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THE IMPACT OF CLIMATE CHANGE AWARENESS ON BANK'S RISK EXPOSURE: EVIDENCE FROM EURO-AREA AND NORTH AMERICAN BANKS

LUDOVICA ZAMBROTTA

Work project carried out under the supervision of:

Pranav Desai

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Abstract

Climate change brings risks and opportunities for banks' business. I empirically analyze U.S. and Euro-area banks to investigate how awareness of these risks and opportunities impacts banks' risk exposure. For U.S. banks, I find a statistically insignificant effect of awareness on banks' risk-weighted assets. On the other hand, I find a significant convex relationship for Euro-area banks: overall, awareness reduces the risk taken. However, beyond a certain awareness level, banks shift their portfolios to riskier assets. Possible explanations are lower credit losses and easier access to capital. These results are relevant for banks' risk management and regulatory policies.

Keywords

Risk Management; Risk Exposure; Banking; Climate Change; Sustainability

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INTRODUCTION

Due to climate change, banks face various risks and opportunities (Li, Nguyen, and Narayanaswamy 2016). This research analyzes how banks' awareness of climate change opportunities and risks affects their financial risk-taking behavior. This effect is difficult to predict because, on the one hand, a risk-aware bank may seek to reduce or transfer risks and, consequently, reduce its exposure. On the other hand, it may seek to take advantage of the opportunities presented by the shift to a more sustainable economy by offering new green products or investing in green projects (Miller and Swann 2016). However, investing in sustainable projects may increase the banks' exposure to unknown financial risks due to the lack of transparency in green disclosure, which also increases monitoring costs and harms the company's profitability (Li, Nguyen, and Narayanaswamy 2016).

There are three types of climate-related risks: physical risk, liability risks and transition risks (EBA European Banking Authority 2020; FSB Financial Stability Board 2015). Climate risks could harm companies' revenues and expenses, reducing the firm's ability to repay loans. (Henisz and McGlinch 2019; Li, Nguyen, and Narayanaswamy 2016).

Prior researchers have examined the impact of physical, transitional, and liability risks on companies' creditworthiness, showing a direct link between climate risks and credit risk (Henisz and McGlinch 2019; Jang et al. 2020; Bannier, Bofinger, and Rock 2022). Scholars often use CDS spread as a measure of risk (Kölbel, Busch, and Jancso 2017; Barth, Hübel, and Scholz 2022; Kiesel and Lücke 2019). When focusing on the banking sector, researchers have mainly used Non-Performing Loans (NPLs) or loan losses as a proxy for banks' risk behavior (Simpson and Kohers 2002; Cui et al. 2018; Wu and Shen 2013). These approaches have two main limitations: One is that NPLs focus only on lending activity. However, it is only one component of a bank's overall business, which is shifting toward more non-traditional activities (Meslier, Tacneng, and Tarazi 2014; Nguyen 2012; Luu and Vo 2021). Indeed, non-traditional

banks' risky activities contributed significantly to the 2007-2009 financial crisis (DeYoung and Torna 2013). The other is that NPLs are lagged risk indicators since they only reflect loans already or are about to default. Therefore, they cannot give a real-time evaluation of a bank's risk exposure. Similarly, CDSs are limited in assessing the bank's willingness to take risks because factors beyond the bank's control influence their prices. This study uses the Risk Weighted Asset (RWA) as a comprehensive measure of banks' risk-taking behavior. Unlike NPLs and CDS, RWA considers both the quality of loans and the allocation of assets across different risk classes (Luu and Vo 2021). According to Grill, Lang, and Smith (2015) RWA is the most direct available indicator of banks' risk-taking. Indeed, banks have direct control over RWA and can modify it based on changes in their risk appetite. To the best of my knowledge, this is the first study to investigate how awareness of the risks and opportunities of climate change makes banks shift their asset portfolios toward safer or riskier assets.

This research addresses a key challenge in measuring banks' awareness of climate change. It is important to construct an informative variable that can provide an adequate sample size. To overcome this challenge, I collected data on whether banks have introduced new products to mitigate the risks of climate change or exploit their business opportunities. This information is available in the Refinitiv database in the form of a binary variable. Then, I built a new variable by transforming the Refinitiv variable into a real-valued variable, the value of which is calculated as the weighted average of the binary variable's values of the previous and current years. The weights are linearly increasing, with greater importance in recent years. In this way, banks developing new products/services for longer have a higher awareness score, while those developing green products for less time are penalized. The time frame under consideration spans nine years, from 2013 to 2021. The second challenge is isolating awareness's impact from other confounding factors. The empirical strategy includes several observable control variables for banks' characteristics in the model to reduce this issue. It also includes the bank fixed effect,

the time fixed effect, and the country fixed effect. The last challenge comes from the fact that variations in regulatory and supervisory practices among jurisdictions might result in disparities in RWAs and calculation techniques (Le Leslé and Avramova 2012). The dataset is split into two panels to overcome this challenge. One is composed only of U.S. banks, and the other is composed only of banks located in the Euro area. This approach ensures that the banks in each panel are subject to the same system of financial supervision.

The main finding is that awareness of climate change risks and opportunities significantly impacts banks' risk-taking behavior in Europe but not in the U.S. This result is consistent with the stakeholder influence capacity theory (Barnett 2007): the greater concern for climate-related issues among European legislators and communities incentivizes sustainable corporate actions, making them financially viable. According to Starks (2023) European countries have the highest scores on the Yale Environmental Performance Index and the S&P Environmental Scores over the past four years. The relationship between European banks' awareness and risk-weighted assets is convex. Overall, the most aware banks have lower risk-weighted assets than non-aware banks. However, while an increase in *Awareness* is initially associated with a reduction in risk exposure, banks tend to shift their portfolios to riskier assets after a certain level of *Awareness* is reached (*Awareness* = 0.70). For example, for a low-aware bank with an *Awareness* = 0.3, an increase in *Awareness* by 0.1 units is associated with a decrease of about one percentage point in the percentage of RWA over total assets. In contrast, for a high-aware bank with *Awareness* = 0.9, a 0.1 unit increase in *Awareness* is associated with a 0.5 percentage points increase in the RWA/total assets ratio. This relationship is consistent with Schoenmaker's three-step notion of sustainable finance (Schoenmaker 2017): banks at the first stage of sustainable finance are primarily concerned with minimizing physical and transitional risks. In later phases, they seek to seize opportunities and sustain the green economy. This transition happens as banks shift their focus from financial risks associated with transitioning

to a sustainable economy to also considering the environmental value when making decisions. As a result, banks with a moderate level of awareness experience decreased risk-weighted assets (RWA). In contrast, those with a high level of awareness increase their exposure due to the risk associated with green projects. Other empirical results of this study are that an increase in *Awareness* is associated with an increase in banks' Tier 1 leverage ratio and a decrease in non-performing loans in the EU panel. Greater capital accessibility and reduced credit risk exposure during the first stage incentivize banks to reallocate their portfolios to riskier assets without breaching the capital adequacy regulatory requirement during the second stage. These might be possible explanations for the relationship found among the European banks.

Examining the effect of climate change on banks' risk exposure is important for three reasons: First, one of the leading causes of the 2007-2009 financial crisis was the excessive risk taken by banks (Financial Crisis Inquiry Commission 2011). Therefore, monitoring how the banking system approaches climate change risks and opportunities is critical for supervisors to ensure financial stability in the context of climate change. Second, it may help policymakers to develop more appropriate policies and regulations to make the financial system support the transition. Indeed, banks' response to regulators' call for green finance is still slow. According to the 2022 climate stress test of the ECB, the actions taken to support transition cover only a niche of the bank's portfolio for 32% of the banks under the stress test, and 9% of the banks have no planned actions at all (ECB European Central Bank 2022). Finally, by better understanding risks and opportunities, banks can make more informed decisions and eventually obtain a competitive advantage in the market.

This study contributes to the existing research about the relationship between sustainability and financial risks by isolating climate change's effect from other sustainability factors and expanding beyond the traditional focus on credit risk. It also contributes to the literature on the effect of sustainable performance on the cost of capital by providing empirical evidence of the

impact of banks' awareness of climate change risks/opportunities on the Tier 1 leverage ratio.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

To the best of my knowledge, no literature explores the link between climate change awareness and banks' risk-taking behavior. Therefore, this study draws on three main strands of literature, which contribute to the definition of the theoretical framework: Literature exploring the impact of sustainability on financial performance and risks; literature linking sustainable performance to the cost of raising capital, and literature on banks' risk-influencing behavior.

- Empirical research studying the effect of sustainability on firms' performance and credit risk is mainly based on four economic theories: resource-based theory, stakeholder theory, agency theory, and overinvestment theory. Russo and Fouts (1997) demonstrate that environmental investments are strategic since they improve the company's and employees' skills. These skills are difficult to replicate. Hence, they provide performance advantages.

Similarly, awareness of climate change risks/opportunities can be considered a strategic investment.

- Eccles, Ioannou, and Serafeim (2014) find that "high sustainability" companies pay more attention to stakeholder engagement and are more focused on long-term goals than "low sustainability" companies. As a result, these firms have superior long-term performance compared to their counterparts, as measured by the stock market and accounting performance. Similarly, Kölbel, Busch, and Jancso (2017) suggest that non-sustainable firms subjected to CSI media coverage have a higher credit risk due to the potential for stakeholder sanctions. Therefore, according to EBA European Banking Authority (2020) banks can reduce their credit risk exposure by lending money to sustainable companies. Sustainable lenders are less exposed to climate change risk, having a lower probability of default (PD) and higher recovery rates (RR). Brogi,

Lagasio, and Porretta (2022) empirically demonstrate the negative relationship between firms' environmental score (in the ESG framework) and their PD. Among the literature related to banks, Ahmed, Ahmed, and Hasan (2018) suggest that banks may increase their financial performance by introducing ESG considerations in their lending decisions. On the other hand, Rubin and Barnea (2005) argue that managers over-invest in CSR for personal gain, as it increases their reputation. In line with this view, Goss and Roberts (2011) find that low-quality borrowers who engage in CSR practices have worse loan conditions, and Liu and Huang (2022) find a negative impact of sustainable financing and banks' risk management.

This research contributes to the existing body of literature by extending the scope beyond the traditional focus on credit risk and studying the impact of climate change risk and opportunities awareness on banks' risk appetite. Furthermore, the study focuses on assessing the impact of climate change awareness by isolating it from other aspects of sustainability, such as social and governance factors.

- Regarding the literature on the effect of sustainability on cost of capital, Sharfman and Fernando (2008); Bassen, Meyer, and Schlange (2006); El Ghoul et al. (2011) empirically show that firms with better environmental performances and environmental risk management have a lower cost of capital. These outcomes result from a better market perception of their risk profile.

A lower cost of capital would allow banks easier access to capital, which may incentivize banks to increase their risk-weighted assets without affecting the capital adequacy ratio (Grill, Lang, and Smith 2015). The present study contributes to this strand of literature by analyzing the relationship between banks' awareness of climate change risks and opportunities and their Tier 1 leverage ratio to explain the mechanism behind the effect of banks' awareness and RWAs.

- Regarding influencing behaviors among banks' shareholders and banks' managers, Demsetz, Saidenberg, and Strahan (1997) find that, only for banks with low franchise value, agency issues between owners and management may offset the increase in risk-taking behavior resulting from moral hazard associated with deposit insurance. On the other hand, Mondello, Ben, and Smaoui (2021) demonstrate that, due to agency problems between owners and managers, the latter choose less risky investments than the level desired by shareholders, when facing unobservable risks regardless of their remuneration scheme.

If this is the case, banks' managers will not benefit from the incentives provided by a lower cost of capital and will avoid increasing the bank's RWA accordingly. The impact of climate change risks/opportunities on banks' risk-taking behavior may exhibit a non-linear relationship. Ersoy et al. (2022), and El Khoury, Nasrallah, and Alareeni (2021) find a U-shaped relationship between banks' environmental performance and market value. The authors explain that the initial downward trend is related to the high costs of green investments and banks' initial lack of attention paid to sustainable efforts, which prevail in the short term. However, the negative effect becomes positive in the long term. Barth, Hübel, and Scholz (2022) find a U-shaped relationship between ESG performance and CDS spreads. The authors argue that the CDS spread of companies initially decreases due to a high degree of stakeholders' credibility (stakeholder influence capacity). However, this effect is offset by diminishing marginal returns on ESG investments after a given level of ESG investments.

In light of these findings, the hypothesis developed is that awareness of climate change risks and opportunities has a positive quadratic impact on RWA.

THEORY

Climate change risks - opportunities

Furrer, Hamprecht, and Hoffmann (2012) suggest that banks may handle climate change by

acting in three areas: operations, business, and governance. Operational measures are symbolic since they do not affect the investing and financing activities. Examples of these measures are the reduction of energy consumption or the usage of renewable energy sources. At the business level, banks may develop specific climate-related products and services or include climate considerations into core activities such as offering better financing conditions to companies that address climate change. These tasks need significant time and resource investment. Finally, banks can change their management framework at the governance level and include climate considerations in risk management activities. These actions can change decision-makers' assumptions and beliefs.

Climate change risks can directly influence the credit risk of banks' counterparts by increasing their Probability of Default (PD) and Loss Given Default (LGD) (EBA European Banking Authority 2020). These risks can be classified into three types: physical risks, liability risks, and transition risks. Physical risks may burden financial assets, physical assets, or production chains. Liability risks may occur if those who experienced negative consequences of climate change claim to be compensated by those they consider responsible for them. Lastly, transition risks arise during the shift towards a more sustainable economy. Changes in technology, social norms, consumer preferences, and policies are the three main sources of transition risks. The changes in social norms, policies, and consumer preferences can result in reduced sales, and together with the higher costs associated with physical damages caused by climate change, they may increase the companies' PD. Meanwhile, policy changes that cause the value of some collaterals, such as fossil fuel reserves, to fall may be the drivers of an LGD increase. Moreover, transitional risks may result in reputational damage. Physical risks associated with climate change can be considered operational risks for companies due to their pure-risk nature and the potential for significant losses.

To meet the Paris Agreement targets, the OECD predicted in 2015 that around USD 53 trillion

in cumulative capital investment in energy supply would be required between 2015 and 2035 (Kaminker et al. 2015). The increasing need for private capital to sustain the decarbonization process and environmental projects creates new opportunities for banks. First, banks may finance private and public investments in sustainable projects, such as water management, dams, and energy efficiency measures. Second, they can exploit the demand for finance for public policies that promote environmental initiatives and environment-damage mitigation projects. An example of a public initiative is feed-in tariffs for renewable energy. Lastly, banks may fund structured green funds, such as the Green Climate Funds. Green bonds are a common climate finance instrument that investors may buy to provide long-term financing to green projects. Sustaining green economy enables banks to manage their climate-related risks (EBA European Banking Authority 2020), gain access to new markets and clients, and position themselves as leaders in the field (Thompson 1998). However, green products and investments are often seen as risky (Jacobsson and Karltorp 2013; Karltorp 2016; Sadorsky 2012; Geddes, Schmidt, and Steffen 2018). This perception is primarily due to the lack of transparency, information asymmetry, and lack of a standardized classification for sustainable projects. (OECD 2017; Berensmann and Lindenberg 2016; EBA European Banking Authority 2020). Moreover, environmental projects involve high initial capital expenditures, while eventual benefits are only available in the long term. (Ersoy et al. 2022; Schoenmaker 2018; Nelson and Shrimali 2014). This information supports the hypothesis of a non-linear relationship between awareness of climate change risks and opportunities and banks' RWA. Indeed, while aware may be able to improve their risk profile and prevent losses associated with climate change, investing in non-transparent projects exposes them to other financial risks.

RWA

In 1988 the Basel Committee on Bank Supervision (BCBS) published the first set of regulations to establish universal supervision rules for international banks: the Basel I Accord (BIS Bank

for International Settlements 1988). The accord introduced the concept of Risk Weighted Assets. The idea behind this measure is that not all bank assets bear the same risk. Thus, it is reasonable to categorize assets based on their relative risk levels and apply different weights to them to measure the bank's total risk exposure. Then, Banks must assess their capital adequacy by computing the capital-to-RWA ratio (BIS Bank for International Settlements 2006). The most recent version of the capital adequacy framework includes three types of risk in the RWA measure: credit, market, and operational risk. Banks must be adequately capitalized depending on their risk exposure since bigger capital reserves enable them to better absorb potential losses. As a result, BCBS stipulated a minimum capital requirement under Basel III, stating that the ratio of a bank's Tier 1 capital to RWA should be not lower than 6%. Banks can acquire extra capital or lower the value of their risk-weighted assets to meet the required minimum capital adequacy ratio.

Grill, Lang, and Smith (2015) and EBA European Banking Authority (2016) consider RWA/Total Assets the most direct available indicator of banks' risk-taking. However, the literature highlights some issues with RWA measures that limit their comparability power. Specifically, variations in regulatory and supervisory practices among jurisdictions might result in disparities in RWAs and calculation techniques (Le Leslé and Avramova 2012). Moreover, differences in banks' business models and sizes may influence risk-taking behavior, with banks holding more opaque assets like derivatives having incentives to manipulate their internal calculation models (Edson Bastos Santos et al. 2020). Nonetheless, RWAs remain crucial for prudential analysis and may represent a reliable proxy for banks' risk-taking behavior.

According to the information presented, banks' capital availability constrains their capacity to acquire risk. As a result, it is essential to include capital as a control variable when analyzing the effect of awareness of climate change risks and opportunities on banks' RWA. It is reasonable to expect a positive correlation between the capital variable and RWAs.

Furthermore, the accessibility of capital for aware banks may provide a rationale for the relationship between awareness and RWAs.

METHODOLOGY

Empirical methodology

The following lines report the model used to test the impact of climate change risks/opportunities awareness on the banks' risk-taking behavior. The Hausman Test demonstrates the inconsistency of random effect estimators. As a result, the developed model employs fixed-effects estimators.

$$\mathrm{RWA}_{i,t}=\beta_0+\beta_1 Awareness_{i,t-1}+\beta_2 Awareness_{i,t-1}^{2}+\gamma' X_{it-1}+\alpha_i+\delta_c+\gamma_t+\varepsilon_{it} \quad (1)$$

Where RWA_{it}, denotes the ratio risk-weighted assets to total assets reported in year t by bank i. The variable $Awareness_{i,t-1}$ represents the awareness of climate change risks/opportunities lagged by one year. Based on the findings in the literature review section, the model includes the quadratic expression of the variable *Awareness* to test for a possible non-linear relationship with the RWA. α_i represents the bank fixed effect, accounting for differences in banks' characteristics that are constant over time. The year-fixed effect γ_t absorbs any unobserved shock varying in time but constant among banks. δ_c represents the country/state fixed effect. X_{it-1} is a vector that includes the control variables. Robust standard errors ε_{it} are clustered at the bank level to account for cross-sectional correlation in the error terms. I applied the model to two datasets, one containing 184 banks in the euro area and the other including 188 US-based banks. δ_c represents the country-fixed effect in the former, and the state-fixed effect in the latter. Fixed effects estimators help better isolate the effect of *Awareness* on *RWA* while controlling for other potentially confounding factors that may affect both the dependent and independent variables, such as changes in macroeconomic conditions, policy changes, other external factors, or non-observable bank characteristics. As a result, including fixed effects for banks, years, and countries/states allows for more consistency and increases the reliability of

the estimated relationship between climate change awareness and the banks' risk-taking behavior. To deal with outliers, I winsorized the variables in both samples.

Endogeneity

When regressing RWA on climate change risks/opportunities awareness, endogeneity problems may arise from omitted variables and reverse causality. Indeed, Hong, Kubik, and Scheinkman (2012) argue that a firm's financial restrictions play a role in deciding whether to engage in sustainable behaviors. To reduce this concern, I lagged all the regressors in the model by one period (one year), reducing the potential for reverse causality. Moreover, including countries, banks, and time-fixed effects help to reduce unobserved heterogeneity. Finally, I used the difference-in-difference technique to investigate the impact of an exogenous shock on banks' RWA. This analysis follows the model implemented to evaluate the effect of competition on ESG scores by Martins (2022) The models used for the two panels are presented below:

$$RWA = \beta_0 + \beta_1 Heatwave_t + \beta_2 Post\ heatwave_t + \beta_3 Heatwave \times Post\ heatwave_{i,t} + \gamma' X_{it-1} + \varepsilon_{it} \quad (2)$$

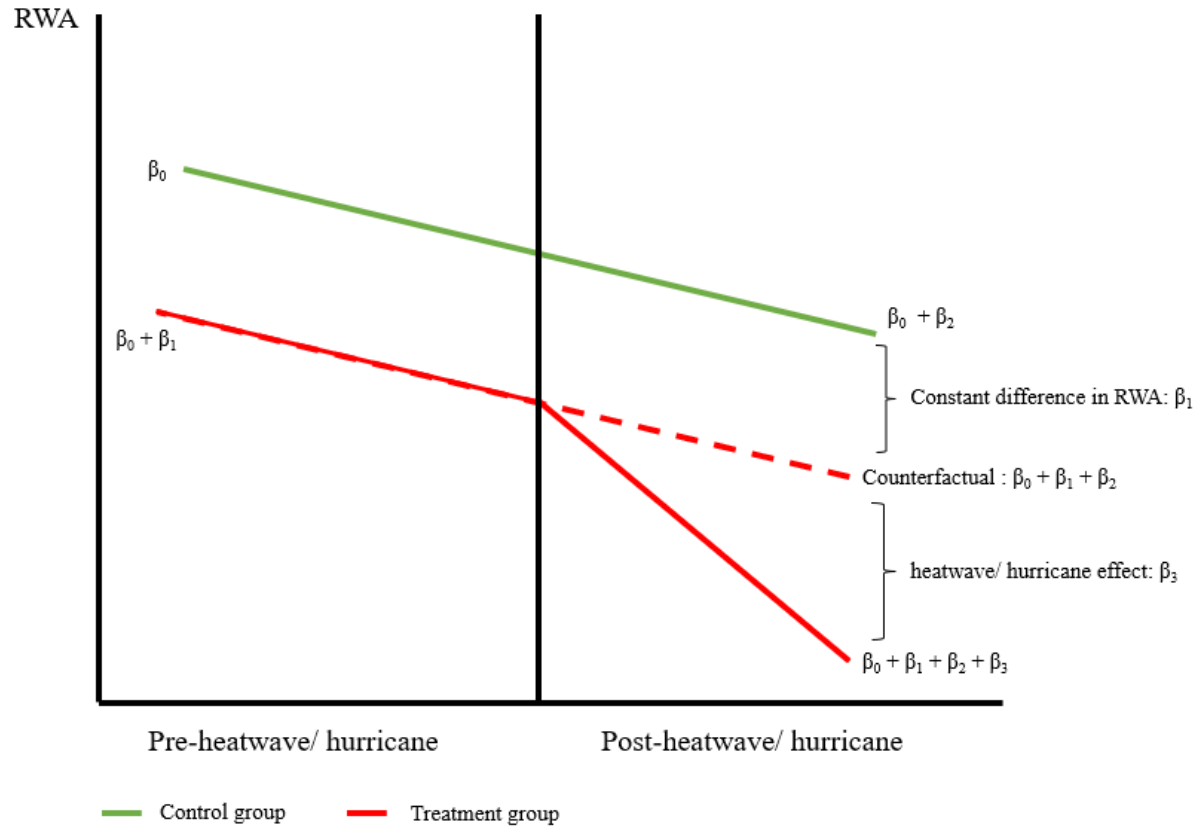
For the Euro area, I chose the heatwave that hit central Europe in 2018 as an exogenous event. It caused 1234 fatalities in Germany and a severe drought resulting in a total loss of 3 bln Euros in damage (Eckstein, Vera, and Schäfer 2021). The global climate risk index declared Germany one of the most damaged countries by climate change events that year, along with Japan and the Philippines. In the model, *Heatwave* is a binary variable, that equals one for banks in one of the countries hit by the heatwave (treatment group) (Bastos et al. 2020), and *post heatwave* equals one for years after 2018. *Heatwave* × *Post heatwave* is the interaction term between the first two variables.

$$RWA = \beta_0 + \beta_1 Hurricane_i + \beta_2 Post\ hurricane_t + \beta_3 Hurricane \times Post\ hurricane_{i,t} + \gamma' X_{it-1} + \varepsilon_{it} \quad (3)$$

I selected the 2017 hurricane season for the US panel as an exogenous climate event. It includes hurricanes Harvey, Irma, and Maria. The global climate index ranked the United States among the twelve countries most damaged by climate change in 2017 (Eckstein, Hutfils, and Winges

2019). *Hurricane* is a binary variable that equals one if the bank is in one of the states hit by the hurricane season (treatment group) (National Weather Service 2017; National Weather Service and Central Pacific Hurricane Center 2017; National Hurricane Center 2017) *Post hurricane* equals one for all the observations after 2017. *Hurricane*×*Post hurricane* is the interaction term between the first two variables. The rationale behind this approach is that natural disasters cause an awareness shock, raising the perceived risks of climate change. Indeed, Duanmu et al. (2022) reveal that US banks have tightened lending conditions in areas afflicted by natural catastrophes due to their increased awareness of climate change. The main assumption of the two models is that without the heatwave/ hurricane, the banks in treatment group would have the same trend in RWA than banks in the control group (banks not located in the countries/states hit by the two climate change events).

Figure 1: Parallel trend graph difference in difference.



Independent variable construction

The Refinitiv database contains information on whether a bank has introduced new products or services to mitigate the risks or to seize opportunities related to climate change to the existing business model. This information is a proxy for banks' commitment at the business level. It is available in the form of a binary variable "Climate Change Commercial Risks Opportunities" here called A for simplicity:

$$A_t = \begin{cases} 1 \text{ if the bank has developed new products at time t} \\ 0 \text{ otherwise} \end{cases} \quad (4)$$

Where A_t is the Refinitiv variable A for a generic bank in the year t.
I computed the variable *Awareness* at year t as the weighted sum of the variable A from the year 2012 (one year before the start of the dataset) to year t

$$Awareness_t = \sum_{j=2012}^{t} [w_{t,j} \times A_j] \quad (5)$$

Where:

$$w_{t,j} = \frac{\text{j-2011}}{\sum_{k=2012}^{t}(\text{k-2011})} = \frac{\text{j-2011}}{\frac{(\text{t-2010})\times(\text{t-2011})}{2}} \quad (6)$$

The denominator of the weight *w* between year j and year t is given by the difference between the year j and 2011 (two years before the start of the dataset) over the sum of the first (t-2011) integer numbers. This design allows the weights to rise linearly, e.g.:

$$Awareness_{2014} = \frac{1}{6} A_{2012} + \frac{2}{6} A_{2013} + \frac{3}{6} A_{2014} \quad (7)$$

As a result, the variable $Awareness_t$ is a real-valued variable ranging between zero and one, with a score of one assigned to a bank that has offered products/services to address climate change risks or opportunities in all previous years.

Dependent variable

Based on self-reported data, this study uses the ratio of risk-weighted assets to total assets to

measure banks' risk-taking behavior. The study employs two separate samples of banks, each composed of banks operating under similar or identical legislation (euro area and the United States), to mitigate concerns raised in the Theory section about the reliability of the RWA measure. The data in the study come from the Refinitiv database.

Control variables

The dataset contains control variables to capture the possible effects of banks' characteristics on their risk-taking behavior (Table 1). They are size, leverage ratio, profitability, inefficiency, revenue diversification, asset structure, capital structure, the board size, board independence, and board gender diversity. The source of the data is the Refinitiv database. The natural logarithm of total assets proxies bank size. On the one hand, large banks have a greater capability to reduce risk due to their better managerial skills and the exploitation of economies of scale and scope (ben Jabra, Mighri, and Mansouri 2017); (Parrado-Martínez, Gómez-Fernández-Aguado, and Partal-Ureña 2019). On the other hand, they often take on more risk due to moral hazard problems (De Jonghe 2010). According to Basel regulation, the leverage ratio is computed as Tier 1 capital over total assets. Leverage ratio should positively impact banks' risk-taking, as higher capital can be an incentive to increase the risk exposure of bank assets while maintaining a good capital adequacy ratio (Grill, Lang, and Smith 2015). ROE is included as a measure of profitability. It is expected to significantly negatively impact risk-taking, as demonstrated empirically (Baselga-Pascual, Trujillo-Ponce, and Cardone-Riportella 2015; Poghosyan and Čihak 2011). Demsetz, Saidenberg, and Strahan (1997) attribute this to the disciplining role of franchise value. Inefficiency is calculated as the ratio of operating expense to operating income. This variable is related to bad management, which should increase banks' risk (Williams 2004; Berger and DeYoung 1997; Baselga-Pascual, Trujillo-Ponce, and Cardone-Riportella 2015). The ratio of non-interest income to operating income represents revenue diversification. Although the literature has found a significant impact of this variable

on banks' risk, the results are ambiguous. Scholars underline the need for risk diversification but also show that banking activities that generate non-interest income are risky (Stiroh 2004; De Jonghe 2010). The ratio between net loans and total assets measures the asset structure. A high loan ratio is associated with lax lending, which increases banks' credit risk (Baselga-Pascual, Trujillo-Ponce, and Cardone-Riportella 2015) Capital structure is expected to have a positive impact on risk as well. Regarding the three governance measures, the board size, board independence, and board gender diversity, they are expected to have a significant impact on banks' risk reduction (Eling and Marek 2014; Vallascas, Mollah, and Keasey 2017). Larger boards usually make fewer drastic decisions due to difficulty finding an agreement (Nakano and Nguyen 2012; Cheng 2008).

Descriptive Statistics

The empirical analysis is performed on two-panel datasets spanning nine years from 2013 to 2021. The EU-Panel dataset includes 184 active banks from 11 Euro-area countries, with 1656 yearly observations. The sample includes only countries that used the Euro for the period under consideration. The distribution of banks in the sample varies by country, with Spain having the largest proportion of banks (23.91%), followed by France (15.22%) and Germany (14.67%) (Table 2). The sample's average awareness is 0.87, and risk-weighted assets account for 38.73% of total assets on average (Table 4). The US-Panel dataset contains 188 active banks from 29 U.S. states, with 1692 yearly observations. New York State has the largest percentage of banks in the sample (19.15%), followed by California (13.30%) and North Carolina (11.70%) (Table 3). The average awareness across the sample is 0.40, and RWA accounts for 71.11% of total assets on average (Table 5). Tables 6 and 7 illustrate the pooled yearly correlations among variables using the Pearson correlation. This analysis reveals a significant negative correlation between the lagged variable for awareness and risk-weighted assets in the EU-Panel and US-Panel datasets. To test the presence of multicollinearity, I performed a variance inflation factor

analysis (VIF), which indicates the absence of multicollinearity.

RESULTS

Empirical results

After controlling for the indicated fixed effects, I find that the awareness of climate change risks and opportunities significantly impacts banks' risk-taking behavior in the European sample but not in the U.S. sample (Tables 8 and 9). In the EU-Panel regression, the relationship between banks' awareness of climate change risks and opportunities and their risk-weighted assets is non-linear. Specifically, it is convex, with an increase in banks' awareness associated with a reduction in their risk exposure at a decreasing rate up to a certain threshold level. However, as the *Awareness* level reaches 0.70, banks begin to take on more risk. Specifically, for a low-aware bank with an awareness level of 0.3, an increase in *Awareness* by 0.1 units is associated with a decrease of about one percentage point in the percentage of RWA to total assets ($0.1 \times (\beta1 + 2 \times \beta2 \times 0.3)$). In contrast, for a high-aware bank with *Awareness* = 0.9, a 0.1 unit increase in *Awareness* is associated with an increase of 0.5 percentage point in the ratio of RWA to total assets ($0.1 \times (\beta1 + 2 \times \beta2 \times 0.5)$). Considering a bank in the EU sample with the average size and *Awareness* value (total assets = 477 bln Euros; *Awareness* = 0.87), a 0.1 unit increase in *Awareness* is associated with a 0.42 percentage point increase in the ratio of RWA to total assets. Under the strong assumption that all the change in this ratio comes from the change in RWA, it means that for an average bank in the EU sample, a 0.1 unit increase in *Awareness* is associated with an increase in risk exposure of about 2 bln Euros. To determine the influence of each fixed effect on the coefficients, I compared the regressions, including each fixed effect individually, with the model without any fixed effects. The *Awareness* coefficient in the EU panel is statistically insignificant in the regression model without any fixed effect (Table 8). In contrast, the coefficient of $Awareness^2$ is significant at a 5% level with a value of 10.82. However, when including the banks' fixed effect, *Awareness* coefficient is significant at a 5%

level and *Awareness*^{2} at a 10% level, the coefficient for the variable *Awareness* shifts to -12.56, while the one for *Awareness*^{2} falls to 8.55. Thus, there are specific time-invariant bank characteristics that have a significant impact on the regression coefficients. Considering only the year-fixed effect, the coefficient for *Awareness*^{2} is significant at a 1% level, and its value changes from 10.82 to 13.64, *Awareness* coefficient is significant at a 5% level, and its value equals -10. Considering only the country fixed effect, both coefficients have significant coefficients at a 1% level with values equal to -16.94 and 17.28, respectively, highlighting the importance of controlling for specific country factors that remain constant over time. Both coefficients are significant at a 1% level when controlling for all these factors simultaneously. In the US panel, with no fixed effects, the coefficient of *Awareness*^{2} is significant at a 10% level. When only the bank fixed effect is included, the *Awareness* and *Awareness*^{2} coefficients are significant at 1%. In all the other models, *Awareness* has an insignificant effect on banks' risk exposure. (Table 9).

The results of the difference-in-difference analysis support the fixed-effects results. In the Euro area panel, β1 is statistically significant, at 1%, indicating that before the heatwave, the RWAs of banks in the treatment group were 4.35 percentage points lower than the RWAs of banks in the control group. β2 indicates that the RWAs of the control group decreased by 3.35 percentage points after the heat wave. β3, significant at a 5% level, shows that the treatment group banks' RWAs decreased 1.42 percentage points more than they would have decreased without the 2018 heatwave (Table 10). This result is consistent with the negative relationship between *RWA* and *Awareness* in the EU panel. In the US panel, β3 is statistically insignificant, suggesting no statistically significant difference in the change in risk-weighted assets between banks in the hurricane-affected states and other US banks after the 2017 hurricane season (Table 11).

Robustness

The results are robust to an alternative measure of awareness and random subsamples, as

illustrated in Tables 12 and 13. The alternative variable is Environmental products, built on the binary variable Environmental Products from the Refinitiv database. This variable shows if a bank has at least one environmentally friendly product or service. This variable represents a broader awareness focused on all environmental issues, not only climate change.

Results interpretation and mechanisms

Stakeholder-influence capacity theory may explain the difference in the effect of awareness of climate change risks and opportunities between U.S. and Euro-area banks. European legislators and communities have shown greater attention to climate-related issues, incentivizing sustainable initiatives, and making them financially viable. According to a 2018 climate survey published by the European Investment Bank, Europeans are more concerned about climate change than Americans, and E.U. countries have more climate-friendly legislation than the U.S.(EIB European Investment Bank 2019). Consistent with these findings, descriptive statistics in Tables 4 and 5 show that the average awareness of the European panel is higher than that of the U.S. panel, suggesting that European industry and competitors have higher sustainability requirements than the American ones. As a result, since the sustainability profile of banks is not a priority for U.S. stakeholders, awareness of climate change risks and opportunities does not impact the risk exposure of American banks. This argument is consistent with Laura Starks' presidential address to the American Finance Association in 2023 (Starks 2023). Starks' speech highlighted the presence of regional disparities in the adoption of ESG investments worldwide. Her research reveals that Europe has consistently held the largest assets under management for ESG mutual funds and ETFs over the past four years. In addition, according to Starks, Europe has the highest scores on both the Yale Environmental Performance Index, which evaluates country policies and the S&P Environmental Scores, which evaluate corporate actions. Breuer et al.(2018) found a decreasing effect of environmentally sustainable investments on the cost of equity only for companies located in countries with strong investment

protection. Such protections ensure that insiders do not expropriate the firm's resources, lowering the agency and overinvestment problems of sustainable finance. This phenomenon could be another possible explanation for the insignificant effect of climate change awareness on banks' RWA in the U.S. panel. Since they also found that European countries are among the countries with the strongest protection. The stakeholder theory and the notion of the three steps of sustainable finance developed by Schoenmaker (2017) may explain the U-shape relationship between banks' awareness and RWA found in the EU panel. The first stage of sustainable finance involves moderate-aware banks disinvesting from companies with a negative environmental impact to avoid risks. According to the literature review section findings, non-sustainable firms have higher PD and LGD. Therefore, stopping investing in them reduces the banks' exposure to credit risk exposure by banks, hence lowering their entire risk exposure.

However, once awareness exceeds a certain level, banks begin taking on more risk. This behavior can be related to the low-risk exposure reached in the previous phase and to the easier access provided by stakeholder trust. As a result, banks can invest in riskier projects, mainly green projects, without negatively affecting their stability. High-aware banks (*Awareness* = 1) are associated with lower RWAs than non-aware banks (*Awareness* = 0). These findings are relevant to regulators since they suggest that higher banks' awareness of climate change risks and opportunities is associated with improving resilience.

Another possible explanation for the convex relationship between the awareness of climate change risks and opportunities and risk-weighted assets among European banks is that more aware institutions engage in "greenwashing" activities, misleading the market and allowing them to undertake greater risk.

Mechanisms evidence

This session presents two pieces of evidence on the European panel supporting the results above explanation. Table 14 summarizes the findings.

First, I conducted a regression analysis between *Awareness* and the ratio of non-performing. The results show a significant negative linear association between the two variables. The quadratic term included in the model is statistically insignificant. The observed decline in non-performing loans supports the idea that banks with a high level of awareness can better lower their credit risk exposure and, thus, their total RWA. Indeed, by regressing RWA on the non-performing loan ratio, I found a positive association between the two. Moreover, this finding may indicate that the initiatives taken by highly aware banks to prevent climate change may help them to limit loan losses, suggesting that such actions are more than just greenwashing.

Secondly, I performed a regression analysis of banks' RWAs on *Leverage ratio*. The leverage ratio measures the proportion of Tier 1 capital to total assets. This ratio has a significant positive effect on a bank's Risk-Weighted Assets. Thirdly, I run a regression of the leverage ratio on *Awareness*. It reveals that capital availability increases quadratically with awareness (with a turning point at *Awareness*=0). This finding supports the idea that banks aware of climate change risks and opportunities have easier access to capital. However, the low coefficient of this regression suggests that there may be other explanations for the increase in RWA associated with the increase in *Awareness* for highly aware banks. Indeed, the regression coefficients of *Capitalization* on *Awareness* indicate a negative quadratic impact, where *Capitalization* is the ratio of Tier 1 capital to banks' risk-weighted assets. Overall, banks with the highest *Awareness* = 1 have higher Capitalization than non-aware banks (*Awareness* = 0). However, after the turning point at *Awareness* = 0.78 the ratio between Tier 1 and RWA starts to decline. As expected, the rise in capital partially mitigates the growth in RWA, keeping bank capitalization roughly stable. However, because RWA grows faster than Tier 1 capital, capitalization begins to fall after a while.

CONCLUSION

This study provides a comprehensive examination of the impact of awareness of climate change

risks and opportunities on banks' exposure to risk. First, it compares the phenomenon between banks in U.S. and Euro-area banks, revealing an insignificant effect of awareness on risk-weighted assets of U.S. banks, as opposed to Euro-area banks. This difference is consistent with stakeholder influence capacity theory and with other studies linking the financial benefits of sustainability to investors' level of protection in legislation. Second, the study explores the quadratic relationship between climate change awareness and risk exposure, finding a significant convex relationship among Euro-area banks. Overall, aware banks have lower risk-weighted assets than non-aware banks. However, the quadratic analysis shows that banks' portfolios shift to riskier assets above a certain level of awareness, inverting the relationship between awareness and RWA. Finally, the study investigates some possible mechanisms that explain the results in the Euro area, providing supporting evidence. In particular, it shows that an increase in awareness is associated with a linear decrease in loan losses and an increase in Tier 1 capital. Moreover, decreased loan losses are associated with a decrease in the total risk-weighted assets. The initial reduction in risk exposure and the increased availability of capital for more aware banks may offer incentives to increase the exposure in a second phase without breaching the regulatory requirements. These findings are helpful for regulators to understand how banks respond to climate change and how to promote financial stability. However, this research has several limitations: first, it employs self-reported data, which can be biased. In addition, due to the lack of specific data on the products offered by each bank, the study ignores the possibility that different products may have a different impact on banks' risk exposure. From a methodological point of view, the empirical process used cannot exclude problems of endogeneity, which affect the causal interpretation of the results. Future research may address the issue by finding appropriate exogenous instruments and using more advanced statistical methods. Furthermore, despite controlling observable bank characteristics and including fixed effects, there may still be unobservable or omitted variables that influence the results.

Moreover, the construction of the *Awareness* variable assumes a linear relationship between climate change awareness and time, which may not correctly reflect the dynamics of awareness over time. Future research can solve these limitations by focusing on specific green products or conducting surveys to get more informative data on bank awareness. Another area for improvement is that the study includes only banks with data in the Refinitiv database, which may limit the generality of the results. For example, the samples do not include small banks. Moreover, in the Euro-panel, data are available only for banks in 11 of the 17 countries that formed the Eurozone in 2013, and the U.S. sample includes only 29 of the 50 U.S. states. In addition, the study focuses only on Eurozone and U.S. banks. Future research may extend the analysis to include countries more impacted by climate change. Furthermore, even if the study acknowledges that non-transparent green disclosure might impact the reliability of information used in banks' decisions, it does not explore the effect of this limitation. Future research may study this aspect. Further research may also investigate the role of stakeholders and capital in the impact of climate change awareness on banks' risk-weighted assets.

REFERENCES

Ahmed, Sarwar Uddin, Samiul Parvez Ahmed, and Ikramul Hasan. 2018. "Why Banks Should Consider ESG Risk Factors in Bank Lending?" *Banks and Bank Systems*. https://doi.org/10.21511/bbs.13(3).2018.07.

Bannier, Christina E., Yannik Bofinger, and Björn Rock. 2022. "Corporate Social Responsibility and Credit Risk." *Finance Research Letters* 44 (January): 102052. https://doi.org/10.1016/J.FRL.2021.102052.

Barnett, Michael L. 2007. "Stakeholder Influence Capacity and the Variability of Financial Returns to Corporate Social Responsibility." *Academy of Management Review*. https://doi.org/10.5465/AMR.2007.25275520.

Barth, Florian, Benjamin Hübel, and Hendrik Scholz. 2022. "ESG and Corporate Credit Spreads." *Journal of Risk Finance* 23 (2). https://doi.org/10.1108/JRF-03-2021-0045.

Baselga-Pascual, Laura, Antonio Trujillo-Ponce, and Clara Cardone-Riportella. 2015. "Factors Influencing Bank Risk in Europe: Evidence from the Financial Crisis." *The North American Journal of Economics and Finance* 34 (November): 138–66. https://doi.org/10.1016/J.NAJEF.2015.08.004.

Bassen, A., K. Meyer, and J. Schlange. 2006. "The Influence of Corporate Responsibility on the Cost of Capital An Empirical Analysis." *Mimeo, University of Hamburg* Retrieved.

Bastos, A, P Ciais, P Friedlingstein, S Sitch, J Pongratz, L Fan, J P Wigneron, et al. 2020. "Direct and Seasonal Legacy Effects of the 2018 Heat Wave and Drought on European Ecosystem Productivity." *Science Advances* 6 (24): eaba2724. https://doi.org/10.1126/sciadv.aba2724.

Berensmann, Kathrin, and Nannette Lindenberg. 2016. "Green Finance: Actors, Challenges and Policy Recommendations." 23/2016. German Institute of Development and Sustainability (IDOS). https://www.idos-research.de/en/briefing-paper/article/green-finance-actors-

challenges-and-policy-recommendations/.

Berger, Allen N., and Robert DeYoung. 1997. “Problem Loans and Cost Efficiency in Commercial Banks.” *Journal of Banking & Finance* 21 (6): 849–70. https://doi.org/10.1016/S0378-4266(97)00003-4.

BIS Bank for International Settlements. 1988. “INTERNATIONAL CONVERGENCE OF CAPITAL MEASUREMENT AND CAPITAL STANDARDS.” *BIS Bank for International Settlements*. Basel: BIS Bank for International Settlements. https://www.bis.org/publ/bcbs04a.pdf.

BIS Bank for International Settlements. 2006. “Basel Committee on Banking Supervision International Convergence of Capital Measurement and Capital Standards.” *BIS Bank for International Settlements*. Basel: BIS Bank for International Settlements.

Breuer, Wolfgang, Torbjörn Müller, David Rosenbach, and Astrid Salzmann. 2018. “Corporate Social Responsibility, Investor Protection, and Cost of Equity: A Cross-Country Comparison.” *Journal of Banking & Finance* 96 (November): 34–55. https://doi.org/10.1016/J.JBANKFIN.2018.07.018.

Brogi, Marina, Valentina Lagasio, and Pasqualina Porretta. 2022. “Be Good to Be Wise: Environmental, Social, and Governance Awareness as a Potential Credit Risk Mitigation Factor.” *Journal of International Financial Management and Accounting* 33 (3). https://doi.org/10.1111/jifm.12156.

Cheng, Shijun. 2008. “Board Size and the Variability of Corporate Performance.” *Journal of Financial Economics* 87 (1): 157–76. https://doi.org/10.1016/J.JFINECO.2006.10.006.

Cui, Yujun, Sean Geobey, Olaf Weber, and Haiying Lin. 2018. “The Impact of Green Lending on Credit Risk in China.” *Sustainability (Switzerland)* 10 (6). https://doi.org/10.3390/su10062008.

Demsetz, Rebecca S., Marc R. Saidenberg, and Philip E. Strahan. 1997. “Agency Problems and

Risk Taking At Banks." *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.943507.

DeYoung, Robert, and Gökhan Torna. 2013. "Nontraditional Banking Activities and Bank Failures during the Financial Crisis." *Journal of Financial Intermediation* 22 (3): 397–421. https://doi.org/10.1016/J.JFI.2013.01.001.

Duanmu, Jun, Yongjia Li, Meimei Lin, and Salman Tahsin. 2022. "Natural Disaster Risk and Residential Mortgage Lending Standards." *Journal of Real Estate Research* 44 (1). https://doi.org/10.1080/08965803.2021.2013613.

EBA European Banking Authority. 2016. "REPORT ON THE LEVERAGE RATIO REQUIREMENTS UNDER ARTICLE 511 OF THE CRR."

EBA European Banking Authority. 2020. "Discussion Paper on Management and Supervision of ESG Risks for Credit Institutions and Investment Firms." Paris: EBA European Banking Authority.

Eccles, Robert G., Ioannis Ioannou, and George Serafeim. 2014. "The Impact of Corporate Sustainability on Organizational Processes and Performance." *Management Science* 60 (11). https://doi.org/10.1287/mnsc.2014.1984.

Eckstein, David, Marie-Lena Hutfils, and Maik Winges. 2019. *BRIEFING PAPER, GLOBAL CLIMATE RISK INDEX 2019, Who Suffers Most From Extreme Weather Events? Weather-Related Loss Events in 2017 and 1998 to 2017. Greenwatch.*

Eckstein, David, Künzel Vera, and Laura Schäfer. 2021. "Global Climate Risk Index 2021 | Germanwatch e.V." Germanwatch. 2021.

Edson Bastos Santos, by, Neil Esho, Marc Farag, and Christopher Zuin. 2020. "Variability in Risk-Weighted Assets: What Does the Market Think?" 844. BIS Bank for International Settlements. www.bis.org.

EIB European Investment Bank. 2019. "2018-2019 EIB Climate Survey." European Investment Bank. 2019. https://www.eib.org/en/surveys/1st-climate-survey/index.htm.

Eling, Martin, and Sebastian D. Marek. 2014. “Corporate Governance and Risk Taking: Evidence From the U.K. and German Insurance Markets.” *Journal of Risk and Insurance* 81 (3). https://doi.org/10.1111/j.1539-6975.2012.01510.x.

Ersoy, Ersan, Beata Swiecka, Simon Grima, Ercan Özen, and Inna Romanova. 2022. “The Impact of ESG Scores on Bank Market Value? Evidence from the U.S. Banking Industry.” *Sustainability (Switzerland)* 14 (15). https://doi.org/10.3390/su14159527.

FSB Financial Stability Board. 2015. “Proposal for a Disclosure Task Force on Climate-Related Risks.” Basel: FSB Financial Stability Board. https://g20.org/wp-content/uploads/2015/04/April-G20-FMCBG-.

Furrer, Bettina, Jens Hamprecht, and Volker H. Hoffmann. 2012. “Much Ado about Nothing? How Banks Respond to Climate Change.” *Business and Society* 51 (1). https://doi.org/10.1177/0007650311427428.

Geddes, Anna, Tobias S. Schmidt, and Bjarne Steffen. 2018. “The Multiple Roles of State Investment Banks in Low-Carbon Energy Finance: An Analysis of Australia, the UK and Germany.” *Energy Policy* 115 (April): 158–70. https://doi.org/10.1016/J.ENPOL.2018.01.009.

Ghoul, Sadok El, Omrane Guedhami, Chuck C.Y. Kwok, and Dev R. Mishra. 2011. “Does Corporate Social Responsibility Affect the Cost of Capital?” *Journal of Banking & Finance* 35 (9): 2388–2406. https://doi.org/10.1016/J.JBANKFIN.2011.02.007.

Goss, Allen, and Gordon S. Roberts. 2011. “The Impact of Corporate Social Responsibility on the Cost of Bank Loans.” *Journal of Banking & Finance* 35 (7): 1794–1810. https://doi.org/10.1016/J.JBANKFIN.2010.12.002.

Grill, Michael, Jan Hannes Lang, and Jonathan Smith. 2015. “The Impact of the Basel III Leverage Ratio on Risk-Taking and Bank Stability.” *Financial Stability Review*, no. 3.

Henisz, Witold J., and James McGlinch. 2019. “ESG, Material Credit Events, and Credit Risk.”

Journal of Applied Corporate Finance 31 (2). https://doi.org/10.1111/jacf.12352.

Hong, Harrison G., Jeffrey D. Kubik, and Jose A. Scheinkman. 2012. "Financial Constraints on Corporate Goodness." *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1734164.

Jabra, Wiem ben, Zouheir Mighri, and Faysal Mansouri. 2017. "Determinants of European Bank Risk during Financial Crisis." *Cogent Economics and Finance* 5 (1). https://doi.org/10.1080/23322039.2017.1298420.

Jacobsson, Staffan, and Kersti Karltorp. 2013. "Mechanisms Blocking the Dynamics of the European Offshore Wind Energy Innovation System – Challenges for Policy Intervention." *Energy Policy* 63 (December): 1182–95. https://doi.org/10.1016/J.ENPOL.2013.08.077.

Jang, Ga Young, Hyoung Goo Kang, Ju Yeong Lee, and Kyounghun Bae. 2020. "ESG Scores and the Credit Market." *Sustainability (Switzerland)* 12 (8). https://doi.org/10.3390/SU12083456.

Jonghe, Olivier De. 2010. "Back to the Basics in Banking? A Micro-Analysis of Banking System Stability." *Journal of Financial Intermediation* 19 (3): 387–417. https://doi.org/10.1016/J.JFI.2009.04.001.

Kaminker, Christopher, Kate Eklin, Osamu Kawanishi, and Robert Youngman. 2015. *Mapping Channels to Mobilise Institutional Investment in Sustainable Energy*. *OECD Publishing*. https://doi.org/10.1787/9789264224582-en.

Karltorp, Kersti. 2016. "Challenges in Mobilising Financial Resources for Renewable Energy—The Cases of Biomass Gasification and Offshore Wind Power." *Environmental Innovation and Societal Transitions* 19 (June): 96–110. https://doi.org/10.1016/J.EIST.2015.10.002.

Khoury, R. El, N. Nasrallah, and B. Alareeni. 2021. "ESG and Financial Performance of Banks in the MENAT Region: Concavity–Convexity Patterns." *Journal of Sustainable Finance*

and Investment. https://doi.org/10.1080/20430795.2021.1929807.

Kiesel, Florian, and Felix Lücke. 2019. "ESG in Credit Ratings and the Impact on Financial Markets." *Financial Markets, Institutions and Instruments* 28 (3). https://doi.org/10.1111/fmii.12114.

Kölbel, Julian F., Timo Busch, and Leonhardt M. Jancso. 2017. "How Media Coverage of Corporate Social Irresponsibility Increases Financial Risk." *Strategic Management Journal* 38 (11). https://doi.org/10.1002/smj.2647.

Leslé, Vanessa Le, and Sofiya Avramova. 2012. "Revisiting Risk-Weighted Assets " Why Do RWAs Differ Across Countries and What Can Be Done About It ?" *IMF Working Paper* 90.

Li, Wenxin, Quyen Thuc Nguyen, and Meera Narayanaswamy. 2016. *How Banks Can Seize Opportunities in Climate and Green Investment*. *How Banks Can Seize Opportunities in Climate and Green Investment*. https://doi.org/10.1596/30353.

Liu, Hao, and Weilun Huang. 2022. "Sustainable Financing and Financial Risk Management of Financial Institutions—Case Study on Chinese Banks." *Sustainability* 14 (15). https://doi.org/10.3390/su14159786.

Luu, Hiep Ngoc, and Xuan Vinh Vo. 2021. "The Impact of Supervisory Stress Tests on Bank Ex-Ante Risk-Taking Behaviour: Empirical Evidence from a Quasi-Natural Experiment." *International Review of Financial Analysis* 75 (May): 101586. https://doi.org/10.1016/J.IRFA.2020.101586.

Martins, Henrique Castro. 2022. "Competition and ESG Practices in Emerging Markets: Evidence from a Difference-in-Differences Model." *Finance Research Letters* 46 (May): 102371. https://doi.org/10.1016/J.FRL.2021.102371.

Meslier, Céline, Ruth Tacneng, and Amine Tarazi. 2014. "Is Bank Income Diversification Beneficial? Evidence from an Emerging Economy." *Journal of International Financial*

Markets, Institutions and Money 31 (1): 97–126. https://doi.org/10.1016/J.INTFIN.2014.03.007.

Miller, Alan, and Stacy Swann. 2016. "Insurance Options for Addressing Climate Change." *EMCompass 13 International Finance Corporation*. http://hdl.handle.net/10986/30339.

Mondello, Gérard, Nissaf Ben, and Ayed Smaoui. 2021. "Agency Theory and Bank Governance: A Study of the Effectiveness of CEO's Remuneration for Risk Taking." https://shs.hal.science/halshs-03502607.

Nakano, Makoto, and Pascal Nguyen. 2012. "Board Size and Corporate Risk Taking: Further Evidence from Japan." *Corporate Governance: An International Review* 20 (4). https://doi.org/10.1111/j.1467-8683.2012.00924.x.

National Hurricane Center. 2017. "Hurricane Harvey -- August 25-September 4, 2017." National Hurricane Center. 2017. https://www.wpc.ncep.noaa.gov/tropical/rain/harvey2017.html.

National Weather Service. 2017. "Hurricane Irma Local Report/Summary." *National Weather Service*. https://www.weather.gov/mfl/hurricaneirma.

National Weather Service, and Central Pacific Hurricane Center. 2017. "Hurricane Maria." National Weather Service. 2017. https://www.nhc.noaa.gov/archive/2017/al15/al152017.public.037.shtml?

Nelson, David, and Gireesh Shrimali. 2014. "Finance Mechanisms for Lowering the Cost of Renewable Energy in Rapidly Developing Countries." www.climatepolicyinitiative.org.

Nguyen, James. 2012. "The Relationship between Net Interest Margin and Noninterest Income Using a System Estimation Approach." *Journal of Banking & Finance* 36 (9): 2429–37. https://doi.org/10.1016/J.JBANKFIN.2012.04.017.

OECD. 2017. "Green Financing: Challenges and Opportunities in the Transition to a Clean and Climate-Resilient Economy." *OECD Journal: Financial Market Trends* 2016 (2): 63–78.

https://doi.org/10.1787/fmt-2016-5jg0097l3qhl.

Parrado-Martínez, Purificación, Pilar Gómez-Fernández-Aguado, and Antonio Partal-Ureña. 2019. “Factors Influencing the European Bank’s Probability of Default: An Application of SYMBOL Methodology.” *Journal of International Financial Markets, Institutions and Money* 61 (July): 223–40. https://doi.org/10.1016/J.INTFIN.2019.04.003.

Poghosyan, Tigran, and Martin Čihak. 2011. “Determinants of Bank Distress in Europe: Evidence from a New Data Set.” *Journal of Financial Services Research* 40 (3). https://doi.org/10.1007/s10693-011-0103-1.

Rubin, Amir, and Amir Barnea. 2005. “Corporate Social Responsibility as a Conflict between Owners.” *Working Paper*, no. April.

Russo, Michael V., and Paul A. Fouts. 1997. “A Resource-Based Perspective on Corporate Environmental Performance and Profitability.” *Academy of Management Journal* 40 (3). https://doi.org/10.2307/257052.

Sadorsky, Perry. 2012. “Modeling Renewable Energy Company Risk.” *Energy Policy* 40 (1): 39–48. https://doi.org/10.1016/J.ENPOL.2010.06.064.

Schoenmaker, Dirk. 2017. “From Risk to Opportunity: A Framework for Sustainable Finance by Dirk Schoenmaker :: SSRN.” *RSM Series on Positive Change* 2.

Schoenmaker, Dirk.. 2018. “A Framework for Sustainable Finance.” *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3125351.

Sharfman, Mark P., and Chitru S. Fernando. 2008. “Environmental Risk Management and the Cost of Capital.” *Strategic Management Journal* 29 (6). https://doi.org/10.1002/smj.678.

Simpson, W. Gary, and Theodor Kohers. 2002. “The Link between Corporate Social and Financial Performance: Evidence from the Banking Industry.” *Journal of Business Ethics* 35 (2). https://doi.org/10.1023/A:1013082525900.

Starks, Laura. 2023. *Sustainable Finance and E, S, & G Issues: Values versus Value*. New

Orleans, LA, New Orleans, LA: Presidential address video AFA. https://afajof.org/presidential-address-videos/.

Stiroh, Kevin J. 2004. “Diversification in Banking: Is Noninterest Income the Answer?” *Journal of Money, Credit, and Banking* 36 (5). https://doi.org/10.1353/mcb.2004.0076.

Thompson, Paul. 1998. “Bank Lending and the Environment: Policies and Opportunities.” *International Journal of Bank Marketing* 16 (6). https://doi.org/10.1108/02652329810241384.

Vallascas, Francesco, Sabur Mollah, and Kevin Keasey. 2017. “Does the Impact of Board Independence on Large Bank Risks Change after the Global Financial Crisis?” *Journal of Corporate Finance* 44 (June): 149–66. https://doi.org/10.1016/J.JCORPFIN.2017.03.011.

Williams, Jonathan. 2004. “Determining Management Behaviour in European Banking.” *Journal of Banking and Finance* 28 (10). https://doi.org/10.1016/j.jbankfin.2003.09.010.

Wu, Meng Wen, and Chung Hua Shen. 2013. “Corporate Social Responsibility in the Banking Industry: Motives and Financial Performance.” *Journal of Banking & Finance* 37 (9): 3529–47. https://doi.org/10.1016/J.JBANKFIN.2013.04.023.

APPENDIX A

This section presents the main statistics of the study.

Table 1: Variable descriptions

This table illustrates the variables used in the study.

Variable	Source	Description
Dependent Variables		
RWA	Refinitiv Database	Percentage of Risk Weighted Assets as reported by banks to total assets. It represents the total value of each asset class multiplied by their assigned risk weighting, as defined by banking regulations. It is a proxy of banks' risk taking and represents the exposure of banks' portfolio. In the current banking regulation, it includes exposure to credit risk, market risk and operational risk.
Non-performing loans	Refinitiv Database	Non-performing-loans over total loans. Where non-performing loans indicates the amount of loans that the bank is not expecting to receive or that are already overdue.
Capitalization	Own calculation from data taken in Refinitiv Database	Capital Adequacy Ratio: Ratio between TIER1 capital, as reported by banks, and RWA. It measures the ability of the bank to absorb losses. It is a regulatory requirement for banks to maintain a minimum capital adequacy ratio to ensure financial stability.
Independent Variables		
Awareness	Own calculation from data taken in Refinitiv Database	Awareness of climate-change-related risks and opportunities: It measures the level of awareness a bank has regarding climate change risks and opportunities. It is calculated based on the Climate Change Commercial Risks Opportunities binary variable in the Refinitiv Database, which is set to 1 if a bank has introduced new products or services to address climate change threats to their existing business model or to seize climate change business opportunities. *awareness* is calculated as the weighted average of the previous and current years' binary variables, with linearly increasing weights. The resulting value ranges between 0 and 1.
Environmental products	Own calculation from data taken in Refinitiv Database	Environmental Products: It is used as an alternative measure of awareness to test the robustness of the results of the regression of RWA on awareness. It is calculated based on the Environment Products binary variable in the Refinitiv Database, which is set to 1 if the bank reports on at least one product line or service designed to have positive effects on the environment or which is environmentally labeled and marketed. env_prod is calculated as the weighted average of the previous and current years' binary variables, with linearly increasing weights. The resulting value ranges between 0 and 1. It reflects a broad awareness of the environment beyond just climate change.
Leverage ratio	Own calculation from data taken in Refinitiv Database	Tier1 leverage ratio: it is a measure of a financial institution's risk of excessive leverage, calculated by dividing Tier1 capital by total assets. The Basel III regulatory framework mandates that this ratio cannot fall below 3%. In this research, it is utilized to give an indication of the availability of capital for aware banks.

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Variable	Source	Description
Heatwave	Science Advances	Equals 1 for banks in countries hit by the Central European heatwave (Austria, Belgium, Finland, Germany, Ireland, Netherlands)
Post heatwave	Science Advances	Equals 1 for years after 2018, year of the Central European heatwave
Hurricane	National Weather Service	Equals 1 for banks in U.S. states hit by the hurricanes Harvey, Irma and Maria (Florida, North Carolina, Texas),
Post hurricane	National Weather Service	Equals 1 for years after 2017, year of the hurricanes Harvey, Irma and Maria
Control Variables		
Size	Own calculation from data taken in Refinitiv Database	Banks' size: It is computed as the natural logarithm of banks' total assets (total assets value expressed in thousands). Total assets value for banks includes the sum of cash & due from banks, total investments, net loans, customer liability on acceptances (if included in total assets), investment in unconsolidated subsidiaries, real estate assets, net property, plant and equipment and other assets.
Profitability	Refinitiv Database	Profitability: Banks' Return on Equity% computed by Worldscope as (Net Income – Bottom Line - Preferred Dividend Requirement) over (Average of Last Year's and Current Year's Common Equity) multiplied by 100.
Inefficiency	Own calculation from data taken in Refinitiv Database	Inefficiency: Ratio between banks' operating expense and operating income.
Diversification	Own calculation from data taken in Refinitiv Database	Revenue diversification: It is computed as the ratio between non-interest income and operating income. It indicates a bank's dependence on non-traditional activities that generate fees, trading revenue, and other forms of non-interest income.
Net loans	Own calculation from data taken in Refinitiv Database	Asset structure: Ratio between net loans and total assets. It measures the proportion of loans in banks' portfolio
Capital structure	Refinitiv Database	Capital structure: Percentage of Total debt to total capital.
Board size	Refinitiv Database	Board size: The total number of board members at the end of the fiscal year.
Board independence	Refinitiv Database	Board independence: Percentage of independent board members as reported by the company.
Board diversity	Refinitiv Database	Board gender diversity: Percentage of female on the board.

Table 2: EU-panel. Distributions of observations and banks by country.

This table illustrates the distribution of the banks-year observations and banks across EU countries. The panel includes 184 active banks in the Euro-area between the years 2013 and 2021 included.

Country Name	Observation Frequency	Banks Frequency	Percentage	Cumulative percentage
Austria	144	16	8.70	8.70
Belgium	45	5	2.72	11.41
Finland	90	10	5.43	16.85
France	252	28	15.22	32.07
Germany	243	27	14.67	46.74.
Greece	54	6	3.26	50.00
Ireland	126	14	7.61	57.61
Italy	189	21	11.41	69.02
Netherlands	90	10	5.43	74.46
Portugal	27	3	1.63	76.09
Spain	396	44	23.91	100.00
Total	1656	184	100.00	

Table 3: U.S.-panel. Distributions of observations and banks by state.

This table illustrates the distribution of the banks-year observations and banks across US states. The panel includes 188 active banks in the U.S. between the years 2013 and 2021 included.

State Name	Observation Frequency	Banks Frequency	Percentage	Cumulative percentage
Alabama	45	5	2.66	2.66
Arizona	18	2	1.06	3.72
Arkansas	9	1	0.53	4.26
California	225	25	13.30	17.55
Connecticut	18	2	1.06	18.62
Delaware	9	1	0.53	19.15
Florida	27	3	1.60	20.74
Georgia	18	2	1.06	21.81
Hawaii	27	3	1.60	23.40
Illinois	63	7	3.72	27.13
Kansas	18	2	1.06	28.19
Minnesota	63	7	3.72	31.91
Mississippi	36	4	2.13	34.04
Missouri	45	5	2.66	36.70

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State Name	Observation Frequency	Banks Frequency	Percentage	Cumulative percentage
Montana	9	1	0.53	37.23
New Jersey	9	1	0.53	37.77
New York	324	36	19.15	56.91
North Carolina	198	22	11.70	68.62
Ohio	153	17	9.04	77.66
Oklahoma	27	3	1.60	79.26
Pennsylvania	63	7	3.72	82.98
Rhode Island	36	4	2.13	85.11
Tennessee	36	4	2.13	87.23
Texas	117	13	6.91	94.15
Utah	36	4	2.13	96.28
Virginia	9	1	0.53	96.81
Washington	27	3	1.60	98.40
West Virginia	9	1	0.53	98.94
Wisconsin	18	2	1.06	100
Total	1692	188	100.00	

Table 4: EU-panel summary statistics.

This table illustrates the summary statistics for the EU-panel. The panel includes 184 active banks in the Euro-area between the years 2013 and 2021.

	Count	Mean	sd	Min	Max
RWA	1656	38.72634	11.8087	17.1618	87.96937
Capitalization	1482	0.1314345	0.0195589	0.0814629	0.1957124
Awareness	1656	0.8712121	0.3011794	0	1
Environmental products	1638	0.9662005	0.1516346	0	1
Leverage Ratio	1482	0.0503119	0.0151488	0.0211054	0.1266675
Non-performing loans	1607	0.0686613	0.0820216	0.0072	0.6407
Size	1656	19.98402	1.312256	16.80789	22.56534
Profitability	1656	3.974408	9.133323	-55.61	27.18
Inefficiency	1646	0.9105796	0.1795686	0.4536824	2.186307
Diversification	1648	0.3597547	0.1398184	0.0635226	0.7310718
Net loans	1656	0.5701503	0.1361802	0.2658324	0.8609006
Capital structure	1656	77.73402	8.752428	30.17	93.59
Board size	1648	15.57464	4.028347	6	28
Board independence	1645	59.13703	22.06294	0	100
Board diversity	1656	29.96242	10.99171	0	55.56

Table 5: U.S.-panel summary statistics.

This table illustrates the summary statistics for the US-panel. The panel includes 188 active banks in the U.S. between the years 2013 and 2021.

	Count	Mean	sd	Min	Max
RWA	1692	71.10595	12.29908	39.9547	110.8291
Awareness	1692	0.3972168	0.4572914	0	1
Environmental products	1611	0.4539812	0.4749818	0	1
Leverage Ratio	1176	0.0811434	0.0144253	0.0543482	0.1513407
Size	1692	18.67051	1.885118	15.28635	22.0433
Profitability	1692	10.05954	4.474496	-1.36	34.59
Inefficiency	1635	0.6881738	0.0868092	0.4506273	1.037571
Diversification	1692	0.310051	0.1491936	0.0134475	1.05315
Net loans	1692	0.5757191	0.1570564	0.1400092	0.9585977
Capital structure	1692	47.63858	16.86571	4.06	72.63
Board size	1608	13.26368	3.130257	7	33
Board independence	1573	84.89531	8.339619	43.24	94.44
Board diversity	1573	23.49914	9.712298	0	55.56

Table 6: EU-panel Pearson correlation.

This table shows the Pearson correlation matrix between the variables of the regression of RWA on awareness. All the independent variables are lagged by one period except RWA. * represents significance at the 5% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RWA	1.00											
(2) $Awareness_{t-1}$	-0.12*	1.00										
(3) $Size_{t-1}$	-0.58*	0.53*	1.00									
(4) $Leverage\ ratio_{t-1}$	0.86*	-0.20*	-0.62*	1.00								
(5) $Profitability_{t-1}$	-0.16*	0.03	0.19*	-0.02	1.00							
(6) $Inefficiency_{t-1}$	0.20*	0.05*	-0.19*	0.02	-0.76*	1.00						
(7) $Diversification_{t-1}$	-0.50*	0.17*	0.33*	-0.58*	0.17*	-0.13*	1.00					
(8) $Net\ loans_{t-1}$	0.62*	-0.38*	-0.71*	0.67*	0.01	0.000	-0.52*	1.00				
(9) $Capital\ structure_{t-1}$	-0.32*	0.27*	0.30*	-0.41*	-0.09*	0.09*	0.07*	-0.11*	1.00			
(10) Board size $_{t-1}$	-0.04	0.26*	0.14*	-0.17*	-0.14*	0.15*	0.22*	-0.33*	0.18*	1.00		
(11) Board independence $_{t-1}$	0.17*	-0.12*	0.0	0.16*	0.07*	-0.09*	-0.03	0.19*	-0.19*	-0.39*	1.00	
(12) Board diversity $_{t-1}$	-0.50*	0.21*	0.46*	-0.46*	0.20*	-0.22*	0.48*	-0.47*	0.02	0.03	0.15*	1.00

Table 7: U.S.-panel Pearson correlation.

This table shows the Pearson correlation matrix between the variables of the regression of RWA on *Awareness*. All the variables are lagged by one period except RWA. * represents significance at the 5% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RWA	1.00											
(2) Awareness$_{t-1}$	-0.25*	1.00										
(3) Size$_{t-1}$	-0.29*	0.80*	1.00									
(4) Leverage ratio$_{t-1}$	0.42*	-0.51*	-0.60*	1.00								
(5) Profitability$_{t-1}$	0.14*	-0.14*	-0.09*	0.15*	1.00							
(6) Inefficiency$_{t-1}$	0.01	0.32*	0.33*	-0.29*	-0.53*	1.00						
(7) Diversification$_{t-1}$	-0.17*	0.47*	0.50*	-0.42*	-0.09*	0.31*	1.00					
(8) Net loans$_{t-1}$	0.65*	-0.56*	-0.57*	0.49*	0.20*	-0.13*	-0.51*	1.00				
(9) Capital structure$_{t-1}$	-0.16*	0.44*	0.56*	-0.20*	-0.01	0.30*	0.12*	-0.22*	1.00			
(10) Board size $_{t-1}$	-0.00	0.22*	0.30*	-0.28*	-0.08*	0.21*	0.37*	-0.19*	0.11*	1.00		
(11) Board independence $_{t-1}$	0.02	0.39*	0.43*	-0.27*	0.12*	0.09*	0.34*	-0.24*	0.20*	-0.06*	1.00	
(12) Board diversity $_{t-1}$	-0.11*	0.43*	0.45*	-0.34*	0.12*	0.07*	0.17*	-0.18*	0.25*	0.09*	0.41*	1.00

Table 8: EU-panel regressions of RWA on *Awareness*

The multiple-regression table displays five regressions of RWA on *Awareness*, with each regression controlling for different fixed effects. Column (1) displays the regression without any fixed effect, column (2) includes only the bank fixed effect. Column (3) considers only the year fixed effect, and column (4) includes only the country effect to the regression. Column (5) includes all the three fixed effects. The standard errors in all the regressions are clustered at the bank level. All the regressors are lagged by one period. Apart from the *Awareness* variables, all the other regressors function as control variables. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

			RWA		
	(1)	(2)	(3)	(4)	(5)
$Awareness_{t-1}$	-7.913	-12.56**	-9.996**	-16.94***	-17.99***
	(-1.36)	(-2.48)	(-2.20)	(-3.45)	(-4.06)
$Awareness^2_{t-1}$	10.82**	8.548*	13.64***	17.28***	12.77***
	(2.11)	(1.75)	(3.40)	(3.96)	(3.04)
$Size_{t-1}$	-0.298	-18.05***	-0.432	0.192	-8.255***
	(-0.80)	(-11.13)	(-1.24)	(0.66)	(-5.00)
Leverage ratio $_{t-1}$	541.0***	150.4***	537.5***	532.0***	171.0***
	(18.10)	(3.08)	(22.69)	(19.70)	(3.48)
Profitability $_{t-1}$	-0.0535**	0.0518***	-0.134***	-0.0738***	-0.0297*
	(-2.40)	(2.80)	(-5.52)	(-3.09)	(-1.69)
$Inefficiency_{t-1}$	4.657***	1.726	-0.0336	2.213	-0.459
	(3.16)	(1.54)	(-0.03)	(1.32)	(-0.65)
Diversification $_{t-1}$	-0.827	-0.884	-1.586	-11.04***	-2.599
	(-0.35)	(-0.33)	(-0.76)	(-4.34)	(-0.99)
$Net\ loans_{t-1}$	3.802	5.090	8.869***	-7.115**	17.04***
	(1.21)	(1.13)	(3.66)	(-2.22)	(3.78)
Capital structure $_{t-1}$	-0.0165	0.214***	-0.0852**	0.0712*	0.0654
	(-0.41)	(5.63)	(-2.27)	(1.67)	(1.54)
Board size $_{t-1}$	0.297***	0.325***	0.404***	-0.0565	0.230***
	(5.16)	(4.04)	(7.41)	(-0.62)	(3.29)
Board independence $_{t-1}$	0.0639***	-0.0550**	0.0722***	-0.0120	0.0135
	(5.42)	(-2.07)	(6.38)	(-0.86)	(0.52)
Board diversity $_{t-1}$	-0.190***	-0.0763***	-0.0463	-0.108***	0.000499
	(-7.07)	(-3.64)	(-1.53)	(-5.56)	(0.02)
constant	7.757	375.4***	10.45	13.72*	181.9***
	(0.92)	(10.76)	(1.40)	(1.97)	(5.24)
N	1291	1291	1291	1291	1291
Adjusted R^2	0.794	0.924	0.845	0.863	0.941
bank FE	No	Yes	No	No	Yes
year FE	No	No	Yes	No	Yes
country FE	No	No	No	Yes	Yes

Table 9: U.S.-panel regressions of RWA on *Awareness*

This table displays six regressions of RWA on awareness, with each regression controlling for different fixed effects. Column (1) shows the regression without any fixed effect, column (2) includes only the bank fixed effect. Column (3) considers only the year fixed effect, and column (4) includes only the state fixed effect to the regression. Column (5) includes all the three fixed effects. Adding the bank fixed effect, the sign of the *Awareness* change. This may raise the concern that the bank-fixed effect absorbs the bank-level variation. Column (6) shows the results without the bank-fixed effect. The standard errors are clustered at the bank level. All the regressors are lagged by one period. Except for the *Awareness* variables, all the other regressors are control variables. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	RWA					
	(1)	(2)	(3)	(4)	(5)	(6)
$Awareness_{t-1}$	-4.600	14.65***	1.449	0.734	2.949	6.897
	(-1.03)	(3.67)	(0.33)	(0.14)	(0.75)	(1.45)
$Awareness^2_{t-1}$	7.621*	-28.94***	2.920	4.363	-7.326	-1.798
	(1.67)	(-4.44)	(0.64)	(0.79)	(-0.88)	(-0.34)
$Size_{t-1}$	-0.444	-11.33***	-0.907	-1.639	-0.788	-0.523
	(-0.81)	(-5.20)	(-1.64)	(-1.14)	(-0.30)	(-0.39)
Leverage ratio $_{t-1}$	141.7***	202.1***	83.97	151.5***	116.2***	33.12
	(3.08)	(4.90)	(1.62)	(2.91)	(3.39)	(0.52)
Profitability $_{t-1}$	0.106	-0.158***	0.259*	-0.0525	-0.268***	0.0636
	(0.81)	(-2.61)	(1.90)	(-0.53)	(-2.96)	(0.49)
$Inefficiency_{t-1}$	7.401	14.23***	22.00***	3.479	19.95***	20.74***
	(1.18)	(2.71)	(3.54)	(0.52)	(2.75)	(2.70)
Diversification $_{t-1}$	16.39***	22.97***	4.207	26.15***	36.43***	11.77
	(3.12)	(3.14)	(0.71)	(2.69)	(3.05)	(1.06)
Net $loans_{t-1}$	54.85***	20.88**	49.92***	55.24***	6.948	58.14***
	(10.62)	(2.20)	(9.58)	(10.91)	(0.57)	(11.12)
Capital structure $_{t-1}$	-0.0627	0.137***	-0.155***	0.00287	0.00663	-0.219***
	(-1.36)	(2.97)	(-3.33)	(0.04)	(0.16)	(-2.81)
Board size $_{t-1}$	0.460**	-1.031***	0.528***	0.511***	-0.934***	0.286
	(2.55)	(-6.96)	(2.94)	(2.66)	(-4.79)	(1.62)
Board independence $_{t-1}$	0.140	-0.0748	0.117	0.0902	-0.140**	0.0514
	(1.37)	(-1.50)	(1.30)	(1.03)	(-2.60)	(0.83)
Board diversity $_{t-1}$	-0.0541	-0.130***	0.0361	0.0496	0.0259	0.282***
	(-1.42)	(-3.00)	(0.95)	(0.79)	(0.58)	(3.61)
constant	9.023	266.4***	20.29*	28.77	74.13	18.71
	(0.88)	(5.68)	(1.93)	(1.31)	(1.35)	(0.84)
N	941	936	941	941	936	941
Adjusted R^2	0.520	0.800	0.608	0.588	0.839	0.704
bank FE	No	Yes	No	No	Yes	No
year FE	No	No	Yes	No	Yes	Yes
state FE	No	No	No	Yes	Yes	Yes

Table 10: EU-panel difference-in-difference.

Table shows difference-in-difference regression for the 2018 heatwave's impact on banks' RWA in the EU panel. *Heatwave* equals 1 for banks in countries hit by the heatwaves (Austria, Belgium, Finland, Germany, Ireland, Netherlands), *Post heatwave* equals 1 for years after 2018. *Heatwave*×*Post heatwave* is their interaction. Its coefficient represents how much the average RWA of the treatment group has changed in the period after the heatwave, compared to what would happen to the same group without the heatwave, under the parallel shift assumption. The standard errors are clustered at the bank level. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	RWA
Heatwave	-4.346***
	(-7.51)
Post heatwave	-3.346***
	(-7.69)
Heatwave×Post heatwave	-1.421**
	(-2.58)
$Size_{t-1}$	-0.314
	(-0.83)
Leverage ratio $_{t-1}$	532.7***
	(20.13)
Profitability $_{t-1}$	-0.134***
	(-5.82)
$Inefficiency_{t-1}$	-2.887**
	(-2.21)
Diversification $_{t-1}$	-9.074***
	(-3.78)
Net $loans_{t-1}$	1.784
	(0.71)
Capital structure $_{t-1}$	-0.0338
	(-0.92)
Board size $_{t-1}$	0.391***
	(7.56)
Board independence $_{t-1}$	0.0555***
	(5.67)
Board diversity $_{t-1}$	-0.0950***
	(-3.61)
constant	22.95***
	(2.68)
N	1291
Adjusted R^2	0.848

Table 11: U.S.-panel difference-in-difference.

Table shows difference-in-difference regression for hurricanes 2017 season' impact on banks' RWA in the U.S. panel. *Hurricane* equals 1 for banks in the states hit by the hurricanes (Florida, North Carolina, Texas), *Post hurricane* equals 1 for years after 2017. *Hurricane×Post hurricane* is their interaction. its coefficient represents how much the average RWA of the treatment group has changed in the period after the hurricane season, compared to what would happen to the same group without the hurricane season, under the parallel shift assumption. The standard errors are clustered at the bank level. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	RWA
Hurricane	0.454
	(0.44)
Post hurricane	-2.992***
	(-3.31)
Hurricane×Post hurricane	-1.617
	(-1.15)
$Size_{t-1}$	-0.159
	(-0.34)
Leverage ratio $_{t-1}$	139.7***
	(2.81)
Profitability $_{t-1}$	0.151
	(1.13)
$Inefficiency_{t-1}$	10.62*
	(1.79)
Diversification $_{t-1}$	12.28**
	(2.08)
Net $loans_{t-1}$	50.93***
	(10.27)
Capital structure $_{t-1}$	-0.0769*
	(-1.72)
Board size $_{t-1}$	0.513***
	(2.93)
Board independence $_{t-1}$	0.169
	(1.61)
Board diversity $_{t-1}$	-0.0307
	(-0.76)
constant	5.042
	(0.57)
N	941
Adjusted R^2	0.530

Table 12: EU-panel robustness check.

The table shows two robustness tests for the Euro-area panel. In columns (1) to (4), RWA is regressed on *Awareness* of four different random subsamples. Each subsample contains 75% of banks in the original datasets. In column (5), there is the entire sample regression. In column (6), the *Environmental products* variable substitutes *Awareness*. It indicates if the banks provide services that benefit the environment. Standard errors are clustered at the bank level. t-statistic is shown in parentheses.* represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	RWA					
	(1)	(2)	(3)	(4)	(5)	(6)
$Awareness_{t-1}$	-16.74***	-17.23***	-21.48***	-16.64***	-17.99***	
	(-3.33)	(-3.52)	(-3.68)	(-3.45)	(-4.06)	
$Awareness^2_{t-1}$	12.41**	12.19***	15.48***	11.18**	12.77***	
	(2.59)	(2.61)	(2.91)	(2.39)	(3.04)	
Environmental $products_{t-1}$						-27.59***
						(-3.13)
Environmental $products^2_{t-1}$						17.31***
						(2.75)
$Size_{t-1}$	-10.22***	-7.279***	-8.147***	-7.702***	-8.255***	-9.410***
	(-5.56)	(-3.90)	(-4.00)	(-4.09)	(-5.00)	(-6.43)
Leverage $ratio_{t-1}$	147.9***	186.4***	151.0**	190.7***	171.0***	163.2***
	(2.69)	(3.51)	(2.48)	(3.49)	(3.48)	(3.58)
$Profitability_{t-1}$	-0.0407**	-0.0301	-0.0312*	-0.0196	-0.0297*	-0.0292*
	(-2.03)	(-1.39)	(-1.71)	(-0.95)	(-1.69)	(-1.66)
$Inefficiency_{t-1}$	-1.036	-0.397	-0.692	0.0764	-0.459	-0.482
	(-1.03)	(-0.53)	(-0.76)	(0.10)	(-0.65)	(-0.59)
$Diversification_{t-1}$	-1.282	-2.622	-2.801	-3.187	-2.599	-0.734
	(-0.44)	(-0.79)	(-1.06)	(-0.96)	(-0.99)	(-0.44)
$Net\ loans_{t-1}$	13.75***	18.06***	17.34***	18.47***	17.04***	7.064
	(3.08)	(3.19)	(3.59)	(3.39)	(3.78)	(1.49)
Capital $structure_{t-1}$	0.119***	0.0678	0.0186	0.0583	0.0654	0.0824**
	(2.95)	(1.40)	(0.35)	(1.15)	(1.54)	(2.12)
Board $size_{t-1}$	0.298***	0.192**	0.239***	0.202**	0.230***	0.237***
	(3.51)	(2.52)	(2.95)	(2.45)	(3.29)	(3.83)
Board $independence_{t-1}$	0.0289	-0.000271	0.0256	0.000988	0.0135	-0.0118
	(1.05)	(-0.01)	(0.82)	(0.03)	(0.52)	(-0.52)
Board $diversity_{t-1}$	-0.0156	0.00986	-0.00185	0.00811	0.000499	-0.0260
	(-0.61)	(0.35)	(-0.06)	(0.28)	(0.02)	(-1.15)
constant	218.3***	161.8***	184.4***	170.2***	181.9***	217.0***
	(5.58)	(4.14)	(4.33)	(4.34)	(5.24)	(6.80)
N	961	978	953	981	1291	1281
Adjusted R^2	0.949	0.936	0.938	0.941	0.941	0.945
bank FE	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes
country FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 13: US-panel robustness check.

The table shows two robustness tests for the U.S. panel. In columns (1) to (4), RWA is regressed on *Awareness* of four different random subsamples. Each subsample contains 75% of banks in the original datasets. In column (5), there is the entire sample regression. In column (6), the *Environmental products* variable substitutes *Awareness*. It indicates if the banks provide services that benefit the environment. Standard errors are clustered at the bank level.. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	RWA					
	(1)	(2)	(3)	(4)	(5)	(6)
$Awareness_{t-1}$	2.789	4.494	1.974	3.532	2.949	
	(0.68)	(0.87)	(0.46)	(0.67)	(0.75)	
$Awareness^2_{t-1}$	-7.604	-11.09	-7.312	-3.566	-7.326	
	(-0.83)	(-1.01)	(-0.81)	(-0.38)	(-0.88)	
Environmental $products_{t-1}$						-6.361
						(-1.08)
Environmental $products^2_{t-1}$						15.28
						(1.56)
$Size_{t-1}$	-3.351	-1.951	-0.468	2.581	-0.788	0.119
	(-1.08)	(-0.57)	(-0.15)	(0.98)	(-0.30)	(0.05)
Leverage $ratio_{t-1}$	115.9***	78.12*	146.8***	102.9**	116.2***	119.5***
	(2.91)	(1.69)	(4.05)	(2.61)	(3.39)	(3.44)
$Profitability_{t-1}$	-0.390***	-0.239**	-0.256**	-0.195**	-0.268***	-0.226**
	(-3.26)	(-2.25)	(-2.52)	(-2.00)	(-2.96)	(-2.46)
$Inefficiency_{t-1}$	13.56	26.69***	21.08***	18.36**	19.95***	21.09***
	(1.57)	(3.19)	(2.63)	(2.12)	(2.75)	(2.86)
$Diversification_{t-1}$	37.55***	33.22**	35.54***	45.99***	36.43***	36.73***
	(2.82)	(2.28)	(2.89)	(2.99)	(3.05)	(3.00)
$Net\ loans_{t-1}$	10.12	5.826	11.08	1.227	6.948	7.786
	(0.68)	(0.41)	(0.82)	(0.09)	(0.57)	(0.67)
Capital $structure_{t-1}$	0.0393	-0.0557	0.0341	-0.0173	0.00663	0.0136
	(0.93)	(-1.05)	(0.76)	(-0.34)	(0.16)	(0.35)
Board $size_{t-1}$	-0.863***	-1.036***	-0.952***	-0.862***	-0.934***	-0.901***
	(-3.64)	(-5.05)	(-4.00)	(-3.77)	(-4.79)	(-4.90)
Board $independence_{t-1}$	-0.170***	-0.141**	-0.181***	-0.0790	-0.140**	-0.145***
	(-2.81)	(-2.03)	(-3.01)	(-1.34)	(-2.60)	(-2.68)
Board $diversity_{t-1}$	0.0181	0.0563	0.0372	-0.0125	0.0259	0.0380
	(0.35)	(0.91)	(0.76)	(-0.25)	(0.58)	(0.91)
constant	127.2*	101.1	64.74	5.231	74.13	47.38
	(1.94)	(1.43)	(1.03)	(0.10)	(1.35)	(0.92)
N	693	709	704	702	936	933
Adjusted R^2	0.838	0.816	0.852	0.848	0.839	0.839
bank FE	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes
state FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 14: Mechanism Evidence.

Column (1) and (2) show the regression analysis of RWA on *Non-performing loans* and of *Non-performing loans* on *Awareness*. Columns (3) and (4) examine the impact of the *Leverage ratio* on RWA and the impact of *Awareness* variables on the leverage ratio. Column (5) displays the regression of *Capitalization* on *Awareness*. All regressors are lagged by one period. The analysis is performed on the EU-panel comprising 184 banks across the Euro-area for the time period between 2013 and 2021. All regression models include bank, country, and year fixed effects. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	(1) **RWA**	(2) **Non-performing loans**	(3) **RWA**	(4) **Leverage ratio**	(5) **Capitalization**
$Awareness_{t-1}$		-0.103**		-0.00151	0.0433***
		(-2.04)		(-0.44)	(4.02)
$Awareness^2_{t-1}$		0.0752		0.00859**	-0.0279***
		(1.54)		(2.21)	(-2.61)
Leverage ratio $_{t-1}$	75.59**	0.742	147.7***		
	(2.27)	(1.32)	(3.02)		
Non-performing loans $_{t-1}$	39.55***				
	(5.92)				
$Size_{t-1}$	-9.788***	0.0520	-10.05***	-0.0185***	-0.0173***
	(-6.83)	(1.51)	(-5.71)	(-7.61)	(-3.25)
Profitability $_{t-1}$	-0.00354	-0.000614**	-0.0250	-0.000137***	-0.000103
	(-0.17)	(-2.21)	(-1.45)	(-3.61)	(-1.35)
$Inefficiency_{t-1}$	-5.193***	0.0664***	-1.502	-0.00400	0.00390
	(-4.30)	(4.14)	(-1.61)	(-1.01)	(0.55)
Diversification $_{t-1}$	-4.009	-0.0870***	-3.238	-0.00105	0.00395
	(-1.33)	(-2.65)	(-1.08)	(-0.43)	(0.58)
$Net\ loans_{t-1}$	15.76***	0.118	11.23***	0.0126**	-0.00358
	(3.97)	(1.44)	(2.65)	(2.36)	(-0.27)
Capital structure $_{t-1}$	-0.0255	0.00187***	0.107***	0.000129***	0.000271**
	(-0.54)	(5.93)	(2.62)	(3.26)	(2.49)
Board size $_{t-1}$	0.228***	0.00272***	0.268***	0.000222	-0.000419
	(3.60)	(3.49)	(3.78)	(1.44)	(-1.13)
Board independence $_{t-1}$	0.0284	-0.000793***	0.00737	0.0000470***	0.0000118
	(1.21)	(-2.90)	(0.30)	(2.73)	(0.24)
Board diversity $_{t-1}$	-0.00312	0.000783*	-0.0186	0.00000112	0.000188**
	(-0.15)	(1.67)	(-0.83)	(0.06)	(2.37)
constant	221.5***	-1.246*	215.9***	0.396***	0.441***
	(7.78)	(-1.72)	(5.74)	(7.97)	(4.03)
N	1242	1258	1291	1472	1472
Adjusted R^2	0.947	0.816	0.937	0.893	0.728
bank FE	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes
country FE	Yes	Yes	Yes	Yes	Yes

APPENDIX B

This section presents additional calculations employed in the study.

Table 15: EU-panel Hausman test.

The table illustrates the Hausman test performed to choose between the fixed effects model or the random effects model. The null hypothesis of the test is H0 = Difference in coefficients not systematic. The test is performed on 184 active banks in the Euro-area between the years 2013 and 2021 included. The dependent variable of the regressions is banks' RWA. All the regressors are lagged by one period.

	(b) **FE**	(B) **RE**	(b-B) **Difference**	sqrt(diag(V_b-V_B)) **Std. err.**
$Awareness_{t-1}$	-12.5553	-12.1870	-0.3683	
$Awareness^2_{t-1}$	8.5480	11.8012	-3.2532	
$Size_{t-1}$	-18.0519	-1.0416	-17.0103	1.1375
Leverage ratio $_{t-1}$	150.3513	400.6828	-250.3315	9.7815
Profitability $_{t-1}$	0.0518	-0.0022	0.0733	
$Inefficiency_{t-1}$	1.7264	3.8073	-2.0809	
Diversification $_{t-1}$	-0.8835	-4.0698	3.1863	0.8447
$Net\ loans_{t-1}$	5.0903	4.4439	0.6464	1.8146
Capital structure $_{t-1}$	0.2138	0.0346	0.1792	0.0106194
Board size $_{t-1}$	0.32461	0.1948	0.1298	0.01541
Board independence $_{t-1}$	-0.0550	0.0132	-0.0682	0.0053
Board diversity $_{t-1}$	-0.0763	-0.2038	0.1275	

$$\chi^2_{12} = 331.68$$

$$\text{Prob} > \chi^2 = 0.0000$$

Table 16: U.S.-panel Hausman test.

The table illustrates the Hausman test performed to choose between the fixed effects model or the random effects model. The null hypothesis of the test is H0 = Difference in coefficients not systematic. The test is performed on 188 active banks in the U.S. between the years 2013 and 2021 included. The dependent variable of the regressions is banks' RWA. All the regressors are lagged by one period.

	(b) **FE**	(B) **RE**	(b-B) **Difference**	sqrt(diag(V_b-V_B)) **Std. errs.**
$Awareness_{t-1}$	14.6549	-9.4210	24.0759	3.1005
$Awareness^2_{t-1}$	-28.940	10.2382	-39.1780	5.9110
$Size_{t-1}$	-11.3333	-0.7997	-10.5337	1.9370
Leverage ratio $_{t-1}$	202.1226	189.734	12.3885	26.0046
Profitability $_{t-1}$	-0.1577	-0.0932	-0.0645	0.0371
$Inefficiency_{t-1}$	14.2293	8.4507	5.7786	2.2684
Diversification $_{t-1}$	22.9742	40.8297	-17.8555	5.4452
$Net\ loans_{t-1}$	20.8835	57.7067	-36.8231	8.2630
Capital structure $_{t-1}$	0.1367	0.0724	0.0642	0.0294
Board size $_{t-1}$	-1.0307	-0.3568	-0.6739	0.1103
Board independence $_{t-1}$	-0.0748	-0.0030	-0.0719	0.0254
Board diversity $_{t-1}$	-0.1298	-0.1049	-0.0249	0.0226355
		$\chi^2_{11} = 65.48$		
		Prob > χ^2 = 0.0000		

Table 17: EU-panel variance inflation factor.

This table shows the variance inflation factor (VIF) of the dependent variables of the regression of RWA on *Awareness*. VIF is a measure of multicollinearity. As a rule of thumb, if VIF is higher than 10, the model has multicollinearity issue, which impacts the significance of the regressors.

	VIF	1/VIF
$Size_{t-1}$	3.772	0.265
Net $loans_{t-1}$	3.624	0.276
Leverage $ratio_{t-1}$	3.341	0.299
$Profitability_{t-1}$	2.831	0.353
$Inefficiency_{t-1}$	2.756	0.363
$Diversification_{t-1}$	2.114	0.473
$Awareness_{t-1}$	1.93	0.518
Board $diversity_{t-1}$	1.706	0.586
Capital $structure_{t-1}$	1.616	0.619
Board $size_{t-1}$	1.454	0.688
Board $independence_{t-1}$	1.327	0.754
Mean VIF	2.406	.

Table 18: U.S.-panel variance inflation factor.

This table shows the variance inflation factor (VIF) of the dependent variables of the regression of RWA on awareness. VIF is a measure of multicollinearity. As a rule of thumb, if VIF is higher than 10, the model has multicollinearity issue, which impacts the significance of the regressors.

	VIF	1/VIF
$Size_{t-1}$	7.157	0.14
$Awareness_{t-1}$	4.17	0.24
$Diversification_{t-1}$	3.287	0.304
$Net\ loans_{t-1}$	3.076	0.325
$Capital\ structure_{t-1}$	2.176	0.46
$Inefficiency_{t-1}$	1.928	.0519
$Leverage\ ratio_{t-1}$	1.779	0.562
$Board\ independence_{t-1}$	1.715	0.583
$Board\ diversity_{t-1}$	1.689	0.592
$Profitability_{t-1}$	1.658	0.603
$Board\ size_{t-1}$	1.397	0.716
Mean VIF	2.73	.

Table 19: EU-panel linear regression RWA on *Awareness*

This table shows the regression of RWA on *Awareness* excluding the quadratic term of *Awareness*. The standard errors are clustered at the bank level. All the regressors are lagged by one period. Apart from the *Awareness* variable, all the other regressors function as control variables. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level. The model includes the bank fixed effect, the year fixed effect and the country fixed effect.

	RWA
$Awareness_{t-1}$	-5.643***
	(-4.05)
$Size_{t-1}$	-8.456***
	(-4.81)
Leverage ratio $_{t-1}$	175.6***
	(3.62)
Profitability $_{t-1}$	-0.0205
	(-1.15)
$Inefficiency_{t-1}$	-0.773
	(-0.99)
Diversification $_{t-1}$	-2.608
	(-0.92)
Net $loans_{t-1}$	15.98***
	(3.47)
Capital structure $_{t-1}$	0.0741*
	(1.77)
Board size $_{t-1}$	0.255***
	(3.51)
Board independence $_{t-1}$	0.00693
	(0.28)
Board diversity $_{t-1}$	-0.00507
	(-0.22)
constant	186.1***
	(5.02)
N	1291
Adjusted R^2	0.939
bank FE	Yes
year FE	Yes
country FE	Yes

Table 20: U.S.-panel linear regression RWA on *Awareness*

This table shows the regression of RWA on Awareness excluding the quadratic term of Awareness. The standard errors are clustered at the bank level. All the regressors are lagged by one period. Apart from the *Awareness* variable, all the other regressors function as control variables. t-statistic is shown in parentheses. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level. The model includes the bank fixed effect, the year fixed effect and the state fixed effect.

	RWA
$Awareness_{t-1}$	-1.362
	(-0.42)
$Size_{t-1}$	-0.0697
	(-0.03)
Leverage ratio $_{t-1}$	116.7***
	(3.44)
Profitability $_{t-1}$	-0.261***
	(-2.91)
$Inefficiency_{t-1}$	19.55***
	(2.78)
Diversification $_{t-1}$	38.10***
	(3.08)
$Net\ loans_{t-1}$	9.006
	(0.80)
Capital structure $_{t-1}$	0.00534
	(0.13)
Board size $_{t-1}$	-0.905***
	(-4.92)
Board independence $_{t-1}$	-0.141***
	(-2.64)
Board diversity $_{t-1}$	0.0402
	(0.96)
constant	56.87
	(1.19)
N	936
Adjusted R^2	0.839
bank FE	Yes
year FE	Yes
state FE	Yes