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Sustainability and bank risk

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ABSTRACT Banks play a key role in society and are crucial for economic development. The existing literature finds a positive association between bank performance and sustainability, but tends to neglect the risk dimension. As human-driven processes interact with global social-ecological connectivity and exhibit cross-scale relationships, we investigate whether sustainability affects banks' individual default risk and their systemic risk, that is, their contribution to the risk of the financial system. As banks are financial intermediaries and there is no direct measure of their sustainability, we proxy for sustainability with banks' performance on environmental, social, and governance attributes, especially their policies and performance. We control for relevant bank, market and country characteristics. It shows that higher sustainability scores of banks significantly associate with lower default risk. We also establish that outperformance on sustainability reduces banks' contribution to systemic risk. Thus, it appears that banks' sustainability performance can spill over to the financial system. This implies sustainability is material for banks and their supervisors. Accounting for sustainability can augment bank risk management and prudential policy decision making, and provide guidance as to how to finance a transition towards an economic system that effectively internalizes externalities.

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Introduction

Banks play a central and crucial role in society and they mediate capital and assets between surplus and deficit spending households throughout the economy (Cull et al., 2013). As such, they bear great responsibility for sustainable development (Scholtens, 2017; Galaz et al., 2018). Mark Carney, governor of the Bank of England, points out that especially climate change is a huge concern for the financial industry (Carney, 2015). However, so far, bank management and banking supervisors do not explicitly account for sustainability and responsibility of banks. We want to find out if this omission is material from a risk perspective. In this respect, we account not only for banks' default risk, but for the risk of the financial system as well. It is important from an academic and societal point of view to examine the relationship between sustainability and (systemic) bank risk because the potential consequences of cross-scale systemic environmental risks with global effects are increasing (Homer-Dixon et al., 2015; Keys et al., 2019). In particular, it becomes increasingly clear that human-driven processes interact with global social-ecological connectivity and exhibit cross-scale relationships (Galaz et al., 2018). Then, it is relevant to study how this works out in the case of banking, which plays such a crucial role in society (Berger et al., 2017).

Most research focuses on how sustainability relates to the costs and revenues of firms (Schröder, 2014; Friede et al., 2015). The main finding from this literature is that there is a small but positive association between the two. It also shows that most of the literature does not distinct between industries. However, different industries relate in quite different ways to sustainability due to variation in their production structure and in their position in the economic value chain (Heal, 2008; Dafermos et al., 2018). Further, sustainability is hard to measure at the firm or industry level (Chatterji et al., 2009; Semenova and Hassel, 2015; Capelle-Blancard et al., 2019). Some scholars argue the financial sector should play a crucial role in the transformation of the current economic system to a more sustainable one (Kemp-Benedict, 2018). This implies accounting for sustainability in order to reduce the external (unpriced) economic effects of production (Heal, 2008).

Given the mounting evidence of the importance of sustainability on firm performance (Margolis et al., 2009; Friede et al., 2015; Ferrell et al., 2016), it is highly surprising that there is little knowledge about how it influences banks' default risk: the risk of a bank being unable to fulfill its obligations of repaying its debt. This is important as default risk not only affects the bank itself, but also may influence the entire financial system. There are few studies that explicitly consider default risk of banks in relation to sustainability. These studies suggest that there appears to be a neutral or negative relationship between the two (Boutin-Dufresne and Savaria, 2004; Bouslah et al., 2018). However, because of the importance of human-environment interactions (Keys et al., 2019), we also want to account for the so-called systemic risk of the banking industry. In this respect, systemic risk is the risk resulting from bank operations for the financial system as a whole (Beale et al. 2011; Acharya et al., 2012; Laeven et al., 2016; Berger et al., 2017). Homer-Dixon et al. (2015) argue that crises will increasingly arise from the conjunction of three underlying, long-term, and causally linked global trends. These are the sheer scale of human activity in relation to Earth's resources, the rise in interconnectivity, and the increasing homogeneity, or declining diversity, of human cultures, institutions, practices, and technologies (Homer-Dixon et al., 2015). Therefore, we investigate if and how sustainability relates to banks' default risk and their systemic risk.

We show that banks with high sustainability scores (i.e., those who perform relatively well) have lower default risk, as well as lower contribution to financial system risk. Especially the social dimension of sustainability appears to be important. This may be due to the nature of bank services, which to a great extent rely on information production and processing, as well as social networks. The findings suggest that both banks and financial authorities should extend the scope of their risk analysis and management and explicitly account for information about how banks interact with sustainability.

Banks and sustainability

The global financial crisis of 2007–2009 led to calls for responsible conduct of the finance industry (Cornett et al., 2016). Politically motivated groups and non-governmental organizations insist financial institutions take responsibility for social ills such as human rights violations and climate change by virtue of the economic operations and activities they finance. For example, Amnesty International (2016) requires banks commit to stop all financial activities related to illegal arms or arms destined to an illegal use. Carbon Tracker Initiative (2017) urges pension funds to divest from fossil fuel companies in order to facilitate the transformation towards a carbon-neutral economic system. Increasingly, the financial sector tries to account for such calls. Several initiatives have been set up to stimulate this debate and to try to achieve financial firms integrate responsibility in their business model. For example, the Equator Principles address how banks can account for social and environmental issues in project finance, and the Principles for Responsible Investment stimulate investors to use responsible investment to enhance returns and improve risk management.

A responsible business community can mitigate the impact of poor institutions and reduce corruption (Dixit, 2015). Further, the interaction between global financial markets and the economy influences sustainable development (Huang, 2011). For individual organizations, sustainability translates into corporate social responsibility (Dahlsrud, 2008). Usually, economists measure corporate sustainability via the performance of firms regarding their environmental and social impact and policy, as well as their governance (Chatterji et al., 2009; Ferrell et al., 2016). For financial institutions, this is problematic as they mediate within the economy; their financial products enable other agents to produce their goods and services. The assets of banks are predominantly financial assets, in contrast to those of non-financial companies (Tobin, 1987). Banks provide financial services such as lending, underwriting, guarantees, and investment to all kinds of agents, which requires producing and processing information and depends on network connections (Greenbaum and Thakor, 2007). As such, the banks do not have a direct effect on environmental and social characteristics, but only an indirect one via their lending, investment and financing decisions. In screening potential borrowers, they come across the operations and prospects of the counterparty and can influence decisions about design of the projects they are to finance. Therefore, information about their policies is crucial (Greenbaum and Thakor, 2007).

The economic system directly affects sustainability (e.g., pollution, inequality) and uses resources (e.g., water, human capital, energy). Hence, sustainable development is driven by the organization and efficiency of the economic system. The state of and expectations regarding sustainable development inform banks' sustainability policies. At the corporate level, sustainability usually is proxied by environmental, social and governance characteristics (Semenova and Hassel, 2015; Dorfleitner et al., 2015; Friede et al., 2015). As intermediaries, banks cannot directly influence sustainable development. However, in their financial services, they can account for environmental, social, and governance characteristics and policies of firms and organizations in their financing policy and decision. Further, at the aggregate and macro-level, they interact with the economic system via their balance sheets and their financial market operations. To manage their risks and to organize funding, they cooperate with other financial institutions. Financial authorities monitor and regulate both individual banks and markets and the financial system as a whole (Greenbaum and Thakor, 2007).

Several country studies investigate sustainability in the financial industry (e.g., Simpson and Kohers, 2002 (US); Scholtens, 2007 (the Netherlands); Menassa, 2010 (Lebanon); Callado-Munoz and Utrero-Gonzalez, 2011 (Spain); Uddin et al. (2012) (Bangladesh); Saxena and Kohli, 2012 (India); Bolton, 2013 (US); Kamal, 2013 (Egypt); Adewale and Rahmon, 2014 (Nigeria); Malik and Nadeem, 2014 (Pakistan); Paulik et al., 2015 (Czech Republic); Cornett et al., 2016 (US); Lins et al., 2017 (US)). This literature shows wide variation in how it deals with sustainability: from actual resource usage to generic ratings, and from topical aspects to broad categories or even catch-all indicators. The predominant conclusion is that sustainability results in financial outperformance (the studies of Scholtens (2007), Paulik et al. (2015), and Gonenc and Scholtens (2019) being an exception). Cornett et al. (2016) examine banks' sustainability in the US in the context of the global financial crisis and establish they get rewarded for socially responsible behavior.

In addition, there are several studies using an international sample (for example, Chih et al., 2010; Soana, 2011; Wu and Shen, 2013; Ciciretti et al., 2014; Hu and Scholtens, 2014; Mallin et al., 2014; Jo et al., 2015; Aginer et al., 2016; Shen et al., 2016; Wu et al., 2017). The results from multi-country studies generally point in the same direction as those on individual countries. Chih et al. (2010) provide an overview of the literature and conclude that many key characteristics of social performance are to be positively associated with financial ratios and performance indicators in the banking industry (see also Ioannou and Serafeim, 2015). Wu and Shen (2013) argue that the more banks engage with sustainability, the better their financial performance as reflected in several bank efficiency and performance ratios. They confirm these findings in later research (Shen et al., 2016; Wu et al., 2017). Ciciretti et al. (2014) suggest banks with higher sustainability scores have lower cost of debt and equity. Mallin et al., (2014) and Platonova et al. (2016) establish that Islamic banking too shows the positive effects of responsible conduct. Jo et al. (2015) argue banks' environmental performance improves their operational efficiency and as such results in better financial performance. Very diverse sustainability and financial performance variables are used in these studies. Further, there is substantial variation in the use of estimation methods. This criticism is reminiscent of the critical reflection regarding the study of CSR by Orlitzky et al. (2003), Margolis et al. (2009), and Dam and Scholtens (2015). Only few studies explicitly address causality. Those who do so show that it predominantly is sustainability that precedes risk (Scholtens, 2008; Cornett et al., 2016; Bouslah et al., 2018; Capelle-Blancard et al., 2019; Gonenc and Scholtens, 2019).

We aim to contribute to the literature about the interaction between banks and sustainability by investigating how sustainability relates to individual bank risk (default risk) and how it affects financial system risk (systemic risk).

Model

To investigate the relationships between bank risk and sustainability, we rely on generic indirect measures of sustainability and look into the influence of its constituting dimensions (i.e., environmental, social and governance factors). For bank risk, in line with the literature (Boutin-Dufresne and Savaria, 2004; Greenbaum and Thakor, 2007; Basel Committee on Banking Supervision, 2015; Cornett et al., 2016; Bouslah et al., 2018), we use different measures, namely their *Z*-Score (Berger et al., 2017) and the standard deviation of the return on equity (Laeven and Levine, 2009). We compute the *Z*-score as the sum of the return on average assets (ROAA) and the capital-asset-ratio (CAR) divided by the standard deviation of the return on assets over a pre-specified period. It represents the number of standard deviations by which returns have to decline in order to deplete a bank's equity capital. The variation in the return on equity relates the net income of a bank to its equity (Laeven and Levine, 2009; Berger et al., 2017).

We assess the systemic risk contribution by SRISK. SRISK is the expected capital shortfall of a bank during a period of distress in which the financial market declines substantially, and shows the amount of capital that a bank is expected to need in case of a financial crisis (Brownlees and Engle, 2016). SRISK measures the capital shortfall of a bank conditional on a severe market decline, and is a function of its size, leverage and risk. This metric can deal with drawbacks from more conventional measures that are used in this arena (see Dietz et al., 2016; Battiston et al., 2017). In constructing the SRISK measure, we do not limit SRISK to a threshold of zero (as in Acharya et al., 2012), but allow for negative values too. This is because highly capitalized banks with a large capital buffer can absorb systemic shocks that will reduce the overall systemic risk in the system (Laeven et al., 2016). Appendix 4 explains how SRISK is calculated.

Most of the literature about financial and social performance finds that it is financial outperformance that drives social outperformance (Margolis et al., 2009; Chih et al., 2010; Schröder, 2014; Dorfleitner et al., 2015; Friede et al., 2015). In contrast, as discussed above, the few studies that specifically focus on the relationship between firms' risk and social, environmental and governance performance detect that it usually is changes in the latter that precede (changes) in risk (Scholtens, 2008; Sun and Cui, 2014; Cornett et al., 2016; Bouslah et al., 2018). Therefore, we opt for the risk measures as the dependent variable to be explained by sustainability variables, next to others. However, we will also show model estimations with social performance being explained with the help of risk.

We include a large number of controls. First, we include bank-specific variables such as size of assets held, capital buffer, funding, non-interest income, and deposits. Second, we have financial market size to control for the financial system. In addition, GDP growth, public debt, and inflation control for the economy. Time fixed effect account for bank regulation and supervision. The controls are motivated by the way in which banks operate (see Beale et al., 2011; López-Espinosa et al., 2013; Hull, 2018), and are in line with other studies that investigate social and financial performance (Laeven and Levine, 2009; Chih et al., 2010; Friede et al., 2015; Cornett et al., 2016; Lins et al., 2017; Bouslah et al., 2018; Capelle-Blancard et al., 2019). We do not include additional institutional features as suggested by Waddock and Graves (1997) because our sample banks operate on the basis of the same type of institutions and regulations in the Euro area of the European Union. They all are subject to identical monetary and prudential supervision, operate on liberalized banking markets, and face the same regulation regarding payment systems, financial services and capital mobility.

Thus, first, we investigate the relationship between banks' sustainability and individual bank default risk, in which the following setup is applied:

$$\text{Default risk}_{i,t} = \alpha + \beta_1 \text{Sustainability}_{i,t-1} + \beta_2 \text{Controls}_{i,t-1} + \beta_3 \text{Controls}_{c,t-1} + \omega_t + \gamma_i + \varepsilon_{i,t}, \quad (1)$$

where the measure for individual bank default risk refers to bank i at time t, *Sustainability* to the prior year's sustainability rating of bank i, controls include bank-specific characteristics of bank i at time $t-1$, such as tier-1 capital ratio, deposit ratio, non-interest income, and short-term funding, and country-specific characteristics of country c at time $t-1$, such as GDP growth, public debt ratio, inflation, and stock market capitalization. ω_t are time fixed effects, γ_i bank fixed effects and $\varepsilon_{i,t}$ represents the error term. In a sensitivity analysis, we swap *Sustainability* and *Default Risk* to find out whether specification (1) is valid indeed.

The second regression model accounts for the relationship between sustainability and a bank's contribution to systemic risk:

$$\text{Systemic risk contribution}_{i,t} = \alpha + \beta_1 \text{Sustainability}_{i,t-1} + \beta_2 \text{Controls}_{i,t-1} + \beta_3 \text{Controls}_{c,t-1} + \omega_t + \gamma_i + \varepsilon_{i,t}, \quad (2)$$

here, the dependent variable is systemic risk for bank i at time t. The bank i and country c controls are the same as those in Eq. (1): bank-specific controls are tier-1 capital ratio, deposit ratio, non-interest income, and short-term funding, country-specific controls are GDP growth, public debt ratio, inflation, and stock market capitalization. As bank assets appear to be non-stationary after running a Fisher unit root test, we transform it into stationary variables to make sure the model is correctly specified. As with model (1), we will also swap sustainability and systemic risk for sensitivity purposes.

We estimate models (1) and (2) using a fixed effects regressions, based on the results of the Hausman test. We cluster standard errors at the bank level to correct for heteroskedasticity and autocorrelation. Time-fixed effects are included to account for time trends and those of the Global Financial Crisis. In addition, the explanatory variables are lagged by one year to help control for potential endogeneity. This lag can be motivated by theoretical and practical reasons. The former relates to the argument of Garcia-Castro et al. (2010) that lagging by one year controls for previous year's performance effects on subsequent performance or changes in strategy. Further, there is no theoretical reason as to why longer lags would have an impact. The practical reason relates to the limited time-span of the data series. Using longer lag-lengths would considerably reduce the number of observations.

Data

Our sample (See Appendix 1) relates to banks situated in Euro countries starting January 2002 until 2016. They are subject to the same regime of monetary and prudential supervision (as such, we do not face the problem of differences in relevant institutions affecting the results, see Waddock and Graves, 1997). As to sustainability, it is unfortunate that there are only very few independently audited and verified sustainability reports. Several commercial rating agencies produce assessments of firms' corporate social responsibility. They do so by assessing firms regarding policies and some resource use and emissions data. The academic literature acknowledges the drawbacks of using these data (Garcia-Castro et al., 2010; Semenova and Hassel, 2015; Dorfleitner et al., 2015). In particular, ratings do not inform about sustainability as such and tend to focus on policies instead of performance. However, as of yet, there is no alternative. Therefore, we rely on Thomson Reuters DataStream to obtain information about corporate social responsibility from their ASSET4 database. This used in several other academic studies too (Dorfleitner et al., 2015; Friede et al., 2015). We opted for this database as it is part of our university's subscription to a much more encompassing database. As the sustainability score is the main variable of interest, we exclude banks without such ratings. The overall rating comprises an environmental, social and corporate governance pillar and is an equally weighted score (see Appendix 3). The ASSET4 database holds publicly available information about 226 indicators to create an integrated view of corporate performance. The environmental pillar consists of the categories emission reduction, product innovation and resource reduction. The social pillar consists of the categories community, diversity, employment quality, health and safety, human rights, product responsibility, and training and development. The corporate governance pillar contains the following categories: board functions, board structure, compensation policy, shareholder rights, and vision and strategy. The sustainability score we use is an aggregate equally weighted measure of the three pillars. After matching Thomson Reuters ASSET4 ratings with the banks, our final sample includes 43 banks from 10 countries. This includes all banks in the Euro area that qualify as system banks, i.e., banks that are most relevant for the global financial system. As such, we study the most important banks.

Financial data are from Datastream and World Bank World Development Indicators, as are the bank-specific and country-specific control variables. The data are subject to relevant limitations. First, as mentioned, sustainability ratings data are not independently verified and audited. Further, most data is only available on a yearly basis. Therefore, we can calculate the measures for bank default risk only for a small sample, which affects the estimation of our systemic risk measure. As a financial breakdown occurs suddenly, yearly data cannot accurately assess the effect on a bank its systemic risk contribution. We look forward to be able to both more accurate and granular data to improve the analysis. Appendix 2 gives an overview of the definition of the variables used and provides their source.

Table 1 displays the descriptive statistics. The SRISK measure show that this is the only variable displayed in Euros. As this makes interpretation of its coefficient complicated, the percentage change of SRISK will be used in regressions. Comparing the *Z*-Scores to the US bank sample of Berger et al. (2017), our mean value is 57.456, whereas they have calculated a value of 36.053, suggesting that the European banks are more stable. The Sustainability score ranges from 13.45 to 288.14, with a mean of 186.412.

Bank risk and sustainability. We estimate the effect of sustainability on bank default risk with different risk measures to test our first hypothesis, which holds that sustainability affects bank default risk. Table 2 presents the results. It shows a significant association between the sustainability score and bank default risk. The estimation results for our first risk metric (*Z*-Score) reveal that a bank's sustainability significantly associates with lower default risk: An increase of the sustainability score by one unit is associated with an increase of the bank's *Z*-Score by 0.303 units. The sustainability score negatively relates to the standard deviation of the return on equity, being our second risk measure, but this is only marginally significant. This suggests that an increase in the sustainability score by one unit is to be associated with a decrease of the standard deviation of the return on equity by 0.001, implying a decrease in bank default risk. We conclude that in banking, sustainability negatively relates to default risk. This finding is consistent with previous studies (Oikonomou et al., 2012; Sun and Cui, 2014; Capelle-Blancard et al., 2019).

Next, we associate bank sustainability with systemic risk. Table 3 presents the estimation results of our model as to how banks' sustainability scores relate to their systemic risk contribution. We observe that higher sustainability scores coincides with significantly lower systemic risk contributions. More specifically, an increase of a bank's sustainability score by one unit associates with a reduction of its systemic risk contribution by 1.522

Table 1 Descriptive statistics

	N	Mean	Stdev.	Min	Max	Skewness	Kurtosis
Z-Score	536	57.456	97.464	−2.403	1189.020	5.275	45.193
Stdev. ROE	580	0.168	0.573	0.000	5.869	6.362	49.423
MES	605	0.002	0.002	0.000	0.010	1.762	6.787
SRISK (x€10^7)	600	1.29	2.71	−4.52	16.1	2.504	9.793
Sustainability	562	185.870	80.307	13.450	288.140	−0.660	2.099
Size	622	18.701	1.400	14.708	21.509	−0.088	2.897
Tier-1 ratio (%)	557	10.029	3.081	−7.300	21.400	−0.169	6.468
Deposit ratio	579	0.440	0.152	0.023	0.831	−0.593	3.466
Short-term funding	622	0.189	0.102	0.000	0.589	0.806	4.046
Non-interest income	586	0.569	0.863	−0.157	11.783	7.795	81.504
GDP growth rate (%)	645	0.883	3.218	−9.132	26.276	1.760	20.411
Public debt to GDP	532	83.895	33.284	26.920	151.824	0.107	2.072
Inflation rate (%)	645	1.780	1.428	−4.480	4.880	−0.557	3.786
Market capitalization	623	52.655	24.985	11.740	121.660	0.533	2.484

Note: For the definition of the variables, see Appendix 2 and 3

Table 2 Bank default risk and sustainability

	Z-Score Full model	*Z*-Score Full model robust-cluster	Stdev. ROE Full model robust-cluster
Sustainability	0.303** (0.142)	0.303* (0.154)	−0.001* (0.001)
Size	14.813 (25.663)	14.813 (23.502)	−0.186* (0.106)
Tier-1 capital ratio	2.511 (2.810)	2.511 (2.893)	−0.024** (0.011)
Deposit ratio	−87.834 (81.290)	−87.834 (115.657)	−1.227*** (0.420)
Non-interest income	7.138 (17.153)	7.138 (18.798)	−0.113** (0.051)
Short-term funding	−167.629** (77.524)	−167.629* (89.988)	−0.465 (0.280)
GDP growth rate	1.595 (1.920)	1.595 (1.269)	−0.013 (0.010)
Public debt to GDP	−0.075 (0.447)	−0.075 (0.480)	0.000 (0.001)
Inflation rate	2.264 (6.817)	2.264 (7.910)	−0.022 (0.063)
Market capitalization	−0.308 (0.581)	−0.308 (0.551)	−0.006 (0.004)
Time fixed effects	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Adjusted *R*-squared	0.138	0.138	0.174

Note: For the exact definition of the variables, see Appendix 2. Appendix 1 reports the sample banks. All explanatory variables are lagged by one year. Robust standard errors are reported in the parentheses
*indicates significance at the ten percent level
**indicates significance at the five percent level and
***indicates significance at the one percent level

Table 3 Systemic risk contribution and sustainability

	SRISK % Full model	SRISK% Full model robust-cluster	SRISK% Full model robust-cluster
Sustainability	−1.552* (0.921)	−1.552* (0.855)	−1.457** (0.655)
Risk (*Z*-Score)			−0.269 (0.234)
Size	38.433 (163.509)	38.433 (140.065)	75.023 (85.580)
Tier-1 capital ratio	−7.044 (18.924)	−7.044 (16.219)	−3.645 (15.287)
Deposit ratio	−286.236 (522.864)	−286.236 (471.565)	−255.494 (477.694)
Non-interest income	−42.932 (110.353)	−42.932 (52.857)	−37.768 (60.078)
Short-term funding	125.656 (510.723)	125.656(406.504)	−65.981(389.476)
GDP growth rate	−17.966(12.601)	−17.966 (16.671)	−20.890 (17.318)
Public debt to GDP	1.483 (2.955)	1.483(2.657)	0.847(2.428)
Inflation rate	103.288** (44.182)	103.288** (47.074)	98.524**(44.453)
Market capitalization	−12.367*** (3.667)	−12.367* (6.603)	−10.101 (6.159)
Time fixed effects	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Adjusted *R*-Squared	0.092	0.092	0.087

Note: All explanatory variables are lagged by one year. Robust standard errors are reported in the parentheses
*indicates significance at the ten percent level
**indicates significance at the five percent level and
***indicates significance at the one percent level

Table 4 Individual responsibility pillars, bank risk and systemic risk

	Z-Score Full Model Robust-cluster	*Z*-Score Full model robust-cluster	*Z*-Score Full model robust-cluster	SRISK% Full model robust-cluster	SRISK% Full model robust-cluster	SRISK% Full model robust-cluster
Sustainability: environmental	0.312 (0.216)			−3.698* (1.896)		
Sustainability: social		0.769** (0.355)			−3.596** (1.665)	
Sustainability: governance			0.546 (0.357)			−0.267 (1.924)
Risk (*Z*-Score)				−0.305 (0.239)	−0.261 (0.227)	−0.323 (0.247)
Size	25.065 (21.495)	15.839 (22.638)	26.088 (21.363)	70.168 (92.240)	73.578 (91.026)	−11.142 (85.975)
Tier-1 capital ratio	2.031 (2.828)	2.810 (2.850)	2.523 (2.866)	−1.169 (14.890)	−4.473 (15.758)	−0.000 (14.510)
Deposit ratio	−82.423 (115.668)	−74.277 (109.304)	−80.442 (114.987)	−216.306 (465.978)	−324.897 (493.975)	−323.016 (498.439)
Non-interest income	5.721 (19.944)	8.643 (19.279)	6.264 (18.468)	−30.324 (58.044)	−47.153 (62.179)	−32.089 (60.679)
Short-term funding	−141.921 (84.656)	−165.732* (86.587)	−168.550* (91.878)	−160.728 (398.742)	−110.304 (399.369)	−159.327 (439.804)
GDP growth rate	1.846 (1.253)	1.399 (1.272)	1.770 (1.251)	−21.834 (16.112)	−20.242 (17.903)	−22.021 (17.808)
Public debt to GDP	−0.137 (0.511)	0.022 (0.467)	−0.092 (0.491)	1.301 (2.496)	0.358 (2.394)	0.983 (2.426)
Inflation rate	3.772 (7.709)	1.923 (7.828)	2.993 (7.909)	92.936** (42.646)	100.591** (45.315)	90.543** (42.682)
Market capitalization	−0.313 (0.569)	−0.278 (0.545)	−0.379 (0.541)	−10.334* (6.098)	−10.206 (6.095)	−10.125 (6.124)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted *R*-Squared	0.120	0.140	0.133	0.089	0.087	0.081

Note: All explanatory variables are lagged by one year. Robust standard errors are reported in the parentheses
*indicates significance at the ten percent level
**indicates significance at the five percent level and
***indicates significance at the one percent level

percentage points. As such, this suggests that banks' sustainability is inversely related with their systemic risk contribution.

To account for the sensitivity of the results, we engage in additional checks. First, we run each model with the three individual sustainability pillars (environmental, social, governance) separately on our main dependent variables for the first and second hypothesis. It shows in Table 4 that the main dimension regarding the significant relationship of the *Z*-Score and sustainability in the banking industry is the social pillar as it is significant at a 5% level, whereas the other two pillars are not significant. This makes sense because the direct environmental footprint of financial institutions is limited and bank governance is highly institutionalized (Basel Committee on Banking Supervision, 2015). The social dimension might be impactful as it closely relates to the type of business the banks engage in, which is highly reliant on human and social capital. This finding is in line with that of Lins et al. (2017) for non-financial business.

Further, relating to ordering effects, we again estimate model (1) but now the dependent variable and the main variable of interest are swapped. That is, we estimate if sustainability is explained by (one year lagged) risk. The results are in Appendix 5. It shows that both risk measures do not significantly associate with the sustainability measure. This is in line with previous studies regarding the relationship between sustainability and financial risk (Scholtens, 2008; Sun and Cui, 2014). Further, we re-estimate model (2) with sustainability as the dependent and systemic risk as the explanatory variable. This is reported in Appendix 6. It shows that SRISK has a no significant association with Sustainability.

The regression results for the systemic risk measure also show significance in the case of the social pillar; the environmental pillar is only marginally significant. Banking to a large extent is pure people business and depends on access to networks (Greenbaum and Thakor, 2007). Then, having a committed and motivated workforce can make a substantial difference in keeping customers and in attracting new ones. Again, the governance score does not have a significant influence on bank default risk or systemic risk contribution. This may relate to the fact that there is very little leeway for banks in this respect, due to extensive regulation by monetary and financial authorities.

We also investigated if outliers influence the results and potentially give biased results. To deal with the possibility of a bias in our results, we remove extreme values of the sustainability score by taking out the top and bottom 1% of the scores. It appears the results remain robust to removing outliers.

Potential for sustainability in mitigating bank risk. Increasingly, human-driven processes interact with global social-ecological connectivity and exhibit cross-scale relationships. In this respect, we study whether banks' sustainability interacts with their default risk and their systemic risk. Banks are intermediaries and it is not clear how their operations affect sustainability. Therefore, we rely on information about banks' performance regarding environmental, social and governance characteristics, i.e., their sustainability score, which reflects in their lending operations. We study 43 banks headquartered in the Euro area for the period 2002–2016.

We establish that sustainability negatively associates with bank risk: Banks with high sustainability scores have significantly less default risk. This holds for different proxies of default risk. We also show that a high sustainability score goes hand in hand with a lower systemic risk contribution. We conclude that sustainability coincides with lower bank risk and that it associates with less systemic risk. Several robustness tests confirm these results. Interestingly, separating the sustainability score into the three individual pillars shows that the social pillar is the main driver of the decrease in bank default risk and its systemic risk contribution. This is in line with the intuition that banking is a service industry; highly relying on human capital. Its direct environmental footprint is limited and it faces severe regulation and supervision regarding the corporate board, which reduces the scope to vary governance.

These novel findings complement the extant debate about the relationship between financial performance and sustainability in the international banking industry (Boutin-Dufresne and Savaria, 2004; Bouslah et al., 2018). The results on bank default risk align with the findings of the positive effects of responsibility of non-financial firms (Luo and Bhattacharya, 2009; Sun and Cui, 2014), whereas our results regarding systemic risk contribution provide a novel insight regarding the impact of sustainability on banking.

The findings of this paper have important implications. First, the result that better sustainability is to be associated with lower default risk and systemic risk contribution enhances our understanding of what makes up bank risk. Further research should examine how banks can improve sustainability to mitigate risk. This could help banks strengthen risk management, which is of great importance to society. Second, the positive role of banks' social responsibility in relation to their systemic risk contribution suggests financial authorities should integrate sustainability into their supervisory mechanisms. Further research to determine as to how exactly sustainability drives risks in the financial system will help central banks and other supervisory authorities in their quest to lower systemic risk and to mitigate the effect of future banking crises. Lastly, our study shows that policies regarding the promotion of sustainability need to account for industry specifics.

Data availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the fact that they were sourced from proprietary databases of Thomson Reuters Data-Stream to which the university, where the authors are affiliated, subscribes. The data are available from the corresponding author on reasonable request when the proprietor can agree.

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Additional information

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