therefore, less risk. | Bankfocus database, and author's calculations |
| *Climate-related financial policies variables* | | |
| Climate-related financial policies index number 1 | Composite index measuring the country's bindingness in five climate-related policy areas namely five key areas, namely green prudential regulations, credit allocation policies, green financial principles, other disclosure requirements, and green bonds taxonomy and issuing. The five policy areas are equally weighted | D'Orazio (2023) |
| Climate-related financial policies index number 2 | Composite index measuring the country's bindingness in five climate-related policy areas namely five key areas, namely green prudential regulations, credit allocation policies, green financial principles, other disclosure requirements, and green bonds taxonomy and issuing. The green prudential regulation and green credit allocation policy areas are differently weighted. | D'Orazio (2023) |
| Environmental policy stringency index | Index measuring the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behavior. | OECD Environment Statistics Database |
| *Bank specific variables* | | |
| Leverage | Book value of total liabilities over total assets, measured in market terms, *i.e.*, as the sum of the market value of equity and the book value of total liabilities. | Bankfocus database, and author's calculations |
| Size | Natural logarithm of the book value of total assets. | Bankfocus database, and author's calculations |
| Profitability | Profit after interest expenses over the book value of assets. | Bankfocus database, and author's calculations |
| Cost-income ratio | Operating costs or non-interest costs over net operating income. | Bankfocus database, and author's calculations |
| Income diversity | Measures the diversification across different sources of income and is given by 1-[(net interest income-other operating income)⁄(total operating income)] | Bankfocus database, and author's calculations |
| Asset diversity | Measures the diversification across different types of assets and is given by 1-[(net loans-other earnings assets)⁄(total earnings assets)]. | Bankfocus database, and author's calculations |
| *Macroeconomic variables* | | |
| GDP growth | Annual percentage change of Gross Domestic Product (GDP). | Bloomberg database |
| Inflation | Annual percentage change in the Consumer Price Index (CPI). | Bloomberg database |
| Macroprudential policies index | Sum of the total tightening (+1) and loosening (□ 1) events for the 16 macroprudential policies— Countercyclical capital buffers (CCB), Conservation, Capital Requirements, Leverage Limits (LVR), Loan Loss Provisions (LLP), Limits to credit growth (LCG), Loan Restrictions (LoanR), Limits on Foreign Currency (LFC), Limits on the Loan-to-Value ratio (LTV), Limits on the Debt-Service-to-Income ratio (DSTI), Tax Measures, Liquidity Requirements, Limits on the Loan-to-deposit ratio (LTD), Limits on Foreign Exchange positions (LFX), Reserve Requirements (RR), Systemically important financial institutions (SIFI), and Others-in year t. | Integrated Macroprudential Policy (iMaPP) Database |
| Level of interest rates | 10-year yield rate on government bonds. | Bloomberg database |
| Slope of interest rates | Difference between the 10-year yield rate and the 1-year yield rate on government bonds. | Bloomberg database |
| Concentration | Measures the level of market competition in the banking sector and is given by the fraction of the assets of the three largest banks over the assets of all commercial banks in a country. | World Bank database |
| Crisis | Dummy variable that assumes the value 1 in the years of the systemic banking crisis and 0 otherwise. | Laeven & Valencia (2020) |
| EMDE dummy variable | Dummy variable that assumes the value of 1 for the emerging markets and developing economies and 0 otherwise. | Alam et al. (2019) |

## Appendix II.

Bank-specific and country-specific control variables used, their expected signals according to the empirical literature and empirical studies also using as control variables.

| *Control Variables* | *Expected signal* | *Theory supporting the effects* | *Literature that uses as control variable* |
|---|---|---|---|
| *Bank-specific variables* | | | |
| Leverage | + / − | Banks with higher leverage tend to invest in riskier assets (Fatouh et al., 2023), thus increasing their risk. However, regulation implemented under Basel III, will force banks with higher leverage to hold more capital, thus reflecting in higher loss-absorbing capacity and, consequently, reducing the bank' risk of defaulting (Acosta-Smith et al., 2020; European Central Bank, 2015). | Baumann & Nier (2004), and Chan et al. (2024). |
| Size | + / − | Larger banks haver higher capabilities of diversifying their operations, thus realizing economies of scale and reducing inefficiencies, leading to reduced risk (Regehr and Sengupta, 2016). On the other hand, larger banks create more systemic risk, due to their increased exposure to the financial markets. Notably, the literature points out that other factors, such as the level of capital and its funding, also plays an important role on defining such effect (Laeven et al., 2014). | Baumann & Nier (2004), Bohachova (2008), Gaganis et al. (2020), Meuleman & Vennet (2022), and Belkhir et al. (2023). |
| Profitability | − | Higher levels of profitability allows banks to build a monetary buffer and reserves that can be used to absorb unexpected losses (Baselga-Pascual et al., 2015). | Baumann & Nier (2004), Andrieş et al. (2021), and Belkhir et al. (2023) |
| Cost-income ratio | + / − | According to the cost skimming theory, more efficient banks devote less costs to credit monitoring and will be subjected to higher future risk due to increase in non-performing loans (Fiordelisi et al., 2010). On the contrary, in less efficient banks, the moral hazard theory shows that bank managers have increased incentives to take on more risk (Fiordelisi et al., 2010). | Baumann & Nier (2004), Caprio et al. (2007), Boubakri et al. (2020), and Gaganis et al, (2020). |
| Income diversity | + / − | Diversifying the banks' income can influence banks' risk through two different channels. While higher levels of diversification towards non-interest activities can reduce banks' risk through an increase in income stability (Berger et al., 1999; Campa and Kedia, 2002; Landskroner et al., 2005), it can also induce higher risk taking through increased exposure to volatility arising from these activities (Lapteacru, 2016). | Bohachova (2008), Andrieş et al. (2021), and Chan et al. (2024). |
| Asset diversity | + / − | Diversifying banks' activities away from lending activities can have an ambiguous effect. While it might reduce the banks' idiosyncratic risk and stabilize the banks' earnings (Gelman et al., 2022), it can also increase banks' contribution to systemic risk (Baele et al., 2007) and by diverging banks' investments towards riskier, unsecured and unsupervised investments, thus inducing higher volatility (Stiroh and Rumble, 2005; Stiroh, 2006) and, consequently, higher risk-taking. This positive relation is also supported by the agency theory. | Di Biase and D'Apolito (2012), Teixeira et al. (2020), and Radojičić and Marinković (2023). |
| *Macroeconomic variables* | | | |
| GDP growth | + | Banks are exposed to business cycle conditions. Risk tends to arise during periods of economic growth as banks lend more easily, thus increasing the potential losses of such credits which can be materialized during periods of distress (Bohachova, 2008). | Alam et al. (2019), Beirne & Friedrich (2014), Gaganis et al. (2020), Meuleman & Vennet (2022), and Chan et al. (2024). |
| Inflation | + | Higher inflation threatens banks' profitability as it diminishes the banks' real rates of return of its assets. Furthermore, inflationary periods can impair the earnings of the banks' borrowers, thus impairing the quality of such credits and, consequently, increasing banks' risk (Bohachova, 2008). | Bohachova (2008), Beirne & Friedrich (2014), Ashraf (2017), Gaganis et al. (2020), and Chan et al. (2024). |
| Macroprudential Policies index | − | Tightening macroprudential policies reduces banks' exposure to the financial system, thus reducing its' exposure to systemic risk. Furthermore, capital-aimed policies force banks to create a monetary buffer that can be used to cover unexpected losses and reduce abnormal growth (Andries et al., 2018; Ampudia et al., 2021; Igan et al., 2022; Kumar et al., 2022). | Alam et al. (2019), Ampudia et al., (2021), Matos et al. (2023). |
| Level of interest rates | + / − | Higher market interest rates will translate in higher returns. On the other hand, it threatens credit quality of said bank as it can be materialized in increased credit risk (Bohachova, 2008). Additionally, due to maturity mismatch, banks can be exposed to interest rate risk as banks' assets can decrease their value due to an increase in interest rates (Neely and Neely, 2023) | Ahmed and Khan (2022), Alam et al. (2019), and Gropp et al. (2007). |
| Slope of interest rates | + / − | A steeper yield curve, indicating a larger difference between short-term and long-term interest rates, can enhance bank profitability in countries where bank loans are based on long-term interest rates thus reducing the banks' risk (Aydemir and Ovenc, 2016). This effect is due to the maturity mismatch, where banks borrow at lower short-term rates and lend at higher long-term rates, thus increasing their net interest margin and profitability (Fendoglu, 2023). However, this steeper yield curve can expose banks to increases interest rate risk, thus impacting its' net worth and, consequently, leading to riskier banks. (Neely and Neely, 2023). | Ahmed and Khan (2022), Teixeira et al. (2014), and Gropp et al. (2007). |
| Concentration | + / − | Higher competition leads to a decrease in profit margins, inducing banks to take on more risks to increase their returns (Berger et al., 2008). Furthermore, concentrated market power leads banks to charge higher interest rates, which can impair the capacity of their borrowers to repay their loans, leading to higher risk (Boyd and De Nicolo, 2005; De Nicolo and Loukoianova, 2006). However, this concentration also boosts the banks' charter value, thus inducing risk aversion (Bohachova, 2008). | Bohachova (2008), Baselga-Pascual et al. (2015), Gaganis et al. (2020), and Dutra et al. (2023a). |
| Crisis | + | Bank risk materializes during years of crisis (Altunbas et al., 2018). This effect comes not only from greater exposure to credit risk, materialized through increased non-performing loans (World Bank, 2020) and decreased asset returns (Kuvshinov et al., 2022) but also increased financial market volatility (Matos et al., 2023). | Ashraf (2017), Wang and Sui (2019), Matos et al. (2023), and Chan et al. (2024). |