On Uncertainties & Non-Performing Loans (NPLs)

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Abstract

We examine the relationship between selected uncertainty indices and bank non-performing loans (NPLs), focusing on 77 banks across 19 EU countries, operating under the Single Supervisory Mechanism (SSM), covering the period from 2010 to 2023. Employing a battery of empirical methods and robustness tests, we analyze the impacts of economic, trade, energy, pandemic-related, geopolitical and climate uncertainties on NPL dynamics. Controlling for macro, bank-specific, institutional and cultural indicators, our key findings indicate that all uncertainty indices increase NPLs. However, the pandemic-related uncertainty exhibits a countercyclical effect, mainly attributed to economic support measures and prudent policy responses. Short-term impacts are most pronounced from accumulated uncertainties, followed by economic policy and climate uncertainties, while long-term effects are dominated by climate uncertainty. Strong institutional quality is crucial in mitigating the spillover effects of uncertainties on NPLs, particularly in peripheral EU economies. Cultural factors such as uncertainty avoidance and uncertainty tolerance significantly influence risk-taking behavior. We also unveil key transmission channels through which uncertainties affect NPLs, namely the macroeconomic vulnerabilities, institutional quality, market power, economic growth and cultural preferences.

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1 Introduction

Since the Global Financial Crisis (GFC), bank non-performing loans (NPLs) have been the center of attention for both banks and regulatory bodies as they are connected to bank failures and are often a harbinger of banking crises. NPLs are inherently linked to financial stability and reflect the financial institutions' capacity to absorb exogenous shocks of a diverse nature (Berger and DeYoung 1997). Recent events, such as those linked to the COVID-19 pandemic, the geopolitical conflict between Russia and Ukraine, energy, inflationary pressures and the climate crisis, have introduced new layers of uncertainty affecting various domains (Liu and Gao 2022; Zhang et al. 2023; Vu et al. 2023). The financial sector is no exception, as the heightened negative uncertainty spillovers increase the likelihood of NPLs, with borrowers facing heightened financial pressures (Vu et al. 2023; Zeqiraj et al. 2024).

There is an emerging body of knowledge investigating the impact of diverse uncertainty indices on bank financial stability. Studies such as Liu and Gao (2022), Zhang et al. (2023) and Vu et al. (2023) demonstrate that global uncertainties stemming from events like the COVID-19 pandemic, Brexit and the conflict between Russia and Ukraine affect economic growth, posing heightened risks for European banks, with smaller, less capitalized banks being most vulnerable. Economic policy uncertainty (EPU) has emerged as a significant risk factor affecting financial stability with studies such as those of Deng and Li (2024) and Chi and Li (2017) indicating a cyclical effect between EPU and credit risk volatility. In this context, Zeqiraj et al. (2024) suggest a positive effect from EPU on bank NPLs. Similarly, trade-related uncertainty, driven by international trade fluctuations, destabilizes the financial instability as shown by Hu et al. (2024). Additionally, Phan et al. (2022) and Shabir et al. (2023) emphasize that the uncertainty stemming from the conflict between Russia and Ukraine adversely affects bank risk-taking with smaller banks and those with less capital buffers being particularly vulnerable.

Beyond uncertainties related to economic, trade and geopolitical shocks, climate policy introduces complex challenges as well. Financial institutions face increased risk from fluctuating climate regulations, which can lead to stranded assets and increased default risk (Khan et al. 2023; Carè et al. 2024). Similarly, energy uncertainty, driven by oil price fluctuations and energy market volatility, places additional strain on borrowers in energy-intensive sectors, raising the probability of loan defaults, while also reducing bank operational and investment efficiencies (Dang et al. 2023; Nasim et al. 2023).

Another strand of literature highlights the significant role of institutional quality in mitigating a landscape of multivariate uncertainties. Countries and financial institutions characterized by effective governance and high regulatory standards enhance banking resilience. Studies such as those of Kafka and Kostis (2024), Xing and Shabir (2022) and Laeven and Valencia (2013) demonstrate that strong institutional frameworks experience reduced levels of NPLs. Fazio et al. (2018) highlight that institutional quality lessens the adverse impact of macroeconomic shocks while Beck et al. (2006) and Kostis and Markatou (2021) argue indicating that countries with robust institutional frameworks are better equipped to absorb negative spillovers leading to decreased levels of NPLs.

Beyond institutional quality, cultural factors such as those related to uncertainty avoidance and uncertainty tolerance play a crucial role in shaping banks' financial stability, especially during times of heightened uncertainty. Schwartz’s (1994) cultural framework describes uncertainty avoidance as a society's comfort state, linked with ambiguity and unpredictability, which influences financial behaviors and decision-making processes. In countries with high uncertainty avoidance, people tend to follow risk-averse and conservative financial decisions (Hofstede 2001; Schwartz 1994; Rothwell and Wissema 1986). This implies that banks and borrowers residing in those cultures are more sensitive to economic disruptions stemming from various uncertainties (Chui and Kwok 2008; Gelfand et al. 2011; Marfo and

Tweneboah 2022). This behavioral tendency heightens their vulnerability to external disruptions, hindering innovation and economic growth, while also exerting negative effects on bank stability (Chui and Kwok 2008; Gelfand et al. 2011). On the flip side, cultures with low uncertainty avoidance follow more risk-taking, less conservative behaviors and are more adaptable in periods of increased uncertainty (Knack and Keefer 1997; Petrakis et al. 2015; Kafka et al. 2020). They also exhibit increased innovation and economic growth, because of NPL reduction (Marfo and Tweneboah 2022; Schwartz and Sagiv 1995).

Motivated by the work of Kafka and Kostis (2024), on the interplay between uncertainty, economic institutions, and innovation performance in advanced and developing economies and the work of Zeqiraj et al. (2024) on economic uncertainty, public debt and non-performing loans in the Eurozone, this study investigates the relationship between uncertainty indices and bank NPLs, a valiant credit risk indicator, considering the role of cultural and institutional factors. Our sample encompasses 77 banks, corresponding to nineteen European Union countries (EU28). To this aim, we utilize bank-level data spanning from 2010 to 2023, controlling for a diverse array of factors[1], considering both the COVID-19 pandemic and the Russia-Ukraine conflict, while we apply several empirical methodologies for robustness reasons.

We form the following research questions to be answered: (RQ1) How do uncertainty indices impact NPLs? (RQ2) What uncertainty type is the most influential? (RQ3) Does institutional quality mitigate the uncertainty spillover effects on NPLs? (RQ4) What role do cultural factors, such as uncertainty avoidance and tolerance, play in the dynamics of NPLs?

Our study contributes to the ongoing literature, by being the first to investigate the impact of diverse uncertainty indices on bank NPLs. Second, drawing from the studies of Nguyen and Dang (2023), Mi et al. (2024) and Ahamed and Mallick (2017), it considers the

[1] While the bank-specific variables are at bank level, the rest variables used in this study are at country level.

role of institutional quality, while also considering the cultural preferences towards uncertainty avoidance and uncertainty tolerance amongst the European nations. By integrating these dimensions, this study provides a more comprehensive view of banking sector stability, offering insights for policymakers and financial institutions striving to mitigate uncertainty-induced risks in a globalized economy.

The structure of this paper is organized as follows. Section 2 presents key studies on the subject and defines the testable hypotheses; Section 3 encompasses the data and empirical methodology; The results of the empirical models are presented and discussed in Section 4. Section 5 presents the robustness analysis, while Section 6 reports the concluding remarks and suggestions for future research.

2 Literature review and testable hypotheses

This section aims to provide a presentation of the respective literature and formulate the testable hypotheses. Section 2.1 presents the literature circulating uncertainties and NPLs; Section 2.2 dives into the role of institutional quality; Section 2.3 presents studies related to the role of cultural preferences towards uncertainty avoidance and tolerance; Finally, Section 2.4 highlights the literature gaps identified in Sections 2.1 to 2.3.

2.1 Uncertainties and NPLs

There is a growing body of knowledge circulating about the effects of uncertainties on the economic and banking system. Economic policy uncertainty (EPU), related to economic policy volatility, is highly recognizable for its negative effects on the economy and the banking system in terms of increased credit risk (Ashraf 2019; Wang and Yao 2013; Wang et al. 2024). However, uncertainties extend to diverse factors related to the pandemic, geopolitical, trade, climate and energy nature, each producing negative spillovers that impact economic and banking stability (Vu et al. 2023). According to Vu et al. (2023), banks experience enhanced

risks in periods of heightened uncertainties experiencing decreased profitability and financial stability.

Based on the above, we formulate the following hypothesis to be evaluated:

H1.1. Uncertainties are positively associated with higher levels of NPLs.

Bloom (2009) highlights that uncertainty shocks related to EPU, decrease economic activity and increase financial risks. Deng and Li (2024) argue that EPU exerts a positive effect on systemic risk. They add that bank NPLs act as a mediating channel through which EPU affects banking stability. Chi and Li (2017) empirically demonstrate a cyclical effect between EPU and bank NPLs as well as loan concentration.

We formulate the following hypothesis to be evaluated:

H1.2. EPU-related uncertainty is a statistically significant predictor of bank NPLs, displaying a positive effect.

According to Liu and Gao (2022), the uncertainty stemming from the recent COVID-19 pandemic exerts a negative impact on economic stability. Dash and Maitra (2022) add that there is also a positive correlation between pandemic uncertainty and investor inactivity further influencing economic growth. Zhang et al. (2023) add that corporate investments decrease because of the pandemic uncertainty, implying a ripple effect on the broader economy. They also emphasize that the adverse implications of uncertainty related to the COVID-19 pandemic are significantly greater for smaller or financially weaker enterprises. Xing and Shabir (2022) agree, highlighting that undercapitalized banks are the most affected.

The existing literature suggests that the COVID-19 pandemic indirectly affects NPLs by destabilizing the broader economy and hampering the borrowers' ability to meet their loan obligations. However, it remains unclear whether these effects extend to the financial sector, given the economic support measures implemented during the lockdown period (Plikas et al.

2024). To address this gap, we propose the following bi-directional bi-directional hypotheses to be assessed:

H1.3.A. (H1.3.B.) The COVID-19 pandemic uncertainty is a significant predictor with a positive (negative) effect on NPLs.

With respect to geopolitical uncertainty Phan et al. (2022) indicate that geopolitical risks and the derived uncertainty pose a negative effect on bank stability. The authors highlight that the real geopolitical effect of geopolitical uncertainty in bank stability is stronger than the perceived effect. They also add that bigger, more capitalized banks are less affected. Shabir et al. (2023) agree with the aforementioned authors, adding that geopolitical uncertainty increases bank risks, which implies a rippling effect on NPLs. They empirically demonstrate that strong banking governance not only enhances bank performance but also mitigates the negative impacts of geopolitical uncertainty.

It is inferred that while geopolitical uncertainty increases NPLs, larger and well-capitalized banks can withstand the adverse impacts, ultimately contributing to overall banking stability. Based on these insights, we propose the following competing hypotheses to be evaluated:

H1.4.A. (H1.4.B.) There is a statistically significant positive (negative) effect of geopolitical uncertainty on NPLs.

Trade uncertainty also affects NPLs by destabilizing economies reliant on international trade (Hu et al. 2024). Hu et al. (2024) indicate that trade uncertainty leads to an increased risk of abrupt stock price declines, as well as decreased stock returns. These affect financial institutions, by increasing their risk exposure and reducing their willingness to engage in risk-taking practices. Vu et al. (2023) emphasize that geopolitical tensions and protectionist trade policies elevate NPL ratios, especially in export-driven economies. Similarly, Chen et al. (2018) found that political and trade uncertainties exacerbate credit risks, particularly for

institutions in countries with weaker institutional support. This suggests that the effects of trade uncertainty on NPLs are compounded in volatile regulatory environments.

Building on the above literature, we anticipate a positive relationship between trade uncertainty and NPLs, although these effects appear to be sector specific. Accordingly, we propose the following competing hypotheses:

H1.5.A. (H1.5.B.) Trade uncertainty is a significant predictor with a positive (negative) effect on bank NPLs.

Climate policy uncertainty is a growing concern as economies transition toward sustainability. Banks exposed to high-carbon industries may face may encounter elevated default risks, if regulatory shifts lead to stranded assets (Khan et al. 2023; Carè et al. 2024). Khan et al. (2023) suggest that financial systems are sensitive to environmental policy volatility and should have appropriate compliance mechanisms. Carè et al. (2024) state that there is a necessity for regulatory frameworks and risk management systems to incorporate climate-related risks.

Based on the above, we develop our next hypothesis as follows:

H1.6. Climate policy uncertainty is positively associated with bank NPLs due to shifts in environmental regulations and heightened risks associated with high-carbon borrowers.

Energy uncertainty, driven by global energy price fluctuations, impacts financial stability by increasing credit risk for energy-dependent sectors (Dang et al., 2023). Nasim et al. (2023) demonstrate that energy uncertainty reduces both the operational and investment efficiency of financial institutions. The authors suggest that the impact of energy uncertainty can be significantly mitigated through gradual adjustments in interest rates. Dang et al. (2023) add that because of energy uncertainty economic activities are being reduced with energy-intensive sectors being most vulnerable. Klein (2013) notes that banking sectors exposed to

energy uncertainty are particularly vulnerable to NPL increases, as borrowers in energy-intensive industries may default during periods of high price volatility.

Based on the above, it is inferred that energy-related uncertainty affects NPLs primarily by influencing operational and investment efficiency, as well as increasing risks for banks with exposure to energy-intensive borrowers. Therefore, we present our next hypothesis:

H1.7. Energy-related uncertainty is positively associated with bank NPLs.

2.2 The mitigating effect of institutional quality

The literature highlights the significance of institutional quality in mitigating the adverse effects of uncertainty spillovers on banking stability. According to Kafka and Kostis (2024), enhanced institutional setups support innovation and reduce uncertainties while countries with fewer institutional voids hinder innovation and might grapple with various uncertainties. Xing and Shabir (2022) support this view by adding that a strong institutional environment with higher supervision power reduces bank risk while also acting as a mitigating factor and a barrier to external uncertainties. Laeven and Valencia (2013) agree, adding that countries with robust institutional frameworks such as those related to regulatory and governance factors, experience reduced NPLs, even during significant uncertainties during crisis periods.

Based on the above, we formulate the following hypothesis to be evaluated:

H2.1. Institutional quality is a significant predictor of NPLs displaying a negative effect.

Fazio et al. (2018) demonstrate that robust institutions support effective policy implementation and enhance economic and banking stability in uncertain periods. Beck et al. (2006) add that nations with robust institutional frameworks are better equipped to absorb negative spillovers from economic crises, leading to reduced volatility in NPLs. Further studies such as those of Gupta and Zebedee (2020), Kostis and Markatou (2021) and Gupta and

Zebedee (2020) demonstrate that institutional quality has a significant role in mitigating the impact of various uncertainties in the economy, such as those related to trade, or climate uncertainties. Kostis and Markatou (2021) also demonstrate that countries with robust institutions are more resilient to external shocks, underscoring the significance of robust institutional frameworks in managing and mitigating NPL expansions in uncertain conditions.

So, we develop our next hypothesis:

H2.2. Robust institutional frameworks significantly mitigate the adverse effects of uncertainties on NPLs.

2.3 Uncertainty avoidance and uncertainty tolerance

According to Schwartz (1994), the essence of culture shapes the contingencies to which people adapt in their daily lives. In a broader sense, as stated by Petrakis (2014) and Petrakis and Kostis (2013) culture shapes both economic growth as well as income and wealth distribution. In the financial realm, it affects both borrowers' and lenders' financial behavior such as the behavior related to uncertainty tolerance or uncertainty avoidance. According to Hofstede (2001) and Schwartz (1994), uncertainty avoidance reflects a society's comfort state, linked with ambiguity and unpredictability. The authors add that cultures adhering to this behavior tend to follow risk-averse and conservative financial decisions. This is supported by Rothwell and Wissema (1986), who imply that cultures that are not prone to changes, social progress and reward productivity, innovate less, which in turn decreases economic growth. Regarding the banks and borrowers that reside in those societies, they tend to follow cautious lending and borrowing practices. According to Chui and Kwok (2008) and Gelfand et al. (2011), these practices increase their sensitivity to economic disruptions stemming from various uncertainties. Marfo and Tweneboah (2022) add that high uncertainty avoidance behaviors hinder bank innovations, harming financial intermediation and jeopardizing the banks' stability. From the above analysis of the respective literature, we infer a cyclical

relationship between uncertainty avoidance (conservation) and NPLs. This behavior of borrowers and financial institutions follows more conservative practices hindering innovation and economic growth.

So, we develop our next hypothesis as follows:

H3.1.A. (H3.1.B.) Uncertainty avoidance (conservation) is positively (negatively) associated with bank NPLs.

Complementing the above studies, further research, such as those related to Hofstede (2001), Schwartz (1994) and Rothwell and Wissema (1986), suggest that banks and borrowers residing in cultures that follow uncertainty avoidance behaviors, coupled with strong institutional frameworks, experience reduced probabilities of loan defaults.

We form our next complementary hypothesis as follows:

H3.2. Uncertainty avoidance (conservation) is negatively associated with bank NPLs when strong institutional frameworks are considered.

Contrary to banks and borrowers residing in cultures following a more conservative, risk-averse practice, cultures following more risk-taking, less conservative behaviors are more adaptable in periods of increased uncertainty (Knack and Keefer, 1997). According to Hofstede (2001) and Schwartz (1994), those are more willing to invest in new technologies, presenting a stronger tendency to innovate. Moreover, Petrakis et al. (2015) state that cultures that promote innovation perform better in the long run even in uncertain periods. and Kafka et al. (2020) argue that the coevolution between institutions and culture may lead to optimal economic growth. Marfo and Tweneboah (2022) suggest that economic growth leads to NPL reduction. Additionally, Schwartz and Sagiv (1995) imply that borrowers residing in those cultures are more proactive in their financial behaviors therefore they are more adaptive during uncertain times. Conversely, studies such as those of Kostis and Markatou (2021) and Fazio et al. (2018) highlight that there is a downside in high risk-taking (such as increased volatility and market

fluctuations), which can be stabilized through a robust institutional environment. From the above analysis of the respective literature, we infer a countercyclical relationship between uncertainty tolerance (openness to change) and NPLs since borrowers and financial institutions with those cultural traits can effectively manage the impact of uncertainty on NPLs during uncertain periods. However, there are downsides in high risk-taking behaviors which could potentially lead to NPL inflows.

Based on the above, we develop our final hypotheses as follows:

H3.3.A. (H3.3.B.) Uncertainty tolerance (openness to change) is statistically significant posing a positive (negative) effect on bank NPLs.

H3.4. Uncertainty tolerance (openness to change) is negatively associated with bank NPLs when strong institutional frameworks are considered.

2.4 Literature gap

The preceding literature highlights an emerging body of knowledge related to the effects of various uncertainties on bank stability, specifically in NPLs. It also highlights the mitigating effects of institutional quality and cultural factors on financial stability. While institutional quality provides structural support through effective regulations and governance, cultural dimensions shape societal responses to uncertainties, underscoring the significance of both in maintaining banking stability through NPL reduction.

However, despite these insights, there remains a notable gap in the literature concerning the effects of uncertainty indices on NPLs. Existing studies examine these elements in isolation, without providing a holistic understanding in terms of their effect on bank NPLs. Furthermore, the recent surge in global uncertainties, such as those stemming from the COVID-19 pandemic, geopolitical tensions and the climate crisis, has not been thoroughly investigated. This gap indicates a need for comprehensive analysis, while considering institutional and cultural

factors. Addressing this gap would provide valuable insights for policymakers and financial institutions aiming to enhance resilience in an increasingly uncertain global economy.

3 Data and empirical methodology

This section aims to describe the dependent variables, the candidate predictors, the dummy variables, as well as the sample of the control variables investigated in the empirical analysis (Section 3.1); it also defines the methodology and empirical models (Section 3.2).

3.1 Sample description

The purpose of the current research is to explore the relationship between selected uncertainty indices and NPL ratio, during the period 2010-2023. This timeframe is of intrinsic scientific interest since it encompasses the COVID-19 pandemic, the Russia-Ukraine conflict as well as the climate crisis being at its peak. This offers a holistic view of how diverse global uncertainties affect NPL ratios. Our research focuses on banks residing in the European Union (EU28) while also operating under the Single Supervisory Mechanism (SSM). Our sample consists of an unbalanced panel[2] of bank-level data, encompassing 77 banks, corresponding to nineteen European countries and comprising 964 observations.

Our main response variable is the bank's non-performing loans to total loans (gross) expressed as a ratio (NPL). Regarding the candidate predictors, we incorporate selected uncertainty indices of a diverse nature. Specifically, the World Uncertainty Index (WUI), the Economic Policy Uncertainty Index (ECON), the World Trade Uncertainty Index (TRADE), the Energy-Related Uncertainty Index (EUI), the European Extreme Events Climate Index (E3CI), the World Pandemic Uncertainty Index (PANDM), the Geopolitical Risk Index (GEOP) and finally the Climate Risk Index (CLIM), are incorporated as representatives of various uncertainty indices. The construction methodology of these uncertainty indices is

[2] According to Rinaldi and Sanchis-Arellano (2021), “unbalanced panel data are less dependent on a single time-period and have much more observations”.

primarily based on a systematic textual analysis of data derived from reputable sources, newspaper articles and scientific texts, focusing on the frequency of specific terms such as "uncertain", "uncertainty", "uncertainties" and its variants linked to diverse areas of concern, such as economic, energy, trade, geopolitical, climate and pandemic-related concerns/uncertainties.

To account for external and internal events, we control for: macroeconomic, bank-specific, institutional, as well as cultural indicators. Moreover, to capture the COVID-19 pandemic and the conflict between Russia and Ukraine, we incorporate the COVID_DUMMY (e) and the UKRWAR_DUMMY (f) respectively.

Regarding the data sources of our study, data of our main response variable (NPL) as well as bank-specific indicators all come from the Orbis Bank Focus database. Regarding the candidate predictors, data regarding the uncertainty indices all come from the "Policy Uncertainty" website (Policy Uncertainty, n.d.) which includes not only economic but a diverse set of uncertainty indicators. Regarding the macroeconomic control variables, data for GDP were collected from the International Monetary Fund (IMF), while the data for the rest macroeconomic indicators were gathered from Eurostat. Moreover, to account for institutional quality, we calculate a representative variable (INST_QUAL) as an average of six World Bank indicators: Control of corruption, government effectiveness, political stability and absence of violence/terrorism, regulatory quality, rule of law, and voice and accountability.

To account for cultural factors, we calculated two synthetic variables, namely uncertainty avoidance (UNCRT_AV) and uncertainty tolerance (UNCRT) by utilizing dimensionality reduction through principal component analysis (PCA).

Table A1 of the Appendix presents the sample distribution by country, Table A2 presents the sample distribution by bank, while Tables A3 and A4 present in detail all the variables incorporated in our research, along with an explanation and the data sources of each

one. Also, Table A4 presents in detail the components synthesizing the synthetic cultural variables UNCRT_AV and UNCRT. The synthetic cultural variables were calculated based on Schwartz's (1994) theory of cultural values. Based on this theory, 6 cultural dimensions were included, with data collected from the European Social Survey (ESS)[3] that corresponds to Schwartz's cultural values framework.

3.2 Methodology and empirical models

We use OLS methodology for panel data by utilizing fixed and random effects as estimation approaches. We perform all the requirements for the selected timeframe, and we use the Hausman test to check the suitability of the Random Effects over Fixed Effects method. Based on the results of the Hausman test, all our models developed were estimated using fixed effects, allowing for the management of time-constant unobserved country heterogeneity. To maximize the predictor accuracy, capture growth effects and promote uniformity, we transformed all the variables employed to their first differences. To ensure stationarity, we conducted Levin–Lin–Chu, Im–Pesaran–Shin, ADF - Fisher Chi-square and PP - Fisher Chi-square tests, which confirmed that the final sample contained only stationary components. We also add one lag period of the dependent variable to our analysis, to remove the residuals' autocorrelation, as pointed out by the Durbin-Watson statistic.

In our study, we choose to examine the relationship between our candidate predictors and NPL ratio, in two stages. More specifically, in the first stage (A), we examine the distinct effects of the candidate predictors on NPLs, including the institutional quality (INST_QUAL). In the second stage (B), we examine the same effects while incorporating the effects of uncertainty avoidance (UNCRT_AV), as well as uncertainty tolerance (UNCRT).

[3] Data from four ESS questionnaires were evaluated: ESS Round 7 (2014), Round 8 (2016), Round 9 (2018), Round 10 (2020) and Round 11 (2023). For each nation, a percentage of positive responses was calculated, and biennial figures were assigned to quarters according to the questionnaire timeframes. We imputed the missing data with values corresponding to the nearest preceding questionnaire period, assuming that cultural values remained relatively stable in the short term.

With the variables defined in Section 2.1, the specification models aiming to examine the candidate predictor - NPL ratio relationship, are the following:

$$D(NPL)_{i,t}=\beta_0 + \beta_1\times D(NPL)_{i(t-1),1} + \beta_2\times D(CAND\_PREDIC)_{it,2} + \beta_3\times D(C)_{it,3}+ \beta_4\times COVID\_DUMMY_{it,4} + \beta_5\times UKRWAR\_DUMMY_{it,5} + \beta_6\times D(INST\_QUAL)_{it,6} + \beta_7\times UNCRT_{it,7} + u_{it} \quad (1)$$

where the variable $NPL_{i,t}$ corresponds to the dependent variable of aggregate non-performing loans to total gross loans, $CAND\_PREDIC_{it,2}$ corresponds to the candidate predictor variables, $C_{it,3}$ corresponds to the control variables used, $COVID\_DUMMY_{it,4}$, $UKRWAR\_DUMMY_{it,5}$ corresponds to the dummy variables, as explained in Section 2.1, $INST\_QUAL_{it,6}$ refers to institutional quality, $UNCRT_{it,7}$ corresponds to the cultural variables (UNCRT, UNCRT_AV) and u_{it} corresponds to the error term. D denotes the first differences, representing the change between periods. The time lag (t-1) aims to capture the dynamics of the explanatory variables during the previous year.

4 Empirical results and discussion

This section discusses our main results: first, in Section 4.1, we present selected descriptive statistics and the results of Pearson correlation; second, in Section 4.2, we present the regression estimates related to the baseline estimations as obtained by the OLS fixed effects models.

4.1 Descriptive statistics

Table 1 presents the descriptive statistics for all variables employed. The variables that present non-normal distribution[4], as well as high values of kurtosis and skewness, do not influence the empirical models created.[5]

We identify the highly correlated variables by conducting Pearson correlation analysis. Notably, the dependent variable NPL is highly and positively correlated with the variable UNEMP, while on the other hand, there is a high and negative correlation amongst the variables

[4] Jarque-Bera p-value less than 0,05.
[5] Since our econometric models are based in panel data with country fixed effects approach.

NPL, GDP and INST_QUAL. Moreover, to avoid distorting the empirical results, we avoid including all the uncertainty variables[6] in the same model. Instead, we create alternative models, by sequentially including each uncertainty variable in the baseline regression model. Moreover, since the European Extreme Events Climate Index (E3CI) is similar to the Climate Risk Index (CLIM), we choose to include CLIM in the baseline estimations and E3CI for robustness instead of CLIM. We also created an interaction term by combining the variables INFLAT and UNEMP (INFLAT*UNEMP) to avoid high correlation derived amongst the variable INFLAT and variables such as UKRWAR_DUMMY, PANDM and GEOP, as well as to avoid high correlation derived amongst the variable UNEMP and GDP. This also helps in capturing the non-linear relationship between inflation and unemployment. This term specifically addresses variations in the macroeconomic landscape and is interpreted as how changes in inflation influence the relationship between unemployment and the dependent variable. Additionally, there is a high positive correlation between the variables UKRWAR_DUMMY and GEOP. Similarly, there is a high positive correlation amongst the variables COVID19_DUMMY and PANDM. Therefore, we also exclude the variable COVID19_DUMMY when the variable PANDM is included. Moreover, due to the high positive correlation amongst the variables UNCRT and UNCRT_AV, they are separately included in the analysis. Additionally, despite the strong negative correlation between the variables UNCRT, UNCRT_AV and PANDM, we include them in the baseline estimations.

For robustness checks, however (detailed in the Robustness Section), each variable is regressed individually with the dependent variable. Finally, although the variable COVID19_DUMMY is considerably correlated with the UKRWAR_DUMMY variable, we choose to include those variables in our baseline estimations, since they capture noteworthy events during the period of analysis. Instead, to validate the main findings we choose to

[6] WUI, ECON, TRADE, EUI, E3CI, PANDM, GEOP and CLIM.

separately include the COVID19_DUMMY and UKRWAR_DUMMY variables in separate regression models performed during the robustness analysis (Pearson correlation matrix not reported due to space limitations, available upon request).

Table 1 Descriptive statistics

	NPL	GDP	INFLAT	UNEMP	CIR	BANK_SIZE	ROA	L2A	UKRWAR_DUMMY	COVID19_DUMMY	WUI	ECON	TRADE	EUI	E3CI	PANDM	GEOP	CLIM	INST_QUAL	UNCRT	UNCRT_AV
Mean	0.086.859	4.553.140	1.133.314	9.065.984	5.752.652	7.370.447	3.225.487	5.951.255	0.146.266	0.299.793	0.823.915	0.934452	4.062.815	1.126.534	16580.93	6.178.547	4.394.900	4.027.148	7.601.882	-0.181.971	-0.200.157
Median	0.044.703	7.323.300	1.099.734	7.275.000	5.627.807	7.330.159	8.417.855	5.920.690	0.000.000	0.000.000	0.791.502	0.939399	0.000000	1.172.723	10234.49	0.000000	2.678.770	3.810.790	7.518.333	0.897.431	0.920.088
Maximum	0.994.169	6.595.174	1.557.827	2.782.500	4.222.855	9.028.979	8.188.861	9.806.194	1.000.000	1.000.000	2.158.918	1.990.110	9.141.891	1.855.468	146248.1	6.663.067	3.233.546	4.814.072	9.790.000	1.195.465	1.153.069
Minimum	0.000.156	6.861.982	1.000.000	2.016.667	-3.349.818	4.515.282	-9.923.006	3.926.917	0.000.000	0.000.000	0.000.000	0.000000	0.000000	2.004.635	-3.104.300	0.000000	0.272525	3.560.317	5.436.667	-3.008.713	-3.013.270
Std. Dev.	0.111.192	1.198.072	1.128.369	5.479.861	3.008.416	0.782.419	4.100.935	1.430.535	0.353.556	0.458.405	0.506.879	0.459734	1.202.850	3.924.878	26364.93	1.275.019	5.859.432	3.870.689	1.092.104	1.854.531	1.843.406
Skewness	2.946.723	3.522.542	1.614.500	1.440.135	0.359.432	-0.369.627	-1.671.782	0.064.860	2.002.050	0.873.950	0.129.940	0.094681	4.333.037	-0.112313	2.630.675	2.153.356	3.504.543	0.632754	0.297897	-0.860.105	-0.867.707
Kurtosis	1.492.148	1.494.136	5.651.832	4.744.516	8.376.598	3.899.034	3.748.723	3.525.316	5.008.204	1.763.788	2.255.482	2.199.843	2.361.099	2.138.230	1.109.764	7.185.724	1.651.142	2.174.740	2.519.345	1.759.591	1.762.110
Jarque-Bera	7.103.647	7.721.208	7.012.560	4.554.614	262033.7	5.441.612	5.599.513	1.176.019	8.059.722	1.840.988	2.497.745	2.462.162	18205.19	9.285.941	3.745.683	1.376.597	4.353.760	9.168.303	2.851.859	1.806.592	1.825.185
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002795	0.000000	0.000000	0.000.004	0.000005	0.000000	0.009629	0.000000	0.000000	0.000000	0.000000	0.000001	0.000.000	0.000.000
Sum	8.373.204	4.39E+09	1.092.515	8.739.608	5.545.557	7.105.111	3.109.370	5.737.009	1.410.000	2.890.000	7.942.537	8.167.112	3.550.900	3.165.561	1.598.401	5.659.549	1.982.100	3.882.171	8.878.998	-1.754.205	-1.929.516
Sum Sq. Dev.	1.190.625	1.38E+17	1.226.107	2.891.781	8.715.697	5.895.285	1.619.541	1.970.713	1.203.766	2.023.600	2.474.199	1.845.133	1.263.098	4.313.067	6.69E+11	1.487.495	1.544.983	1.442.789	1.391.869	3.312.030	3.272.413
Observations	964	964	964	964	964	964	964	964	964	964	964	874	874	281	964	916	451	964	964	964	964

Notes: 1. NPL stands for bank non-performing loans to total loans (gross) (%), GDP represents the yearly (%) change of gross domestic product at market prices, INFLAT represents the yearly (%) change of inflation, UNEMP stands for unemployment (%), CIR represents the cost to income ratio, BANK_SIZE stands for the bank size, ROA represents the bank return on average assets, L2A stands for loan to asset ratio, UKRWAR_DUMMY is a dummy capturing the conflict between Russia and Ukraine, COVID19_DUMMY represents the dummy variable used to capture the pandemic COVID-19, WUI indicates the World Uncertainty Index, ECON represents the Economic Policy Uncertainty Index, TRADE stands for the World Trade Uncertainty Index, EUI represents the Energy-Related Uncertainty Index, E3CI stands for European Extreme Events Climate Index, PANDM represents the World Pandemic Uncertainty Index, GEOP indicates the Geopolitical Risk Index, CLIM stands for the Climate Risk Index, INST_QUAL stands for institutional quality, UNCRT stands for uncertainty tolerance (Openness to change) and finally, UNCRT_AV stands for the uncertainty avoidance (Conservation). This note also applies to the subsequent tables.

4.2 Baseline estimations

This Section presents the baseline estimations. Specifically, Section 4.2.1 presents the empirical results related to the effects of uncertainty indices on NPLs and Section 4.2.2 presents the empirical estimates regarding the same relationship, including the effects of uncertainty tolerance and uncertainty avoidance. We complement the results with proposed policy implications.

4.2.1 Uncertainty indices and NPLs

Table 2 Baseline estimations. The effect of uncertainty indices on bank Non-Performing Loans (NPLs)

TABLE 2								
Regression Models:		MODEL (1)	MODEL (2)	MODEL (3)	MODEL (4)	MODEL (5)	MODEL (6)	MODEL (7)
Sample:		**Period: 2010-2023**						
Cross-Section Effects:		**Fixed**						
Methodology: OLS		**Dependent Variable**						
Variable Group	**Variable Symbol**	**D(NPL)**						
Macroeconomic	D(GDP)	(-1.61E-09)**	(-1.10E-09)**	(-1.39E-09)**	(-1.83E-09)**	(-2.07E-09)**	(-1.19E-09)**	(-9.14E-10)**
	D(INFLAT*UNEMP)	(3.94E-06)*	(1.89E-06)*	(2.59E-06)*	(2.54E-06)*	(6.24E-06)*	(2.53E-06)*	(6.31E-07)*
Bank-specific	D(NPL(-1))	(0.936969)***	(0.939758)***	(0.940990)***	(0.994031)***	(0.939361)***	(0.939732)***	(0.962397)***
	D(ROA)	(-4.37E-05)***	(-2.66E-05)*	(-2.44E-05)*	(-9.89E-05)*	(-4.33E-05)***	(-2.39E-05)*	(-0.000252)***
	D(BANK_SIZE)	(-0.141675)***	(-0.229136)***	(-0.235948)***	(-0.204720)***	(-0.144769)***	(-0.236072)***	(-0.193985)***
	D(L2A)	(-0.000357)***	(-0.000452)***	(-0.000454)***	(-0.000768)***	(-0.000342)***	(-0.000499)***	(-0.000389)***
	D(CIR)	(2.60E-05)*	(3.23E-05)*	(3.50E-05)*	(-5.06E-05)*	(3.18E-05)*	(2.87E-05)*	(3.22E-05)*
Uncertainty Indices	D(WUI)	(0.007521)***						
	D(ECON)		(0.006191)***					
	D(TRADE)			(6.51E-09)***				
	D(EUI)				(8.72E-05)***			
	D(CLIM)					(0.000344)***		
	D(PANDM)						(-1.14E-05)***	
	D(GEOP)							(0.000127)***
Institutional	D(INST_QUAL)	(-0.000547)***	(-0.000612)***	(-0.000361)*	(-0.000256)*	(-0.003057)***	(-0.000489)*	(-0.000326)*
Dummy	COVID19_DUMMY	(-0.003579)***	(-0.003538)**	(-0.001754)	(-0.006220)**	(-0.001684)		(-0.000560)
	UKRWAR_DUMMY	(0.000223)***	(0.000947)***	(0.001160)***	(0.002400)***	(0.003417)***	(1.08E-05)***	
Model Statistics:	Observations	924	840	840	237	924	877	438
	R-squared	0.979677	0.982016	0.981564	0.986987	0.979139	0.979479	0.981430
	Adjusted R-squared	0.977815	0.980198	0.979701	0.985019	0.977228	0.979479	0.981430
	F-statistic	5.262832	5.403647	5.268722	5.015697	5.124377	5.047567	5.258912
	Prob(F-stat)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Notes:

1. OLS methodology is employed for the regression model estimation.
2. Fixed Corrected Panel Effects estimations is utilized for all models based on the result of the Hausman test. The values depicted represent the coefficients while the significance of the p-value is presented with an asterisk: ***p < 0.01, **p<0.05, *p<0.1.
3. Durbin-Watson statistic at acceptable levels (amongst 1.5 and 2.0) indicating no levels of residuals' autocorrelation.
4. D stands for differences applied to normalize variables containing a unit root.
5. These notes also apply to the subsequent table.

From Table 2, concerning macroeconomic and bank-specific indicators, we derive a statistically significant and negative relationship between the growth of the economy (GDP), bank profitability (ROA), bank size (BANK_SIZE) and loan to asset ratio/bank liquidity (L2A) to bank non-performing loans to total loans (NPL). Those underscore the significant role of a strong economy and sound banking practices in sustaining lower NPLs at lower levels. Specifically, economic growth implies better economic conditions, which imply increased borrowers' spending power and overall economic well-being, enabling them to better service their loan obligations. Moreover, profitable banks are more resilient in managing their NPL. Larger banks have increased access to resources, tending to diversify their portfolios and employ robust risk management frameworks, therefore reporting lower NPLs. Increased liquidity also implies fewer NPLs since banks have a buffer to absorb potential losses.

Conversely, we derive a statistically significant and positive relationship between the growth of negative macroeconomic implications (INFLAT*UNEMP), the bank non-performing loans to total loans of the prior period (NPL(-1)) and cost-to-income ratio (CIR) to the growth of NPLs (as denoted by the variable NPL). The statistically significant and positive effects as denoted by the interaction term D(INFLAT*UNEMP) suggest that deteriorating economic conditions exacerbate NPLs, underscoring the significance of underscore the need for enhanced macroeconomic stability policies in improving bank stability. The negative effects of and the lagged NPL variable (NPL(-1)), point to the need for targeted risk management interventions to address persistent risk. The effects of CIR underscore that operational inefficiencies also contribute to increased NPLs.

The statistically significant effects of COVID19_DUMMY (negative) and UKRWAR_DUMMY (positive), suggest that the policy interventions and economic support measures during the pandemic period functioned as a protective barrier deflecting a potential NPL increase. On the other hand, the geopolitical conflict between Ukraine and Russia is linked with increased NPLs due to high uncertainty during this period.

Regarding the candidate predictors, the regression estimates of Table 3 reveal a statistically significant and positive effect of all uncertainty indices on NPLs (variable NPL), except the world pandemic uncertainty index (PANDM) (**Hypothesis H1.3.A Rejected/H1.3.B Accepted**). Regarding the positive effects, the world uncertainty index (WUI) poses the highest impact, followed by the economic policy uncertainty index (ECON), climate risk index (CLIM), geopolitical risk index (GEOP), energy-related uncertainty index (EUI) and world trade uncertainty index (TRADE). This implies that the accumulation of all uncertainties, represented by WUI, creates instability in economic factors such as income, operating costs and market conditions, thus weakening borrowers' financial capacity and their ability to repay their loans (**Hypothesis H1.1 Accepted**). The second highest uncertainty effect

that follows (ECON), implies that unclear economic policies create an unpredictable economic environment which weakens the borrowers' financial stability (**Hypothesis H1.2 Accepted**). The third highest effect (CLIM) implies that climate-related uncertainty can disrupt normal business operations, particularly in sectors/industries vulnerable to physical and transitional climate risks, thus increasing the likelihood of loan defaults for borrowers associated with those sectors/industries (**Hypothesis H1.6 Accepted**). The fourth-highest effect (GEOP) implies that geopolitical tensions can further destabilize the economic environment, making it more difficult for borrowers to meet their financial commitments (**Hypothesis H1.4.A Accepted/H1.4.B Rejected**). Coming to energy (EUI) and trade-related (TRADE) uncertainties, they negatively affect business costs, while causing supply chain disruptions. Energy-dependent sectors, as well as businesses reliant on global trade, are particularly affected. This increases financial stress and reduces borrowers' ability to service their loans, leading to higher default risks (**Hypothesis H1.5.A Accepted/H1.5.B Rejected, Hypothesis H1.7 Accepted**).

Finally, we also observe a statistically significant and negative effect of institutional quality (INST_QUAL) on NPL, indicating that enhanced institutional quality reduces NPLs. This suggests that in a stronger institutional environment with effective governance, regulatory enforcement and political stability, borrowers are better equipped to meet loan obligations, while banks can more effectively manage uncertainties and associated risks, leading to a decrease in NPLs (**Hypothesis H2.1 Accepted**). Additionally, INST_QUAL shows higher statistical significance in MODELS (1), (2) and (5), where the WUI, ECON, and CLIM indices are included. This underscores the critical role of institutional quality in mitigating the impact of these specific uncertainties (**Hypothesis H2.2 Accepted**).

4.2.2 Cultural variations: Uncertainty tolerance versus uncertainty avoidance

Table 3 Baseline estimations. The effect of uncertainty indices on bank Non-Performing Loans. The role of uncertainty tolerance (openness to change)

	TABLE 3							
Regression Models:		MODEL (8)	MODEL (9)	MODEL (10)	MODEL (11)	MODEL (12)	MODEL (13)	MODEL (14)
Sample:		**Period: 2010-2023**						
Cross-Section Effects:		**Fixed**						
Methodology: OLS		**Dependent Variable**						
Variable Group	**Variable Symbol**	**D(NPL)**						
Macroeconomic	D(GDP)	(-1.94E-09)***	(-1.26E-09)***	(-1.48E-09)***	(-3.04E-09)***	(-2.31E-09)***	(-1.38E-09)***	(-8.60E-10)***
	D(INFLAT*UNEMP)	(3.72E-06)*	(1.99E-06)*	(2.42E-06)	(2.21E-06)*	(5.32E-06)**	(2.33E-06)*	(1.44E-06)*
Bank-specific	D(NPL(-1))	(0.933161)***	(0.937829)***	(0.939842)***	(0.974606)***	(0.936547)***	(0.937467)***	(0.958531)***
	D(ROA)	(-4.34E-05)**	(-2.76E-05)*	(-2.71E-05)*	(-8.56E-05)*	(-4.41E-05)**	(-2.42E-05)*	(-0.000255)**
	D(BANK_SIZE)	(-0.140829)***	(-0.227483)***	(-0.234190)***	(-0.187465)***	(-0.143986)***	(-0.234230)***	(-0.192443)***
	D(L2A)	(-0.000354)**	(-0.000459)**	(-0.000440)**	(-0.001060)**	(-0.000330)**	(-0.000514)**	(-0.000385)**
	D(CIR)	(2.34E-05)*	(3.28E-05)*	(3.45E-05)*	(4.40E-05)*	(2.86E-05)*	(2.93E-05)*	(3.21E-05)*
Uncertainty Indices	D(WUI)	(0.008285)***						
	D(ECON)		(0.006936)***					
	D(TRADE)			(8.70E-05)***				
	D(EUI)				(9.35E-02)***			
	D(CLIM)					(0.000425)***		
	D(PANDM)						(-0.000221)***	
	D(GEOP)							(0.000128)***
Institutional	D(INST_QUAL)	(-0.000591)***	(-0.000344)***	(-0.000211)***	(-0.003397)***	(-0.000438)***	(0.000572)***	(0.000363)***
Cultural	D(UNCRT)	(0.003660)***	(0.002845)***	(0.008765)***	(-0.024686)***	(0.008532)***	(0.054636)***	(0.003945)***
Dummy	COVID19_DUMMY	(0.009944)	(0.007380)	(-0.033360)*	(-0.109255)**	(-0.031674)*		(0.015717)
	UKRWAR_DUMMY	(-2.45E-05)***	(0.001038)***	(0.001206)***	(0.000941)***	(0.003144)***	(5.58E-06)***	
Model Statistics:	Observations	924	840	840	237	924	877	438
	R-squared	0.979842	0.982067	0.981663	0.987747	0.979308	0.979470	0.983475
	Adjusted R-squared	0.977948	0.980203	0.979757	0.985755	0.977364	0.979470	0.981531
	F-statistic	5.173678	5.268478	5.150185	4.958932	5.037402	4.926887	5.058816
	Prob(F-stat)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

The regression estimates in Table 3 are generally consistent with those in Table 2, except for the uncertainty indices and GDP. Specifically, the inclusion of the uncertainty tolerance (UNCRT) variable in the equations, not only increases the statistical significance of all uncertainty indices but also increases the statistical significance of economic growth (GDP). This suggests that the high risk-taking behavior/culture of individuals and institutions implies increased investments, innovations and adaptability to periods of heightened uncertainty, which lead to economic growth and subsequently decreased NPLs. While risk-taking can lead to greater investment, innovation and economic growth, it also inherently increases exposure to volatility and financial instability, as denoted by the increased significance of uncertainty indices (**Hypothesis H3.3.A Accepted; Hypothesis H3.3.B Rejected**). This highlights the need for a balancing act, with institutional quality (INST_QUAL) serving as the key stabilizing factor. This is evident in Table 3, where the inclusion of UNCRT increases all uncertainty

indices, although the increase is not extreme. This implies that institutional quality favors more risk-taking behavior and acts as a catalyst creating a supportive environment where banks can take more risks, without significantly increasing the probability of increased NPLs (**Hypothesis H3.4 Accepted**).

Table 4 Baseline estimations. The effect of uncertainty indices on bank Non-Performing Loans. The role of uncertainty avoidance (conservation)

		TABLE 4						
Regression Models:		MODEL (15)	MODEL (16)	MODEL (17)	MODEL (18)	MODEL (19)	MODEL (20)	MODEL (21)
Sample:		**Period: 2010-2023**						
Cross-Section Effects:		**Fixed**						
Methodology: OLS		**Dependent Variable**						
Variable Group	**Variable Symbol**	**D(NPL)**						
Macroeconomic	D(GDP)	(-2.00E-09)**	(-1.34E-09)**	(-1.58E-09)**	(-1.19E-08)**	(-2.31E-09)**	(-1.34E-09)*	(-8.63E-10)**
	D(INFLAT*UNEMP)	(6.12E-06)*	(5.87E-06)*	(6.80E-06)*	(8.28E-07)*	(8.08E-06)*	(2.48E-06)*	(8.18E-07)*
Bank-specific	D(NPL(-1))	(0.933962)***	(0.938397)***	(0.940163)***	(0.968473)***	(0.936797)***	(0.937979)***	(0.961370)***
	D(ROA)	(-4.58E-05)***	(-3.28E-05)**	(-3.17E-05)**	(-7.47E-05)**	(-4.62E-05)***	(-2.40E-05)**	(-0.000253)***
	D(BANK_SIZE)	(-0.142203)***	(-0.228026)***	(-0.234246)***	(-0.177597)***	(-0.145429)***	(-0.234861)***	(-0.193706)***
	D(L2A)	(-0.000336)***	(-0.000455)***	(-0.000449)***	(-0.000956)***	(-0.000318)***	(-0.000511)***	(-0.000407)***
	D(CIR)	(2.21E-05)	(3.20E-05)	(3.46E-05)	(3.66E-05)	(2.52E-05)	(2.91E-05)	(3.29E-05)
Uncertainty Indices	D(WUI)	(0.006701)***						
	D(ECON)		(0.005692)***					
	D(TRADE)			(3.98E-05)***				
	D(EUI)				(0.000120)***			
	D(CLIM)					(6.00E-05)***		
	D(PANDM)						(-7.91E-06)***	
	D(GEOP)							(4.65E-05)***
Institutional	D(INST_QUAL)	(-0.000457)***	(-0.000240)***	(-0.000123)***	(-0.002315)***	(-0.000326)***	(-0.000229)***	(0.000350)***
Cultural	D(UNCRT_AV)	(-0.018362)***	(-0.022231)***	(-0.026596)***	(-0.040553)***	(-0.025907)***	(0.000351)***	(-0.002128)***
Dummy	COVID19_DUMMY	(-0.077565)***	(-0.091950)***	(-0.107566)***	(-0.169042)*	(-0.105651)***		(-0.008571)
	UKRWAR_DUMMY	(8.61E-05)***	(0.001095)***	(0.001273)***	(-0.001018)***	(0.001445)***	(0.000966)	
Model Statistics:	Observations	924	840	840	237	924	877	438
	R-squared	0.979960	0.982210	0.981801	0.987741	0.979442	0.981447	0.983423
	Adjusted R-squared	0.978078	0.980361	0.979909	0.985748	0.977511	0.979453	0.981473
	F-statistic	5.204859	5.311566	5.189957	4.956539	5.071067	4.922656	5.042594
	Prob(F-stat)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

The results of the regression estimates presented in Table 4 validate the previous findings while offering additional insights. First, when UNCRT_AV is included, the statistically significant effects of GDP remain consistent with Table 2. On the other hand, the statistical significance of ROA, L2A and INST_QUAL increase. We also notice a decrease in the coefficients of the uncertainty indices. These results imply that banks operating in cultures that have a robust institutional framework, while also favoring uncertainty avoidance behaviors, tend to adopt more conservative lending practices, reserving a higher proportion of loans relative to their assets. As a result, they report higher profitability, as they are more cautious in their risk-taking and maintain stronger financial buffers to withstand periods of

uncertainty. Moreover, by maintaining higher reserves and focusing on risk mitigation, these banks are better equipped to manage the volatility associated with various uncertainty indices. On the borrower's side, in a robust institutional framework combined with cultural avoidance behavior, borrowers follow a more conservative borrowing approach and more prudent debt management practices, making them less likely to default on their loans during periods of heightened uncertainty (**Hypothesis H3.1.A Rejected; Hypothesis H3.1.B Accepted; Hypothesis H3.2 Accepted**).

5 Robustness

The results previously reported are based on the application of the fixed effects method for the full sample period. To validate the baseline estimation, we conducted additional tests.

First, we applied Robust Least Squares (RLS) as an alternative econometric method. Tables A5, A6 and A7 of the Appendix, present the results of the RLS method. While the magnitude and significance of the derived coefficients reported differ, they both follow the same trend followed by baseline estimations, thus validating the results derived in Section 4. Additionally, their results also yield an increase in both cost-to-income ratio (CIR) and D(INFLAT*UNEMP) interaction terms, highlighting the negative effects of uncertainties on both economic and banking stability.

To address endogeneity, we employed the Generalized Method of Moments (GMM) (Hansen, 1982) as an alternative econometric method, choosing Arellano and Bond (1991) difference specification. In the dynamic model, we employed the dependents' variable one lag period as an instrumental variable since the current bank NPLs are also a by-product of the NPLs of the previous period. Additionally, we also applied ridge regression to stabilize the coefficient estimates to address potential multicollinearity concerns in our model and eventually enhance the reliability of our results.

We also accounted for the nature of the uncertainty indices utilized in this research, since they reflect both past and future concerns. Specifically, while they are mainly backward-looking in nature, they also include forward-looking elements depending on the extent that the source materials discuss uncertainties related to future events. Therefore, given the dual nature of those indices, their impact on NPLs may not immediately materialize. To capture the detailed effects to NPLs, we expanded our analysis by introducing two-period lags for each uncertainty index and the baseline estimation models. The statistically significant effects derived from this analysis revealed the following: The first lags of all indices were statistically insignificant; Regarding the second lags, all exerted positive impacts to NPLs and more specifically, WUI(-2) posed the strongest impact, followed by ECON(-2), GEOP(-2), EUI(-2) and TRADE(-2), indicating that uncertainties captured by these indices take time to materialize in loan performance possibly due to delayed borrower responses or gradual economic mechanisms; The second lag of PANDM exhibited a negative effect to NPLs possibly due to policy interventions; The second lag related to climate risk index, namely CLIM(-2), was statistically insignificant. This implies that the risks associated with climate-related uncertainties materialize faster, highlighting the need for targeted policy interventions.

To assess the effects of uncertainties across different percentiles of the NPL distribution, we conducted panel quantile regressions. Our results indicated that banks with higher NPLs (upper quantiles) are more sensitive to uncertainties compared to those with lower NPLs. This suggests that banks reporting higher NPLs could require more robust risk management frameworks, compared to those with fewer NPLs.

To assert the effects of uncertainties not only in the short term but also in long-term as well, we applied the Autoregressive Distributed Lag (ARDL) method for panel data. The results from the ARDL method reinforced the main findings, while also showing that while in the short-term, economic policy uncertainty (ECON) is more statistically significant than

climate-related uncertainty (CLIM), in the long-term, CLIM exerts a stronger effect. This suggests that, in the long run, uncertainty related to climate risks is more likely to influence borrowers' ability to meet their obligations than uncertainty related to economic policy. We also derived that in the long-term, the inclusion of UNCRT combined with INST_QUAL increases the statistical significance, not only for GDP but ROA and L2A as well, implying that in the long-term, risk-taking leads to greater investments, innovations and economic growth, while institutional quality helps manage and mitigate the potential negative consequences of increased risk (uncertainty), such as higher NPLs.

Additionally, we conducted sensitivity analyses by systematically considering scenarios, where we first included and then excluded certain years, countries and banks from our empirical estimates. This test validated our main findings. Additionally, we also estimated the econometric models by independently incorporating the variables UNCRT, UNCRT_AV and PANDM and regressing against the dependent variable. The same procedure was applied by independently incorporating the COVID19_DUMMY and UKRWAR_DUMMY variables. Moreover, to observe the significance of institutional quality, we also conducted the regressions reported in Table 2, Table 3 and Table 4 without the inclusion of the variable INST_QUAL. This test revealed that without the presence of institutional quality, the effects of uncertainty variables on the dependent variable NPL were higher. Regarding the distinct effects of UNCRT and UNCRT_AV, excluding the variable INST_QUAL, the effects associated with UNCRT were significantly stronger, while UNCRT_AV did not exhibit a significant impact. This suggests that, in an environment with strong institutional quality, banks benefit from improved regulatory standards and enhanced risk management, allowing them to take more risks while being able to manage the downside of risk-taking. Additionally, excluding the INST_QUAL variable, reduced the negative and statistically significant effect of

the COVID19_DUMMY, indicating that institutional quality played a key role in mitigating the pandemic's impact.

Aiming to confirm the effects of uncertainty tolerance on NPLs, we also conducted subsample analysis by dividing the total period of analysis based on high- (2010 - 2019) and low-growth periods (2020 - 2023) and performing the same regression analyses. The high growth period was characterized by strong global economic recovery and steady GDP growth, while the low growth period was characterized by global economic slowdown mainly due to the COVID-19 pandemic and the geopolitical conflict between Ukraine and Russia. Our findings indicated that during the high-growth period, the uncertainty tolerance effects were rendered statistically insignificant in terms of impact on bank NPLs, contrary to the effects observed during the total period. This suggests that during periods of high growth, banks have increased loan inflows due to economic growth, allowing them to maintain their capital reserves, thus allowing them to take more risks while preventing a rise in NPLs. On the other hand, the effects of uncertainty tolerance during the low-growth period were statistically significant and higher than the baseline estimations, indicating that during a weaker economic environment, high bank risk-taking behaviors increase the possibility of loan defaults and, therefore the possibility of higher NPL volumes.

To verify whether the interaction between the uncertainty indices and institutional quality mitigates their effects on NPLs, we created interaction terms for each uncertainty variable and institutional quality and we regressed against the variable NPL. The results of this test indicated that institutional quality mitigates the negative effects of uncertainty indices on NPLs. Additionally, to account for heterogeneity across diverse country groups within our sample, we divided our sample into core and peripheral economies, based on the classification of the studies De Santis and Cesaroni (2016), Bartlett and Prica (2017) and De Grauwe and Ji

(2018)[7] (detailed classification presented in Table A1 of the Appendix) and then we re-run the regression analysis using OLS method. Our findings revealed that banks operating in core economies were more resilient to uncertainty-related risks, with economic policy uncertainty (ECON) emerging as the primary driver of NPLs in these economies (ECON coefficient value: 0.002945***). In contrast, banks residing in peripheral economies exhibited heightened vulnerability, particularly to accumulated uncertainty (WUI) (coefficient value: 0.007744***), followed by economic policy (ECON) (coefficient value: 0.006543***) and climate-related uncertainties (CLIM) (coefficient value: 0.000406***). Furthermore, the inclusion of institutional quality as a control variable mitigated the aforementioned prevailing forms of uncertainty. However, this effect was more pronounced in banks residing in peripheral economies. This reinforces our main finding that in a stronger institutional environment, banks are better equipped to manage uncertainties and associated risks and borrowers are in a better financial position enabling them to meet loan obligations.

Furthermore, to assess whether our estimations are confounded by differences in market structures, we accounted for market power and concentration using two complementary measures. First, we incorporated the Lerner Index (LI), as a measure of bank market power[8] based on the study of Anginer et al. (2014). The LI is estimated at the bank level and is not influenced by the rest banks of our sample. It is While the inclusion of LI slightly altered the

[7] De Santis and Cesaroni (2016) and Bartlett and Prica (2017), categorize Austria, Belgium, Germany, France, Finland and the Netherlands as core. De Grauwe and Ji (2018), also categorize Netherlands as a core country. We end up in the following categorization of core economies: Austria, Belgium, Germany, France, Finland, Netherlands and Luxembourg, while the rest are categorized as peripheral. Since our sample includes selected banks from specific countries, the classification into core and peripheral economies is detailed in Table A1 of the Appendix

[8] According to Altunbas et al. (2023), the Lerner Index of monopoly power ranges between zero (a perfectly competitive bank) and one (a monopolistic bank) and is calculated utilizing bank level data from Orbis Bank Focus, to measure a bank's pricing ability relative to its marginal costs (competitive position). It is derived as the difference between the price (P) and marginal costs (MC), scaled by the price ((P-MC)/P). P is estimated as the ratio of total (interest and non-interest) income to total assets for each bank for each year. MC is estimated using a translog cost function based on a single output (total assets) and three input prices for deposits, labor and physical capital. This index reflects market power, with higher values indicating stronger pricing ability and lower competition. The Lerner index, where a higher index means a greater market power and thus a lower competition.

coefficients of the baseline estimation, their signs and significance remained the same. This implies that variations in competitive environments do not significantly influence risk-taking behavior and loan performance validating our primary estimations. Second, we replaced LI with the Herfindahl-Hirschman Index (HI)[9] from the European Central Bank (ECB). By incorporating the HI in the baseline estimations, our regression analysis revealed a statistically significant negative relationship between HI and bank NPLs. Notably, when HI is included, the coefficients related to all uncertainty indices are reduced, with the strongest reduction observed in climate-related uncertainty. This suggests that a concentrated banking system may strengthen the banks' overall market power, enabling more efficient capital allocation to address external risks, particularly those associated with climate-related uncertainties. However, as Tian et al. (2020) emphasize, in a concentrated banking system, maintaining sufficient competition is essential to preserve market integrity and prevent monopolistic behaviors or reduced competition.

The empirical results of the above robustness checks, including the alternative econometric methods, heterogeneity, sub-sample analysis, interaction terms, differences in market structures and sensitivity analyses, validate and reinforce the baseline estimations as reported in Section 4. They also reveal critical transmission channels through which uncertainty indices affect bank NPLs. These include the macroeconomic vulnerabilities, as heightened uncertainties amplify adverse economic conditions; Institutional quality, which mitigates external risks and bolsters risk management capacity; Market power dynamics, which shape capital allocation; Economic growth, since uncertainties exert a more pronounced effect during low-growth periods; Cultural preferences, since behaviours towards uncertainty avoidance and

[9] Herfindahl-Hirschman Index (HI). Ranging from 0 to 10,000, it measures the concentration of banking business based on total assets. It is calculated by summing the squares of the market shares of all credit institutions in the banking sector.

uncertainty tolerance distinctly shape affects both borrowers' and lenders' financial behavior, ultimately affecting bank NPLs.

6 Concluding remarks

This study investigates the relationship between uncertainty indices and bank NPLs, considering the role of cultural and institutional factors. For our purpose, we utilize bank-level data spanning from 2010 to 2023, accounting for a diverse array of factors, while considering both the COVID-19 pandemic and the Russia-Ukraine conflict and using OLS and RLS as empirical methods.

In line with our research questions, we find that the world uncertainty (WUI), economic policy uncertainty (ECON), climate uncertainty (CLIM), geopolitical (GEOP), energy-related (EUI), as well as world trade uncertainty (TRADE) uncertainties, decrease economic and banking stability, which contribute to increased NPLs. This is consistent with the literature, where uncertainties, particularly economic policy uncertainty, are noted for their negative effects on both economic and banking stability (Ashraf 2019; Wang and Yao 2013; Bloom 2009; Deng and Li 2024; Vu et al. 2023; Chi and Li 2017; Wang et al. 2024).

Regarding the pandemic-related uncertainty, our study showed a countercyclical effect on bank NPLs. While studies such as Liu and Gao (2022), Zhang et al. (2023) and Xing and Shabir (2022) showed the uncertainty stemming from the recent COVID-19 pandemic exerts a negative impact on investor activity and economic stability, this economic stability did not reach the interconnected European banking sector, mainly due to economic support measures and prudent policies implemented during the lockdown period, in line with Plikas et al. (2024). In the short-term, the world uncertainty (WUI) exerts the highest impact followed by economic policy and climate uncertainties, while in the long-term climate-related uncertainty surpasses the economic policy uncertainty, in terms of NPL increase. Moreover, the impacts of climate-related uncertainty on NPLs materialize faster contrary to rest uncertainty indices. This comes

in line with the work of Khan et al. (2023) and Carè, Fatima and Boitan (2024), who highlight the growing concern about climate policy uncertainty, as economies transition toward sustainability.

Geopolitical (GEOP), energy-related (EUI) and world trade uncertainties (TRADE) also contribute to NPL fluctuations, although their impact is less pronounced than that of world uncertainty, economic policy and climate-related uncertainties. This is consistent with the work of Phan et al. (2022), Hu et al. (2024), Shabir et al. (2023), Chen et al. (2018), Dang et al. (2023), Nasim et al. (2023), Klein (2013) and Vu et al. (2023), which highlight the influence of these uncertainties on financial stability. Institutional quality implies a robust institutional environment where borrowers are better equipped to meet loan obligations, while banks can more effectively manage uncertainties and associated negative spillover effects to NPLs, in line with Kafka and Kostis (2024), Xing and Shabir (2022), Beck et al. (2006) and Laeven and Valencia (2013). Institutional quality has the highest mitigating effect in the accumulated uncertainty (world uncertainty index: WUI), as well as economic policy (ECON) and climate-related uncertainties (CLIM).

Cultural factors, such as uncertainty avoidance and tolerance, play a significant role in the dynamics of NPLs. Specifically, banks and borrowers residing in cultures with strong institutional frameworks and uncertainty avoidance behavior adopt conservative lending and borrower behaviors, in line with Hofstede (2001), Schwartz (1994) and Rothwell and Wissema (1986), reducing the probability of loan defaults. This contradicts Chui and Kwok (2008) and Gelfand et al. (2011), Marfo and Tweneboah (2022) which state that high uncertainty avoidance behaviors hinder bank innovations, eventually jeopardizing the banks' stability. Conversely, in cultures with strong institutions and a risk-tolerant attitude, banks and borrowers are more willing to take risks, which can spur innovation and economic growth. This comes in line with studies that support that cultures with risk-taking behavior tend to perform better in

uncertain periods (Knack and Keefer 1997; Hofstede 2001; Schwartz 1994; Schwartz and Sagiv 1995; Petrakis et al. 2015; Kafka et al. 2020). However, a robust institutional environment allows them to take more risks while being able to manage the downside of risk-taking, in line with studies such as Kostis and Markatou (2021) and Fazio et al. (2018), which underscore the significance of robust institutional frameworks in enhancing economic and banking stability in uncertain periods.

Moreover, by dividing the sample into high and low growth periods, we find during periods of high economic growth, banks can maintain their capital reserves, thus allowing them to take more risks, while preventing a rise in NPLs, in line with Marfo and Tweneboah (2022) which suggest that economic growth leads to NPL reduction. While we disagree with Chui and Kwok (2008) and Gelfand et al. (2011), Marfo and Tweneboah (2022) regarding the short-term effects of uncertainties on NPLs, our findings regarding the high growth period come in line with those studies. Additionally, in line with Knack and Keefer (1997), Petrakis et al. (2015), Kafka et al. (2020), Marfo and Tweneboah (2022), Schwartz and Sagiv (1995), we find that in the long-term, risk-taking behavior leads to greater investments, innovations, which spur growth, while at the same time, institutional quality helps manage and mitigate the potential negative consequences of increased risk (uncertainty), such as higher NPLs, in line with Kostis and Markatou (2021) and Fazio et al. (2018). Notably, the mitigating effect of institutional quality is more pronounced in banks located in peripheral economies, which are particularly vulnerable to external risks. Furthermore, in line with Mi et al. (2024) and Tian et al. (2020), we also deduce that if effectively leveraged, bank concentration and market power can serve as a strategy for mitigating external risks, particularly those associated with climate-related uncertainties.

In addition, this study also reveals the critical transmission channels through which uncertainty indices affect bank NPLs. Those transmission channels include macroeconomic

vulnerabilities, institutional quality, market power dynamics, economic growth and cultural preferences. These transmission channels underscore the interplay of macroeconomic, institutional, market, economic and cultural factors in shaping the financial stability of the banking sector during periods of heightened uncertainty.

The findings of this study have significant policy implications for both financial regulators and banking institutions. Policymakers should recognize the substantial impact of various uncertainty indices on banking stability, particularly in the context of NPLs. They could also utilize the findings of this research to strategically apply targeted policies based on those uncertainties that impact bank stability the most. Moreover, policymakers, governments and central banks should prioritize strengthening the current institutional frameworks, especially in cultures more susceptible to heightened uncertainty, in line with Laeven and Valencia (2013) and Gupta and Zebedee (2020). Robust institutional frameworks can act as catalysts in protecting the economy and financial institutions against external shocks, in line with Kostis and Markatou (2021). Based on Schwartz and Sagiv (1995), which support that the culture of a society is linked with financial behavior, banks should also take a proactive approach, by incorporating various uncertainties and institutional and cultural factors into their risk management methods. Finally, policymakers should recognize that in a robust institutional environment, calculated risk-taking can play a crucial role in driving long-term economic growth. This comes in line with literature, such as Knack and Keefer (1997), Petrakis et al. (2015), Kafka et al. (2020), Marfo and Tweneboah (2022), Schwartz and Sagiv (1995). In such environments, banks can support innovation and technological advancement, by providing more loans, while also benefiting from higher profits and market share.

Future studies could examine the effect of uncertainty indices in bank NPLs, within specific economic sectors, such as agriculture, manufacturing and services. They could also explore how specific institutional variables (e.g., legal systems, corruption levels) interact with

uncertainty indices and NPLs and the influence of different policies and regulatory frameworks in mitigating NPLs during high uncertainty periods.

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Appendix A

Table A1 Country sample

Country	Observation per Country	Percent	Cumulative Observation Count	Cumulative Percentage Count	Core / Periphery Categorization
Austria	29	3.01	29	3.01	Core
Czech Republic	55	5.71	84	8.71	Peripheral
Denmark	48	4.98	132	13.69	Peripheral
Estonia	17	1.76	149	15.46	Peripheral
Finland	12	1.24	161	16.70	Core
Greece	64	6.64	225	23.34	Peripheral
Hungary	78	8.09	303	31.43	Peripheral
Italy	40	4.15	343	35.58	Peripheral
Latvia	31	3.22	374	38.80	Peripheral
Lithuania	37	3.84	411	42.63	Peripheral
Luxembourg	28	2.90	439	45.54	Core
Malta	45	4.67	484	50.21	Peripheral
Poland	94	9.75	578	59.96	Peripheral
Portugal	50	5.19	628	65.15	Peripheral
Romania	68	7.05	696	72.20	Peripheral
Slovakia	83	8.61	779	80.81	Peripheral
Slovenia	56	5.81	835	86.62	Peripheral
Spain	87	9.02	922	95.64	Peripheral
Sweden	42	4.36	964	100.00	Peripheral
Total	964	100.00	964	100.00	-

Notes: **1.** This table presents the sample of countries that synthesize the data of our research, as well as the observation distribution by country. **2.** The total number of observations is 964 observations. **3.** The categorization of core/peripheral economies is based on De Santis and Cesaroni (2016), Bartlett and Prica (2017) and De Grauwe and Ji (2018).

Table A2 Bank sample

Country	Bank	Observation per Country	Percent	Cumulative Observation Count	Cumulative Percentage Count
Slovakia	365.BANK	13	1.35	13	1.35
Lithuania	AB SEB BANKAS	9	0.93	22	2.28
Spain	ABANCA CORPORACION BANCARIA	12	1.24	34	3.53
Greece	ALPHA BANK	14	1.45	48	4.98
Malta	APS BANK	12	1.24	60	6.22
Greece	ATTICA BANK	12	1.24	72	7.47
Romania	BANCA COMERCIALA ROMANA	14	1.45	86	8.92
Spain	BANCO BILBAO VIZCAYA ARGENTARIA	14	1.45	100	10.37
Portugal	BANCO BPI	14	1.45	114	11.83
Spain	BANCO DE CREDITO SOCIAL COOPERATIVO	11	1.14	125	12.97
Spain	BANCO DE SABADELL	14	1.45	139	14.42
Portugal	BANCO SANTANDER TOTTA	13	1.35	152	15.77
Poland	BANK HANDLOWY W WARSZAWIE	14	1.45	166	17.22
Poland	BANK MILLENNIUM	14	1.45	180	18.67
Malta	BANK OF VALLETTA	14	1.45	194	20.12
Luxembourg	BANQUE ET CAISSE DEPARGNE DE LETAT LUXEMBOURG	14	1.45	208	21.58
Luxembourg	BANQUE INTERNATIONALE A LUXEMBOURG	14	1.45	222	23.03
Romania	BRD-GROUPE SOCIETE GENERALE	14	1.45	236	24.48
Portugal	CAIXA GERAL DE DEPOSITOS	14	1.45	250	25.93
Romania	CEC BANK	14	1.45	264	27.39
Slovakia	CESKOSLOVENSKA OBCHODNA BANKA	14	1.45	278	28.84
Czech Republic	CESKOSLOVENSKA OBCHODNI BANKA	14	1.45	292	30.29
Denmark	DANSKE BANK	14	1.45	306	31.74
Hungary	ERSTE BANK HUNGARY	14	1.45	320	33.20
Austria	ERSTE GROUP BANK	14	1.45	334	34.65
Greece	EUROBANK ERGASIAS	13	1.35	347	36.00
Malta	HSBC BANK MALTA	10	1.04	357	37.03
Czech Republic	HYPOTECNI BANKA	14	1.45	371	38.49
Spain	IBERCAJA BANCO	13	1.35	384	39.83
Poland	ING BANK SLASKI	14	1.45	398	41.29
Italy	INTESA SANPAOLO	14	1.45	412	42.74
Hungary	K&H BANK ZRT	14	1.45	426	44.19
Czech Republic	KOMERCNI BANKA	13	1.35	439	45.54
Spain	KUTXABANK	12	1.24	451	46.78
Estonia	LUMINOR BANK	12	1.24	463	48.03
Estonia	LUMINOR HOLDING	5	0.52	468	48.55

Table A2 Bank sample (cont.)

Country	Bank	Observation per Country	Percent	Cumulative Observation Count	Cumulative Percentage Count
Poland	MBANK	14	1.45	482	50.00
Malta	MDB GROUP LIMITED	9	0.93	491	50.93
Italy	MEDIOBANCA	12	1.24	503	52.18
Hungary	MKB BANK	14	1.45	517	53.63
Czech Republic	MONETA MONEY BANK	14	1.45	531	55.08
Finland	MUNICIPALITY FINANCE	5	0.52	536	55.60
Greece	NATIONAL BANK OF GREECE	13	1.35	549	56.95
Finland	NORDEA BANK	7	0.73	556	57.68
Slovenia	NOVA KREDITNA BANKA MARIBOR	14	1.45	570	59.13
Slovenia	NOVA LJUBLJANSKA BANKA	14	1.45	584	60.58
Portugal	NOVO BANCO	9	0.93	593	61.51
Denmark	NYKREDIT REALKREDI	14	1.45	607	62.97
Austria	OESTERREICHISCHE KONTROLLBANK	1	0.10	608	63.07
Hungary	OTP BANK	14	1.45	622	64.52
Poland	PEKAO BANK HIPOTECZNY	11	1.14	633	65.66
Greece	PIRAEUS FINANCIAL HOLDINGS	12	1.24	645	66.91
Poland	POWSZECHNA KASA OSZCZEDNOSCI BANK POLSKI	13	1.35	658	68.26
Slovakia	PRIMA BANKA SLOVENSKO	14	1.45	672	69.71
Romania	RAIFFEISEN BANK	14	1.45	686	71.16
Hungary	RAIFFEISEN BANK ZRT	14	1.45	700	72.61
Denmark	REALKREDIT DANMARK	10	1.04	710	73.65
Latvia	RIETUMU BANK GROUP	14	1.45	724	75.10
Poland	SANTANDER BANK POLSKA	14	1.45	738	76.56
Lithuania	SIAULIU BANKAS	14	1.45	752	78.01
Slovenia	SID - SLOVENE EXPORT	14	1.45	766	79.46
Sweden	SKANDINAVISKA ENSKILDA BANKEN	14	1.45	780	80.91
Slovakia	SLOVENSKA SPORITELNA	14	1.45	794	82.37
Sweden	SVENSKA HANDELSBANKEN	14	1.45	808	83.82
Sweden	SWEDBANK	14	1.45	822	85.27
Lithuania	SWEDBANK AB VILNIUS	14	1.45	836	86.72
Latvia	SWEDBANK BALTICS	3	0.31	839	87.03
Latvia	SWEDBANK LATVIA	14	1.45	853	88.49
Slovakia	TATRA BANKA	14	1.45	867	89.94
Denmark	TOTALKREDIT	10	1.04	877	90.98
Romania	TRANSILVANIA BANK	12	1.24	889	92.22
Poland	UNICAJA BANCO	11	1.14	900	93.36

Table A2 Bank sample (cont.)

Country	Bank	Observation per Country	Percent	Cumulative Observation Count	Cumulative Percentage Count
Italy	UNICREDIT	14	1.45	914	94.81
Austria	UNICREDIT BANK AUSTRIA	14	1.45	928	96.27
Hungary	UNICREDIT BANK HUNGARY	8	0.83	936	97.10
Slovenia	UNICREDIT BANKA SLOVENIJA	14	1.45	950	98.55
Slovakia	VSEOBECNA UVEROVA BANKA	14	1.45	964	100.00
Total	-	964	100.00	964	100.00

Notes: This table presents the sample of banks that synthesize the data of our research, as well as the observation distribution by bank and country.

Table A3 Data sources & description

Variable Role	Variable Type	Data	Explanation	Source	Parameter
Bank-specific	Response/Dependent variable	NPL	Bank non-performing loans to total loans (gross) (%)	Orbis Bank Focus	%
Bank-specific	Control variable	ROA	Return on average assets. This ratio shows how profitable a bank is relative to its total assets (a measure of efficiency)	Orbis Bank Focus	%
Bank-specific	Control variable	CIR	Cost to income ratio, indicating the efficiency of the bank by comparing its operating costs to its income	Orbis Bank Focus	%
Bank-specific	Control variable	BANK_SIZE	The natural logarithm of the bank total assets (=bank size)	Orbis Bank Focus	No.
Bank-specific	Control variable	L2A	Loan to asset ratio. The proportion of a bank's assets that are comprised of loans (a measure of its liquidity and risk profile)	Orbis Bank Focus	%
Dummy	Dummy Variable	COVID19_DUMMY	A dummy variable where 1 indicates the period affected by the COVID-19 pandemic and 0 otherwise.	Author's Calculations. 1: Years 2020 - 2022 / 0: Years 2010 - 2019	Dummy
Dummy	Dummy Variable	UKRWAR_DUMMY	A dummy variable where 1 indicates the period affected by the Ukraine-Russia conflict and 0 otherwise.	Author's Calculations. 1: Years 2022 - 2023 / 0: Years 2010 - 2021	Dummy
Macroeconomic	Control variable	GDP	Yearly (%) change of gross domestic product at market prices	IMF	%
Macroeconomic	Control variable	INFLAT	Yearly (%) change of HICP (Harmonized index of consumer prices - all items (standardized))	Eurostat	%
Macroeconomic	Control variable	UNEMP	% of unemployment	Eurostat	%
Institutional	Control variable	INST_QUAL	Institutional Quality: A composite measure derived by calculating the average of the following variables: Control of corruption, Government effectiveness, Political stability and absence of violence/terrorism, Regulatory quality, Rule of law, Voice and accountability (All expressed as %)	World Bank & Author's Calculations	%
Uncertainty Index	Candidate predictor	WUI	World Uncertainty Index. It reflects negative global conditions and major events based on the frequency counts of "uncertainty" (and its variants) in the quarterly Economist Intelligence Unit (EIU) country reports	https://www.policyuncertainty.com	No.
Uncertainty Index	Candidate predictor	ECON	Economic Policy Uncertainty Index. It quantifies newspaper coverage of policy-related economic uncertainty	https://www.policyuncertainty.com	No.
Uncertainty Index	Candidate predictor	TRADE	World Trade Uncertainty Index. It reflects uncertainty related to trade based on the frequency counts of "uncertainty" within a proximity to a word related to trade in the EIU country reports	https://www.policyuncertainty.com	No.
Uncertainty Index	Candidate predictor	EUI	Energy-Related Uncertainty Index. It reflects uncertainty related to trade based on the frequency counts of energy-related keywords in the EIU country reports	https://www.policyuncertainty.com	No.
Uncertainty Index	Candidate predictor	CLIM	Climate Risk Index. An aggregated index of physical and transitional climate concerns. The physical and transition risk concerns quantify climate-related uncertainties using a text-based approach by analyzing news articles from Reuters	https://www.policyuncertainty.com	No.
Uncertainty Index	Candidate predictor	PANDM	World Pandemic Uncertainty Index. It is constructed by counting the number of times a word related to pandemics is mentioned in the EIU country reports	https://www.policyuncertainty.com	No.
Uncertainty Index	Candidate predictor	GEOP	Geopolitical Risk Index. A measure of adverse geopolitical events based on a tally of newspaper articles covering geopolitical tensions	https://www.policyuncertainty.com	No.
Uncertainty Index	Candidate predictor/Used for Robustness	E3CI	European Extreme Events Climate Index. A composite measure reflecting the impact and severity of weather-induced hazards in Europe	https://www.policyuncertainty.com	No.

Notes: 1. This table presents the variables employed, their classification according to the variable nature, the data sources, the variable explanation, as well as the variable type (No, %). 2. Before empirical testing, we normalized the variables containing a unit root by transforming them into first differences, based on the result of the unit root test. 3. Bank-specific variables are at bank level, while the rest of the variables used in this study are at country level.

Table A4 Data sources & description for cultural dimensions

Literature	Variable Symbol	Cultural Dimensions	Short Definition	ESS (European Social Survey) question	Values / Answer Range from ESS (European Social Survey)	
Schwartz National Culture Values (Schwartz, 1994)	ipcrtiv	Self-direction	independent thought and action	Important to think new ideas and being creative	Value	Category
	ipgdtim	Stimulation	excitement, novelty and challenge in life	Important to have a good time	1	Very much like me
	ipudrst	Hedonism	pleasure or sensuous gratification for oneself	Important to understand different people	2	Like me
	ipstrgv	Security	safety, harmony, and stability of society, of relationships and of self	Important that government is strong and ensures safety	5	Not like me
	ipbhprp	Conformity	restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms	Important to behave properly	6	Not like me at all
	imptrad	Tradition	respect, commitment, and acceptance of the customs and ideas that one's culture or religion provides	Important to follow traditions and customs	7	Refusal*
Author's Calculations	UNCRT	Uncertainty tolerance (Openness to change)	Percentage (%)	Cultural dimension /variable representing uncertainty tolerance		
Author's Calculations	UNCRT_AV	Uncertainty avoidance (Conservation)	Percentage (%)	Cultural dimension/variable representing uncertainty avoidance		

*Notes***:** 1. This table presents the data, their explanation, as well as the data sources of the Schwartz (1994) variables employed in our analysis. The variables depicted in this Table are related to the cultural dimensions, as derived from the European Social Survey (ESS). The second column refers to the name of the cultural value, the third column provides a short description of the respective cultural dimension, the fourth column depicts the ESS question, from which the data for each variable were derived, the fifth column represents the name of the variable, as depicted in the ESS survey and finally, the last column depicts the respective questions represented in the ESS survey for each cultural dimension. 2. The values for these cultural dimensions are aggregated at the country level to allow for a broad analysis across different national contexts. Unit root testing was not conducted on these variables as they were not directly incorporated into empirical estimations. Instead, they served as foundational components for developing new variables. UNCRT represents "uncertainty tolerance," reflecting an openness to change, while UNCRT_AV reflects "uncertainty avoidance," emphasizing conservation of cultural values, by utilizing Principal Component Analysis (PCA) methodology (= UNCRT & UNCRT_AV). More specifically, the variables presented in the two last rows of the above table are calculated utilizing the PCA and are not derived from the ESS survey. 3. UNCRT was created from the Security, Conformity, and Tradition dimensions and reflects a cultural tendency toward stability, adherence to norms and the preservation of established customs. It contains information from the first principal component, explaining 80% of the total variation. The variable generated is primarily and positively driven by the cultural value of ipgdtim ("Stimulation"). 4. UNCRT_AV was formed from the Self-direction, Stimulation and Hedonism dimensions. It embodies a preference for openness to change, novelty and personal gratification. It contains information from the first principal component, explaining 75% of the total variation. The variable generated is primarily and positively driven by the cultural value of ipbhprp ("Conformity").

Table A5 Robustness. The effect of uncertainty indices on Non-Performing Loans (NPLs)

Regression Models:		MODEL (1)	MODEL (2)	MODEL (3)	MODEL (4)	MODEL (5)	MODEL (6)	MODEL (7)
Sample:		**Period: 2010-2023**						
Cross-Section Effects:		**Fixed**						
Methodology: RLS		**Dependent Variable**						
Variable Group	**Variable Symbol**	**D(NPL)**						
Macroeconomic	D(GDP)	(-2.56E-11)**	(-2.12E-11)**	(-4.78E-12)**	(-5.65E-09)**	(-1.83E-11)**	(2.34E-11)**	(-1.12E-10)**
	D(INFLAT*UNEMP)	(7.78E-07)**	(4.50E-07)**	(6.16E-07)**	(6.65E-07)**	(9.29E-07)***	(5.89E-07)**	(6.16E-07)**
Bank-specific	D(NPL(-1))	(1.001133)***	(1.002472)***	(1.002015)***	(1.013705)***	(1.001452)***	(1.000171)***	(1.002489)***
	D(ROA)	(-0.000109)***	(-0.000124)*	(-0.000124)*	(-0.000248)*	(-0.000104)***	(-0.000131)*	(-9.95E-05)***
	D(BANK_SIZE)	(-0.046443)***	(-0.045893)***	(-0.047884)***	(-0.035227)***	(-0.046368)***	(-0.048162)***	(-0.045455)***
	D(L2A)	(-3.03E-05)***	(-2.74E-05)***	(-2.84E-05)***	(-2.48E-05)**	(-2.73E-05)***	(-3.27E-05)***	(-2.71E-05)***
	D(CIR)	(2.33E-05)**	(1.62E-05)**	(1.71E-05)**	(4.62E-05)**	(2.45E-05)**	(1.69E-05)**	(2.45E-05)**
Uncertainty Indices	D(WUI)	(0.000990)***						
	D(ECON)		(0.000842)***					
	D(TRADE)			(1.78E-05)***				
	D(EUI)				(2.69E-05)***			
	D(E3CI)					(0.000542)***		
	D(PANDM)						(-0.003121)***	
	D(GEOP)							(0.000495)***
Institutional	D(INST_QUAL)	(-5.12E-05)***	(-5.42E-05)***	(-6.03E-05)*	(-5.23E-05)***	(-4.94E-05)*	(-4.10E-05)*	(-9.13E-05)*
Dummy	COVID19_DUMMY	(-0.000494)***	(-0.000331)***	(0.000594)	(-0.000889)**	(-0.000683)***		(-0.000322)
	UKRWAR_DUMMY	(0.000441)***	(0.000485)***	(0.000461)***	(0.001240)***	(0.000807)***	(3.41E-08)***	
Model Statistics:	Observations	924	840	840	237	924	877	438
	R-squared	0.729962	0.729792	0.713952	0.715908	0.719482	0.998447	0.997326
	Adjusted R-squared	0.727542	0.727098	0.710502	0.712481	0.707070	0.998447	0.997326
	Rn-squared statistic	1.327219	1.333755	1.113996	1.091313	1.261182	1.139486	2.410657
	Prob(Rn-squared stat.)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Notes:

1. RLS (Robust Least Squares) methodology is employed for the regression model estimation.
2. The values depicted represent the coefficients while the significance of the p-value is presented with an asterisk: ***p < 0.01, **p<0.05, *p<0.1.
3. D stands for differences applied to normalize variables containing a unit root.
4. These notes also apply to the subsequent tables.

Table A6 Robustness. The effect of uncertainty indices on bank Non-Performing Loans. The role of uncertainty tolerance (openness to change)

Regression Models:		MODEL (8)	MODEL (9)	MODEL (10)	MODEL (11)	MODEL (12)	MODEL (13)	MODEL (14)
Sample:		**Period: 2010-2023**						
Cross-Section Effects:		**Fixed**						
Methodology: RLS		**Dependent Variable**						
Variable Group	**Variable Symbol**	**D(NPL)**						
Macroeconomic	D(GDP)	(-6.96E-11)***	(-8.19E-11)***	(-7.54E-11)***	(-4.32E-09)***	(-6.96E-11)***	(-1.14E-10)***	(-1.32E-11)***
	D(INFLAT*UNEMP)	(8.39E-07)**	(5.60E-07)**	(6.93E-07)**	(1.25E-06)**	(1.01E-06)**	(8.10E-07)**	(5.48E-07)**
Bank-specific	D(NPL(-1))	(1.006995)***	(1.006585)***	(1.007281)***	(1.015740)***	(1.007067)***	(1.007654)***	(1.028677)***
	D(ROA)	(-0.000112)**	(-0.000121)*	(-0.000125)*	(-0.000244)*	(-0.000105)**	(-0.000119)*	(-0.000126)**
	D(BANK_SIZE)	(-0.045905)***	(-0.041517)***	(-0.043892)***	(-0.035037)***	(-0.045976)***	(-0.047361)***	(-0.043735)***
	D(L2A)	(-2.85E-05)**	(-3.02E-05)**	(-3.27E-05)**	(-3.21E-05)**	(-2.57E-05)**	(-3.19E-05)**	(-4.05E-05)**
	D(CIR)	(-1.80E-05)**	(-1.41E-05)**	(-1.46E-05)**	(-4.75E-05)**	(-2.13E-05)**	(-1.55E-05)**	(-1.40E-05)**
Uncertainty Indices	D(WUI)	(0.008500)***						
	D(ECON)		(0.000724)***					
	D(TRADE)			(2.40E-04)***				
	D(EUI)				(2.43E-04)***			
	D(E3CI)					(0.000221)***		
	D(PANDM)						(-2.43E-06)***	
	D(GEOP)							(4.12E-03)***
Institutional	D(INST_QUAL)	(-5.09E-05)***	(-5.32E-05)***	(-5.75E-05)***	(-5.19E-05)***	(-4.83E-05)***	(-5.59E-05)***	(-9.15E-05)***
Cultural	D(UNCRT)	(0.000752)***	(0.000545)***	(0.001876)***	(0.000141)***	(0.001007)***	(-0.000330)***	(-0.000217)***
Dummy Variables	COVID19_DUMMY	(0.003783)	(0.002808)	(-0.008471)*	(-7.84E-05)**	(-0.004981)*		(0.004231)
	UKRWAR_DUMMY	(-0.000503)***	(-0.000544)***	(-0.000536)***	(-0.001173)***	(-0.000786)***	(-0.000590)***	
Model Statistics:	Observations	924	840	840	237	924	877	438
	R-squared	0.731014	0.704714	0.713614	0.706254	0.729695	0.910610	0.732141
	Adjusted R-squared	0.727790	0.700429	0.709458	0.690517	0.726455	0.909782	0.725868
	Rn-squared statistic	1.347441	1.205402	1.155557	1.345163	1.346085	3.150276	219358.3
	Prob(Rn-squared stat.)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Table A7 Robustness. The effect of uncertainty indices on bank Non-Performing Loans. The role of uncertainty avoidance (conservation)

Regression Models:		MODEL (15)	MODEL (16)	MODEL (17)	MODEL (18)	MODEL (19)	MODEL (20)	MODEL (21)
Sample:		**Period: 2010-2023**						
Cross-Section Effects:		**Fixed**						
Methodology: RLS		**Dependent Variable**						
Variable Group	**Variable Symbol**	**D(NPL)**						
Macroeconomic	D(GDP)	(-9.22E-07)**	(-5.47E-11) **	(-3.32E-11) **	(-5.04E-09)**	(-2.54E-11) **	(-6.13E-11)*	(-1.30E-11)**
	D(INFLAT*UNEMP)	(1.007352)**	(5.73E-07)**	(5.17E-07)***	(1.21E-06)**	(8.85E-07)**	(1.08E-06)**	(5.50E-07)**
Bank-specific	D(NPL(-1))	(-0.000107)***	(1.008002)***	(0.996115)***	(1015893)***	(0.992546)***	(1007050)***	(1028491)***
	D(ROA)	(-0.046068)***	(-0.000133)**	(-0.000105)**	(-0.000241)*	(-6.11E-05)***	(-0.000103)**	(-0.000126)***
	D(BANK_SIZE)	(-2.84E-05)***	(-0.045183)***	(-0.026349)***	(-0.034422)***	(-0.024045)***	(-0.046087)***	(-0.043619)***
	D(L2A)	(-2.09E-05)***	(-3.52E-05)***	(-2.99E-05)***	(-2.90E-05)**	(-1.43E-05)***	(-2.50E-05)***	(-4.07E-05)***
	D(CIR)	(0.000491)**	(1.28E-05)**	(2.34E-05)**	(5.73E-05)**	(1.21E-05)**	(2.22E-05)**	(1.39E-05)**
Uncertainty Indices	D(WUI)	(0.001715)***						
	D(ECON)		(0.000712)***					
	D(TRADE)			(2.27E-05)***				
	D(EUI)				(3.41E-05)***			
	D(E3CI)					(5.38E-05)***		
	D(PANDM)						(-3.80E-05)***	
	D(GEOP)							(4.08E-05)***
Institutional	D(INST_QUAL)	(-5.21E-05)***	(-5.62E-05)***	(-3.07E-05)***	(-4.26E-05)***	(-2.80E-05)***	(-5.04E-05)***	(-9.15E-05)***
Cultural	D(UNCRT_AV)	(-0.000810)***	(-0.000162)***	(-0.000113)***	(-0.003734)***	(-8.94E-05)***	(-0.000228)***	(-0.000218)***
Dummy	COVID19_DUMMY	(-0.002457)***	(-0.000592)***	(-0.002664)***	(-0.014300)*	(-0.001039)***		(-0.000875)*
	UKRWAR_DUMMY	(0.000500)***	(0.000574)***	(0.000571)***	(0.001239)***	(0.000567)***	(0.000445)***	
Model Statistics:	Observations	924	840	840	237	924	877	438
	R-squared	0.731264	0.718265	0.924997	0.718074	0.910610	0.723509	0.732365
	Adjusted R-squared	0.728043	0.714942	0.924113	0.702971	0.909782	0.719993	0.726097
	Rn-squared statistic	1.356526	0.998518	2.335233	1301652.	3.150553	0.998515	0.997632
	Prob(Rn-squared stat.)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000