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A TURNING POINT FOR BANKING: UNRAVELING THE CHANGING LANDSCAPE OF BANKING ACTIVITY IN EUROPE SINCE THE COVID-19 PANDEMIC

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This study investigates how the COVID-19 pandemic affected the European banking system, focusing on lending activities and risk-taking behavior. We use a difference-in-differences (DID) approach to compare the performance of banks highly impacted by the pandemic with those operating in less affected countries. Our results indicate a negative impact on lending activities, as banks reduced their exposure to both individuals and businesses. Nonetheless, the impact on bank risk-taking was heterogeneous, as certain banks increased their risk-taking by relaxing their lending standards to support their borrowers while others tightened lending criteria. The reduction in total lending for the banking system was primarily driven by less capitalized banks — with a sharp decline in corporate loans combined with stability in mortgages and consumer loans — and those with limited access to public guarantee schemes. Different characteristics, such as size, profitability, and listing status, led to varied lending behaviors during the COVID-19 pandemic, with smaller and more profitable banks exhibiting greater resilience.

Keywords: Banks; finance; risks; lending activities; financial crisis; pandemic.

JEL Classifications: G21, G22, G23, G24, F3

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1. Introduction

The global economy has been significantly affected by the COVID-19 pandemic, and the European banking system is no exception. Given the crucial role that the banking system plays in stimulating economic growth (Rajan & Zingales 1998, Beck *et al.* 2000, Beck & Levine 2004, Levine 2005) through the provision of liquidity (e.g. Berger & Sedunov 2017, Kahn & Wagner 2021) and allocating credit (e.g. Jayaratne & Strahan 1996, Kashyap *et al.* 2002, Gatev & Strahan 2006) to the real economy, understanding how the COVID-19 pandemic affected financial markets and institutions, and whether banks adapted their lending behaviors and risk strategies in response to increased uncertainty, has become essential for researchers and policymakers.

In contrast to the Global Financial Crisis (GFC), during which banks significantly reduced the provision of credit to firms and households (e.g. Ivashina & Scharfstein 2010, Cornett *et al.* 2011, Kahle & Stulz 2013), in the early phases of the COVID-19 pandemic the banking system effectively addressed the increased demand for liquidity, for instance, through deposits and liquidity injection programs for highly capitalized banks (Li *et al.* 2020). However, not all banks benefited from lending stimulus programs, and in response to the deterioration of the economic outlook, many sought to reduce risk by implementing stricter lending standards.

Previous studies have explored the impact of COVID-19 on lending and risk, typically adopting a global or single-country perspective (e.g. Ari *et al.* 2021, Çolak & Öztekin 2021, Beck & Keil 2022, Cao & Chou 2022), with limited emphasis on the specifically European context. When examining European conditions (see, for example, Dursun-de Neef & Schandlbauer 2021), the focus has mainly been on short-term effects and total loans, with very limited information on the composition of lending activities in terms of different products and duration, and scarce evidence on the level of portfolio deterioration. Consequently, a comprehensive empirical investigation into how bank credit changed during the pandemic in Europe is still underway.

This study addresses these gaps by delving into the impact of the pandemic on the European banking system, focusing on two key areas: lending activities and the level of risk that banks are willing to assume, and the potential deterioration of their credit portfolios. Our first hypothesis posits that the COVID-19 pandemic negatively affected the lending activities of banks by reducing their exposure to both individuals and businesses. In particular, the pandemic may have significantly increased the risks for less capitalized banks operating in the most affected countries, due to economic deterioration. The second hypothesis posits that the pandemic might have resulted in an increase in risk portfolio deterioration, e.g. nonperforming loans (NPLs), as has occurred in previous crises and during periods of heightened economic uncertainty.

To assess the pandemic's impact on the lending activities of European banks, we examine five key areas. First, we assess the total medium-to-long-term (MLT)

financing provided for private investments by individuals and businesses. We then distinguish between mortgages and consumer loans for individuals, and corporate loans for businesses. Additionally, we examine guarantees such as standby letters of credit offered to mitigate the risks of third-party debt default. Regarding the quality of the credit portfolios of banks, we analyze NPLs for risks associated with borrower insolvency (e.g. Messai & Jouini 2013, Beccalli & Girardone 2016, Cincinelli & Piatti 2017), as well as net loans charged or written off, as a measure of credit loss for loans (e.g. Basu *et al.* 2020, Zamore *et al.* 2019).

To test our hypotheses, we employ a difference-in-differences (DID) approach, comparing banks in countries highly affected by the pandemic (treatment group) with those in less affected areas (control group). This approach mitigates bias from broader trends affecting all banks, irrespective of COVID-19. We compare pre- and post-COVID-19 periods (2010–2019 versus 2020–2022). The impact of COVID-19 is measured by deaths per million inhabitants. Bank financial and balance sheet data are drawn from BankFocus (Bureau van Dijk), encompassing 4183 European banks.

Our results suggest that the COVID-19 pandemic adversely affected lending activities in European banks. Banks highly impacted by the pandemic reduced their exposure to both individuals and businesses, likely due to increased economic uncertainty, a higher risk of borrower default, and regulatory requirements to increase capital buffers. Moreover, there has been a shift in the loan portfolio mix, with more resources allocated to mortgages than corporate or consumer loans, signaling a preference for longer-term products. Despite this, the analysis shows a decrease in NPLs in treated banks post-pandemic, suggesting that the initial impact did not significantly exacerbate the risk profiles of banks in the most affected European countries.

Our results are robust to various alternative specifications. We estimate the DID model (i) using different definitions of the treatment and control groups; (ii) introducing placebo treatments to simulate what would have happened to banks' behavior in a "fake" year of treatment; (iii) using different dependent variables accounting for product contribution (i.e. mortgages, consumer loans, and corporate loans) to total loans; and (iv) excluding individual countries to assess whether the findings are driven by single large financial systems. Our estimations also account for several additional factors at the bank (e.g. size, leverage, and profitability), financial market (e.g. GDP growth and financial development), and institutional (i.e. public health expenditure) levels, ensuring consistent results across all analyses.

Despite results indicating that the COVID-19 pandemic significantly impacted the European banking sector, banks may have behaved differently in their lending activities and risks based on several characteristics. Thus, we analyze several channels to determine whether banks responded heterogeneously, depending on the level of capital requirements, bank characteristics such as size, profitability, relevance in the banking system and market exposure, and the role of public support through guarantee schemes.

The reduction in total loans seen across the sample was primarily driven by less capitalized banks, while their more capitalized counterparts maintained relatively stable loan issuance. Less capitalized banks experienced a significant reduction in total loans driven by corporate loans, while mortgages and consumer finance remained relatively stable. Conversely, more capitalized banks increased their mortgage issuance without significantly altering their lending mix. In countries heavily impacted by the pandemic, larger banks drove the overall loan reduction, partially offsetting the modest increases of smaller banks. This reduction was mainly due to decreased corporate and consumer loans, while mortgage lending remained stable. In contrast, smaller banks increased their loans, primarily through an increase in mortgage volumes. Profitability levels also played a role, with more profitable banks maintaining lending levels, unlike less profitable ones. The lending reduction seems to have been less influenced by being a listed bank, although listed banks exhibited more divergent behavior compared to the total system than unlisted banks. Last, public support impacted lending reduction, with banks lacking access to public support in the form of guarantees experiencing sharper declines compared to those with access.

Our research provides a comprehensive analysis of the impact of the COVID-19 pandemic on the European financial system, offering novel insights. Unlike the global perspectives and individual country analyses found in Ari *et al.* (2021), Çolak & Öztekin (2021), Beck & Keil (2022), and Cao & Chou (2022), our focus is exclusively on the European context. Notably, we contribute to the ongoing discourse by extending the analysis beyond the initial response observed by Dursun-de Neef & Schandlbauer (2021), encompassing data until the end of 2022 for a comprehensive medium-term perspective. Moreover, our study's distinctive contributions extend to the granularity of our analysis, particularly in exploring lending activity and mix, as well as portfolio deterioration. While previous studies have examined specific components of total loans, such as real estate and small business/corporate loans, we adopt a more comprehensive approach. Çolak & Öztekin (2021) and Beck & Keil (2022) delve into loan composition, relying on aggregated data at the country level. In contrast, our research investigates the individual contributions of key components within the same analytical framework, emphasizing mortgages, consumer loans, and corporate loans. This approach enables a detailed examination of both individual and corporate financing dynamics, leveraging bank-level data. Additionally, our work extends the micro-founded approach to scrutinize the impact of the pandemic on guarantees within the European banking system.

By examining the behavior of relevant financial players in the context of the pandemic, our work aims to contribute to the literature investigating the response of banks to shocks and crises (e.g. Love *et al.* 2007, Ivashina & Scharfstein 2010, Chava & Purnanandam 2011, Beltratti & Stulz 2012, Van der Veer & Hoeberichts 2016). Specifically, this study aims to enrich the ongoing dialogue surrounding the

repercussions of COVID-19 on the behavior of different financial intermediaries, such as banks (e.g. Acharya & Steffen 2020, Li *et al.* 2020, Ari *et al.* 2021, Çolak & Öztekin 2021, Dursun-de Neef & Schandlbauer 2021, Beck & Keil 2022, Cao & Chou 2022, Chodorow-Reich *et al.* 2022, Greenwald *et al.* 2023) and equity investors (Howell *et al.* 2020, Bellavitis *et al.* 2021, Gompers *et al.* 2021, 2022, Bellucci *et al.* 2023), and of financial markets (e.g. Alfaro *et al.* 2020, Baker *et al.* 2020, Ramelli & Wagner 2020, Zhang *et al.* 2020).

The remainder of this paper is structured as follows. Section 2 reviews the literature and develops the hypotheses. Sections 3 and 4 present the data and the empirical strategy. Section 5 explores the findings and channels. Section 6 focuses on a battery of robustness tests. Section 7 offers some concluding remarks.

2. Literature Review and Hypotheses Development

The outbreak of the COVID-19 pandemic in 2020 marked a pivotal moment, triggering unprecedented disruptions across global economies and prompting adaptive responses from financial institutions, especially within the banking sector. As an unforeseen shock, the pandemic increased economic uncertainty as a result of lockdowns, supply chain disruptions, and demand shocks (e.g. Gopinath 2020, Vidya & Prabheesh 2020, Szczygielski *et al.* 2021, Ozili & Arun 2023). This turbulent environment prompted financial institutions to reassess risk exposure, leading to potential shifts in lending behaviors and risk portfolio strategies.

From a theoretical standpoint, financial crises are often associated with frictions in the flow of credit from lenders to borrowers (credit crunches), which, in extreme cases, can lead to complete freezes. The underlying theoretical motivations are usually primarily attributed to moral hazard and adverse selection (Stiglitz & Weiss 1981). According to the first line of inquiry, based on the seminal work of Holmstrom & Tirole (1997), if a borrower who has received funds from a financial institution can divert those resources, creditors will be less inclined to lend them money. This issue can impose a limit on credit capacity during crises, and implementing corrective measures to reduce the moral hazard of borrowers diverting resources may be challenging (Hart 1995, Burkart & Ellingsen 2004). The second line of inquiry, based on Akerlof (1970), suggests that lenders generally lack in-depth knowledge about the quality of their borrowers. However, an increase in the interest rate to compensate for higher risk primarily attracts borrowers with poor creditworthiness, preventing the interest rate from increasing freely to meet market demand, potentially resulting in an equilibrium with credit rationing (Bolton *et al.* 2011, Kowalik 2014). Informational asymmetry intensifies in crises because nonfinancial borrowers may tend to conceal their difficulties when applying for credit (Healy & Palepu 2001), while financial institutions might hold more problematic assets whose exposure is uncertain or challenging to evaluate externally (Goldstein & Razin 2013).

Empirical evidence, rooted in both these theoretical foundations, has consistently shown the adverse impacts of crises on bank lending. Notable studies of various crises, including the Asian crisis of 1997 and the GFC of 2008, revealed reductions in bank lending (Love *et al.* 2007, Ivashina & Scharfstein 2010, Chava & Purnanandam 2011, Flannery *et al.* 2014). These adverse effects were compounded by changes in lending standards, increased interest rates, and negative consequences on borrower performance (Van der Veer & Hoeberichts 2016).

Traditional bank risk measures may underestimate the increase in bank risk during economic turmoil (Beltratti & Stulz 2012). At the same time, credits granted even before the onset of a crisis can worsen their condition due to financial crises, for instance, through an increase in NPLs. Specifically, studies on the deterioration of bank credit quality during recent financial crises indicate that rapid credit growth coupled with a current account deficit predicts the relative amount of NPLs (Kauko 2012), the increase in which can be attributed to excessive loans granted during expansionary phases (Caporale *et al.* 2014). The severity of post-crisis recessions is closely linked to the presence of unresolved NPLs, making it crucial to address these issues during the crisis for effective post-crisis output recovery (Ari *et al.* 2021).

While closely aligned with the financial crisis literature, the studies examining the impact of the COVID-19 pandemic on the banking system present mixed results. Some works, such as those by Al-Awadhi *et al.* (2020) and Çolak & Öztekin (2021), report a decrease in lending activities and an increase in risk. Conversely, research by Beck & Keil (2022), for instance, suggests a more mixed impact, with certain banks increasing lending and their risk appetite to support borrowers, while others have tightened their lending standards.[a]

This difference depends on two aspects. On the one hand, bank lending is heterogeneously affected by financial crises depending on the category of loans (D'Aurizio *et al.* 2015). For instance, real estate loans were found to increase during the COVID-19 pandemic, especially in the case of banks that had accumulated significant amounts of deposits (Dursun-de Neef & Schandlbauer 2021). Moreover, small business lending surged at the onset of the pandemic, driven by government support programs, while syndicated loans and nonsupported small business loans experienced a contextual decrease (Beck & Keil 2022). This is consistent with previous findings suggesting that financial crises such as the GFC and the credit crunches linked to these were less severe for smaller companies (Presbitero *et al.* 2014).

On the other hand, the characteristics of financial institutions affect their ability to lend in times of crisis. The historical tendency of banks to contract lending during periods of heightened economic uncertainty is acknowledged, yet this impact is not

[a] We should acknowledge that some studies have also focused on the impact of COVID-19 on other related aspects such as the banking labor force and employment (e.g. Hoshi *et al.* 2022, Wu 2023) and profitability (e.g. Arafat *et al.* 2021). However, these topics go beyond the scope of this research and further analyses in these fields are left for future studies.

uniform across financial institutions. For instance, the level of capitalization emerges as a critical factor: banks with higher capitalization are expected to exhibit more resilience (Velliscig *et al.* 2022) and may maintain or even increase lending. Conversely, less capitalized banks may face heightened vulnerability, potentially engaging in unsustainable lending practices (Cao & Chou 2022). The size of banks becomes a key consideration (Udell 2020), with larger institutions leveraging their resources and risk management capabilities to navigate economic shocks more effectively (Giese & Haldane 2020), despite higher regulatory scrutiny and greater market expectations (Boyd & Runkle 1993, Kok *et al.* 2023). Profitability also plays a role, as banks with a greater capacity to absorb losses are likely to continue lending (Martynova *et al.* 2020), albeit with a potential shift towards less stable and riskier sectors (Chang & Talley 2017). Furthermore, the listing status introduces another layer, with listed banks potentially exhibiting more divergent behaviors, benefiting from access to capital markets and regulatory oversight (Bouvard *et al.* 2015, Goel *et al.* 2019), while the efficacy of regulatory enforcement in restraining risk-taking among undercapitalized banks diminished during the crisis, as a result of ineffective debtholder oversight (Tran *et al.* 2019). The different characteristics of banks contribute to a diversified landscape of lending behaviors during a crisis, influencing their ability to navigate challenges and contribute to economic recovery.

Focusing on the deterioration of existing loan portfolios, studies have primarily centered on analyses aimed at identifying predictors of the financial crisis stemming from the pandemic on NPLs. For instance, Ari *et al.* (2021), relying on a machine-learning analysis of over 90 financial crises occurring between 1990 and 2017, identify pre-crisis macroeconomic conditions that make low NPL levels more likely and resolution more manageable. Similarly, Apergis (2022) investigates macroeconomic factors that can, *ex-ante*, lead to a divergence in NPL growth during the recent pandemic crisis in Europe. Other works, such as that of Barua & Barua (2021), instead predict the growth of NPLs in Bangladesh. A limited number of studies examine the *ex-post* impact: NPLs were found to be increasing in China (Kryzanowski *et al.* 2023), despite a reduction in total loans, as well as in the US (Beck & Keil 2022, Cao & Chou 2022).

Our paper aims to analyze the impact of COVID-19 on the European financial system, contributing to the ongoing debate with novel elements. Specifically, we examine the European context, distinguishing it from the global perspective (as seen in Çolak & Öztekin (2021) and Ari *et al.* (2021)), as well as from analyses focused on individual countries (such as Beck & Keil (2022) and Cao & Chou (2022), for the US). To the best of our knowledge, there are no systematic studies extensively examining the impact of COVID-19 on bank financing in Europe, with the exception of Dursun-de Neef & Schandlbauer (2021). Concerning this latter study, which observes the initial response of banks to COVID-19 (Q1/Q3 2020), we extend the analysis until the end of 2022 to assess the financial system's feedback over the medium term.

The second main contribution concerns the granularity of our analysis with regard to lending activity and portfolio deterioration. In the realm of lending, other studies have analyzed specific components of total loans, such as real estate (Dursun-de Neef & Schandlbauer 2021) and small business/corporate loans (Beck & Keil 2022). Çolak & Öztekin (2021), in particular, look at the details of loan compositions for consumer and corporate loans across the globe, using data already aggregated at the country level retrieved from central bank repositories. In contrast, our study investigates the differential contribution of each component of total loans within the same analytical framework at the micro-level, thus leveraging bank-level data and focusing on mortgages, consumer loans, and corporate loans, covering both individual and company financing. Moreover, we employ the same microfounded approach to examine the pandemic's impact on guarantees.

We address these gaps in the literature by positing the following hypotheses to be tested:

H1. *All else being equal, a higher impact of COVID-19 is associated with a greater medium-term reduction in lending activities in Europe.*
H2. *All else being equal, a higher impact of COVID-19 is associated with a greater deterioration of the risk portfolios (e.g. higher NPLs) of European banks.*

We contend that the pandemic had a negative impact on the lending activities of banks operating in countries highly affected by COVID-19, resulting in a reduction of their new exposure to both individuals and businesses (H1). Moreover, we posit that the pandemic deteriorated the quality of outstanding credits of banks operating in the most affected European countries due to economic worsening (H2). Both of these hypotheses align with observations from previous crises, emphasizing a potential contraction in lending and an increase in NPLs during periods of heightened economic uncertainty. However, these assertions require confirmation, as our analysis is focused on Europe, extends over a more prolonged timeframe, and leverages bank-level data.

With this strong focus on Europe and granular and extensive time-related data, we are then able to go into a high level of detail to explore underlying mechanisms related to the evolution of bank lending and credit portfolios in the context of the pandemic. Specifically, we posit the following additional hypotheses related to capitalization (H3), bank characteristics (H4), and the influence of public support (H5):

H3. *All else being equal, more capitalized banks operating in the most affected European countries are (i) more resilient in loan provisions and (ii) more able to contain NPLs.*

Banks with higher levels of capitalization are expected to exhibit greater resilience during times of crisis. These banks, characterized by a larger buffer to absorb potential losses, are anticipated to maintain their loan issuance, thereby mitigating the risk of a credit crunch and supporting economic stability. Conversely, banks with lower levels of

capitalization are hypothesized to be more vulnerable to losses during a crisis, leading to a reduction in lending as these banks seek to mitigate risk exposure.

H4. *All else being equal, a greater impact of the COVID-19 pandemic associated with loan reduction and increased risks depends on bank characteristics, specifically (i) size, (ii) level of profitability, and (iii) listing status.*

This hypothesis is grounded in the understanding that certain bank characteristics may lead to heterogeneous responses in the face of economic challenges. Despite having resource advantages, larger banks may face greater regulatory scrutiny and market expectations, influencing their lending behavior. While indicative of a bank's ability to absorb losses, profitability may also drive risk-taking behavior during crises. Being listed offers access to capital markets but may introduce complexities related to regulatory oversight, as well as divergent behavior compared to unlisted counterparts.

H5. *All else being equal, public schemes and guarantees moderate the reduction of loans for the banks most affected by the COVID-19 pandemic.*

This hypothesis is motivated by the fundamental role of public support, particularly in the form of guarantees, during financial crises. Public guarantees can serve as a crucial risk-mitigation mechanism, easing concerns about potential borrower defaults in crisis situations. The assurance provided by these guarantees is expected to encourage banks to sustain their lending activities. The hypothesis contends that the existence of robust public support mechanisms can effectively address liquidity constraints, ensuring a continuous flow of credit to productive sectors and individuals, and serving as a stabilizing force to avert a more severe credit crunch.

3. Data

3.1. *Dataset*

For our analysis, we use bank data from the BankFocus database, provided by Bureau van Dijk. This commercial database has been frequently employed in cross-country analyses of banking systems, such as those of Demirgüç-Kunt & Huizinga (2010), Gropp & Heider (2010), Bertay *et al.* (2016) and Devereux *et al.* (2019), among others. Our focus is annual balance sheet and income statement information on European-based[b] banks within the 2010–2022 timeframe. Our analysis is limited to active banks operating as commercial, cooperative, investment, private, and savings banks that consistently reported positive values for total assets and total liabilities throughout the entire sample period. Our dataset comprises 4183 European banks, resulting in a total of 54379 bank–year observations. Summary statistics for all the variables included in the dataset are reported in Table 1.[c]

[b] The sample includes banks based in the EU27 and the United Kingdom, which was part of the European Union for most of the time period investigated.

[c] Observations decrease to 14730 due to missing information for relevant indicators.

Table 1. Summary statistics.

Variables	Obs.	Mean	Standard deviation	Median	Min	Max
HighCOVID	14730	0.444	0.497	0	0	1
Total Loans	14730	0.340	0.193	0.378	0.001	1.184
Mortgages	9086	0.282	0.162	0.297	0.001	0.722
Corporate Loans	8305	0.172	0.163	0.139	0.000	1.184
Consumer Loans	10368	0.128	0.139	0.078	0.001	1.005
Guarantees	11888	0.053	0.203	0.018	0.000	6.164
NPLs	12355	0.044	0.070	0.023	0.001	1.485
Written off Loans	9230	0.001	0.043	0.000	−2.872	2.192
Equity	14730	12.171	2.006	11.956	0.000	18.822
Tot Assets	14730	14.524	2.178	14.340	5.545	21.606
Liquidity	14730	12.950	2.359	12.784	0.000	21.143
ROA	13630	1.017	8.132	0.332	−5.878	24.538
GDP Growth	14730	1.426	3.482	1.760	−11.325	24.370
Financial Institutions	14730	0.733	0.106	0.741	0.358	0.937
Financial Markets	14730	0.656	0.191	0.721	0.019	0.949
Health Expenditure	14730	9.773	1.653	9.634	4.702	12.951
HighMortality	14730	0.440	0.496	0	0	1

Notes: The table includes the summary statistics in terms of mean, standard deviation, median, minimum, and maximum for the variables included in the dataset underlying the empirical analysis.

3.2. *Bank data*

To study the impact of the pandemic on the European banking system, we focus on two main areas: lending activities and credit risk portfolio management. Regarding lending activities, we examine five variables that indicate the extent of exposure granted by banks. Specifically, we concentrate on the total amount of MLT financing provided by banks to support the private investments of both individuals and businesses (*Total Loans*). We then distinguish between loans for individuals, such as mortgage loans secured for residential property (*Mortgages*), and consumer loans, which offer detailed insights into support for individuals with expenses smaller than mortgages (*Consumer Loans*). As for businesses, we also explore corporate loans, which are financing options designed for enterprises (*Corporate Loans*). Beyond MLT financing, we also observe the guarantees (*Guarantees*) that banks typically provide against third-party debt defaults, such as standby letters of credit usually issued to businesses.

Regarding risk portfolio management, we employ two indicators that signal the deterioration of a bank's positions and the overall cumulative risk. Specifically, we use NPLs (*NPLs*), a commonly used measure of the level of risk associated with a bank due to borrower insolvency (e.g. Messai & Jouini 2013, Cincinelli & Piatti 2017), and net loans charged or written off (*Written off Loans*), which are loans deemed to be uncollectible and written off from the bank's balance sheet during the period, net of recoveries, and serve as a measure of credit loss for loans

(e.g. Zamore *et al.* 2019, Basu *et al.* 2020). Both lending and risk variables are scaled with respect to total assets, adopted as a proxy of the size of a bank, and then transformed using their natural logarithms.

The database also includes other information about banks that may lead to heterogeneous behaviors regarding the impact of the pandemic on lending and risk, including size, approximated by total assets (*Size*); capitalization level, approximated by total equity (*Equity*); available liquidity (*Liquidity*); and return on assets (*ROA*).

3.3. *COVID-19 indicators*

To distinguish between the periods before and after the onset of COVID-19, we employ a binary indicator, *Post*, that takes a value of 1 for the years 2020, 2021, and 2022, and 0 for all years before the emergence of the coronavirus (2010–2019).[d] We also differentiate between "treated" and "untreated" banks, depending on the extent of the impact of the pandemic in the country where they operate. To measure the impact of the pandemic, we rely on data from the *Our World in Data COVID-19* dataset to obtain indicators that capture the spread and impact of the pandemic in various countries, namely the total number of deaths normalized per million inhabitants and the excess mortality rate. We then construct a binary indicator, *HighCOVID*, which takes a value of 1 for banks operating in countries with a total number of deaths per million inhabitants above the median, and zero otherwise. In alternative specifications, for the sake of robustness, we rely on the excess mortality rate as a proxy for the impact of COVID-19.[e]

3.4. *Country characteristics*

Our database also includes information about the economic and institutional framework in which the European banks operate. The data are sourced from various references and pertain to two main areas of interest: the macroeconomic context and public healthcare intervention. Concerning the first aspect, our dataset includes an indicator of a country's economic growth, namely the GDP growth rate (*GDP Growth*), and two indicators developed by the International Monetary Fund (IMF) (Svirydzenka 2016) that are commonly used to measure the development of a country's financial system at the level of financial institutions (*Financial Institutions*) and financial markets (*Financial Markets*) (see, for example, Daway-Ducanes & Gochoco-Bautista 2021). All three indicators are collected from IMF public

[d]The first case of COVID-19 was confirmed and registered in China on 31 December 2019.

[e]In our sample, the 14 treated countries with a total number of deaths per million inhabitants above the sample median are: Belgium, Bulgaria, Croatia, Czech Republic, Greece, Hungary, Italy, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia, and the United Kingdom. The other 14 countries with a total number of deaths per million inhabitants is below the European median are included in the control group: Austria, Cyprus, Denmark, Germany, Estonia, Finland, France, Ireland, Luxembourg, Malta, the Netherlands, Portugal, Spain, and Sweden. When we use the excess mortality rate as a proxy for the impact of COVID-19, the lists of treated and control groups are the same, except for Belgium, which is included in the control group, and Spain, which is included in the treated group.

databases. In order to approximate the level of public health intervention, and thus the public response efforts to the pandemic, we employ World Bank data on public healthcare expenditure (*Healthcare Expenditure*) at the country level.

4. Empirical Methodology

Our empirical approach capitalizes on the panel structure of the dataset, that is, on both cross-sectional and time-series variation in bank exposure to the pandemic, enabling us to investigate differences in bank behavior between normal times and during the COVID-19 pandemic. By harnessing the varied impact of the pandemic across countries, we aim to evaluate how each bank responded. In addition to the country factor, various bank-specific characteristics, including size, equity, liquidity and performance, can influence these responses. Furthermore, there are other sources of variability that may impact the results, such as the overall strength of the banking and financial system. We take account of all these aspects in the development of the empirical model.

To facilitate a comparison before and during the pandemic between countries highly affected by the pandemic and those that experience limited effects, we create two binary indicators: one for the post-pandemic period (*Post*), and another for banks heavily impacted by COVID-19 (*HighCOVID*). *Post* is a binary indicator equal to 1 for banks observed from 2020 to 2022, and 0 otherwise. For *HighCOVID*, we adopt an indicator based on the number of deaths per million of inhabitants that has been used in similar investigations (e.g. Al-Awadhi *et al.* 2020, Çolak & Öztekin 2021). Specifically, *HighCOVID* is a binary indicator that takes a value of 1 for countries with higher-than-the-median levels of infections (in terms of the number of deaths), and 0 otherwise. In the spirit of Çolak & Öztekin (2021), we employ a DID model that compares treatment banks (those significantly affected by the COVID-19 shock) with control banks (those less affected) both before and after the pandemic's onset, akin to a quasi-natural experiment. This modeling approach helps eliminate potential bias stemming from trends affecting all banks, irrespective of COVID-19.

$$Y_{itc} = \beta HighCovid_i \times Post_t + \gamma B_{it} + \delta M_{it} + \zeta H_{it} + \phi_i + \phi_c + \phi_t + \epsilon_{it}, \qquad (1)$$

where i denotes banks, t denotes years, c denotes countries, and Y is one of our outcome variables, in the sphere of lending (*Total Loans*, *Mortgages*, *Consumer Loans*, *Corporate Loans*, and *Guarantees*) or risk portfolio deterioration (*NPLs*, and *Written off Loans*). As part of our control variables, we incorporate a range of bank characteristics represented by B, including *Equity*, *Size*, *Liquidity*, and *ROA*. Additional control variables (denoted by M) encompass macroeconomic indicators such as *GDP Growth* and the development of *Financial Institutions* and *Financial Markets*. Finally, we also factor into the model the level of public healthcare expenditure as a fraction of GDP, *Healthcare Expenditure* (H), to consider varying responses to the pandemic across European countries. To alleviate the possibility that our estimation might be affected by other specific unobserved characteristics, we include

a set of fixed effects (FEs) in our estimations. First, we control for unobservable heterogeneity across banks by including bank FEs, ϕ_i, along with time FEs to account for common shocks at time t, ϕ_t. We also control for possible heterogeneity across countries using country FEs, ϕ_c. Last, we cluster the errors, ϵ_{it}, at the bank level. In this model, the coefficient β represents the DID estimate of the impact of COVID-19 on the different banking market outcomes.

5. Results and Channels

5.1. *Validity of the common trend assumption*

An essential premise of the DID approach is the presence of similar trends in outcomes between the treated and control groups before any treatment occurs. In our specific context, this means that banks operating in countries highly exposed to the pandemic should exhibit similar trends to those in less exposed countries during the period before COVID-19 emerged. To establish the validity of this assumption, we perform a common trend equality test similar to the one conducted by Gertler *et al.* (2016). This test examines whether, in the absence of the pandemic, changes in all lending and risk-related variables would have followed a similar trajectory for both groups. More precisely, the test compares the changes in the average growth rates of these variables across the groups during the last pre-treatment periods. As shown in Table 2, none of the growth rates are significantly different across categories prior to the onset of COVID-19, thereby providing support for the assumption of common trends.

Table 2. Test of the assumption of common trends.

	Treated		Untreated		Difference	
	Obs.	Mean (S.E.)	Obs.	Mean (S.E.)	Mean (S.E.)	p-value
Total Loans	599	−0.002	746	0.430	0.432	0.348
		(0.002)		(0.413)	(0.014)	
Mortgages	402	0.164	427	0.084	−0.080	0.501
		(0.082)		(0.085)	(0.119)	
Corporate Loans	265	0.353	504	6.981	6.628	0.403
		(0.196)		(5.741)	(7.921)	
Consumer Loans	501	−0.957	414	−1.008	−0.051	0.951
		(0.630)		(0.489)	(0.823)	
Guarantees	461	0.460	624	0.234	−0.227	0.431
		(0.407)		(0.101)	(0.288)	
NPLs	544	1.833	638	0.474	−1.359	0.238
		(1.767)		(0.281)	(1.151)	
Written off Loans	166	−0.031	478	3.409	3.440	0.619
		(0.607)		(2.588)	(6.918)	

Notes: This test follows the methodology outlined by Gertler *et al.* (2016) and examines the differences in the mean growth rate of the dependent variables between treated and untreated groups during the last years before the treatment. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

5.2. *Baseline findings*

In this section, we describe the results of the model estimates for Eq. (1). For each outcome variable (lending- or risk-related), we estimate three different versions of the model. The first estimation includes all FEs and bank-related control variables. The second is expanded by also incorporating macroeconomic control variables into the model. Finally, the third adds the country's public health expenditure.

5.2.1. *Lending*

Panel A in Table 3 reports the coefficient estimates for the specifications of the model using lending outcomes, that is, total loans (Columns (1)–(3)), mortgages (Columns (4)–(6)), corporate loans (Columns (7)–(9)), consumer loans (Columns (10)–(12)), and guarantees (Columns (13)–(15)). We find that the coefficient for the *Total Loans* indicator is negative and highly statistically significant throughout the different models, with the coefficients being fairly stable across all specifications (between −12% and −13%). As expected, we find a positive relationship between *Total Loans* with respect to bank *Equity* and *Size*, and a negative relationship with respect to *Liquidity*, in line with previous findings (see, for example, Tran 2020). Coming to macroeconomic factors, we document a negative relationship between *Total Loans* and *GDP Growth* and a weak one between *Total Loans* and the development of *Financial Institutions*. When we examine the effect of total loans by dividing it into its three main components, we see that the overall negative result is driven by corporate loans (−3.6%) and consumer loans (−1.2%), and is partially mitigated by significant growth in mortgages (+1.4%). In contrast, we do not find significant effects of an increased pandemic risk on the issuance of new guarantees.

Overall, these results seem to support the hypothesis that banks based in the countries most affected by the pandemic have significantly reduced their lending since 2020 (H1). In doing so, they have also changed their portfolio mix, allocating more available resources to long-term products (i.e. mortgages to individuals) than to short-term ones (i.e. corporate and consumer loans). These conclusions are consistent with earlier research on total loans, corporate loans, consumer loans (Çolak & Öztekin 2021) and mortgages (Fuster *et al.* 2021). Our results were obtained for Europe, a relatively more homogeneous market than that examined by Çolak & Öztekin (2021), who took a global perspective and found that the difference in COVID-19 diffusion was significantly heterogeneous across countries. We also use micro-level data to validate their macro-level findings for business and consumer loans. This empirical approach further supports the relevance of the estimated impact. Similarly, we confirm the findings of Fuster *et al.* (2021) for the US lending market, but focusing the analysis on the European market and adopting a quasi-natural empirical experiment. Last, our results are also consistent with previous findings regarding bank behavior during times of crisis, indicating a tendency for banks to diversify their loan portfolios in order to lower risk and strengthen financial stability (Rossi *et al.* 2009, Shim 2019, Norden *et al.* 2021).

Table 3. Baseline findings.

Panel A — Lending															
	Total loans			(o/w) Mortgages			(o/w) Corporate loans			(o/w) Consumer loans			Guarantees		
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
HighCOVID × *Post*	−0.013***	−0.012***	−0.012***	0.014***	0.014***	0.014***	−0.036***	−0.035***	−0.036***	−0.012**	−0.011**	−0.012**	−0.003	−0.003	−0.001
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.004)
Equity	0.018***	0.018***	0.018***	0.016**	0.016**	0.015**	0.004	0.004	0.004	0.020***	0.019***	0.019***	−0.018	−0.019	−0.019
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.016)	(0.016)	(0.016)
Size	0.032***	0.033***	0.033***	0.035***	0.036***	0.035***	0.016**	0.016*	0.016*	0.001	0.001	0.001	−0.040	−0.040	−0.040
	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.036)	(0.036)	(0.036)
Liquidity	−0.032***	−0.032***	−0.032***	−0.032***	−0.031***	−0.031***	−0.018***	−0.018***	−0.018***	−0.015***	−0.015***	−0.015***	0.004	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
ROA	0.000	0.000	0.000	−0.000	−0.000	−0.000	0.000	0.000	0.000	−0.000	−0.000	−0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GDP Growth		−0.001***	−0.001**		−0.000	0.001**		−0.001**	−0.001**		−0.001	−0.001		−0.001**	−0.001**
		(0.000)	(0.000)		(0.000)	(0.000)		(0.001)	(0.001)		(0.001)	(0.001)		(0.000)	(0.000)
Financial Institutions		−0.103*	−0.101*		−0.074	−0.075*		−0.042	−0.042		−0.026	−0.026		−0.010	−0.004
		(0.054)	(0.054)		(0.046)	(0.045)		(0.061)	(0.062)		(0.059)	(0.059)		(0.035)	(0.035)
Financial Markets		0.000	0.005		0.037	0.078**		0.031	0.033		−0.060	−0.070		0.001	0.005
		(0.042)	(0.042)		(0.032)	(0.034)		(0.030)	(0.031)		(0.042)	(0.043)		(0.036)	(0.035)
Health Expenditure			0.003			0.016***			0.001			−0.005			0.004
			(0.003)			(0.003)			(0.004)			(0.005)			(0.003)
Observations	14730	14730	14730	9086	9086	9086	8305	8305	8305	10368	10368	10368	31194	31194	31194
Adjusted R-squared	0.895	0.895	0.895	0.912	0.912	0.913	0.894	0.894	0.894	0.840	0.840	0.841	0.909	0.909	0.909
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3. (*Continued*)

Panel B — Risk						
	NPLs			Written off loans		
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
HighCOVID × *Post*	−0.017***	−0.018***	−0.017***	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Equity	0.016***	0.017***	0.017***	−0.002	−0.002	−0.002
	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)
Size	−0.013***	−0.014***	−0.013***	0.001	0.001	0.001
	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)
Liquidity	−0.001	−0.001	−0.002*	−0.000	−0.000	−0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ROA	−0.000***	−0.000***	−0.000***	0.000*	0.000*	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GDP Growth		−0.001***	−0.001***		−0.000	−0.000
		(0.000)	(0.000)		(0.000)	(0.000)
Financial Institutions		0.029	0.038		0.008	0.004
		(0.024)	(0.025)		(0.007)	(0.006)
Financial Markets		0.043***	0.050***		0.018	0.016
		(0.014)	(0.014)		(0.015)	(0.013)
Health Expenditure			0.005**			−0.001
			(0.002)			(0.002)
Observations	25302	25302	25302	20423	20423	20423
Adjusted *R*-squared	0.758	0.758	0.758	0.364	0.364	0.364
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	No	Yes	No	Yes	No	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

5.2.2. *Risk*

Panel B in Table 3 reports the coefficient estimates for the specifications of the model using risk portfolio deterioration outcomes, that is, NPLs (Columns (1)–(3)) and written-off loans (Columns (4)–(6)). The coefficients for the *NPLs* indicator are negative and statistically significant, ranging between −1.7% and −1.8%. On the other hand, we do not find significant effects of the pandemic on the level of written-off loans. These findings suggest that in the European context, the impact of the pandemic did not significantly worsen the risk of banks operating in the most affected countries (contrary to H2). Although this result seems to diverge from those obtained in other geographical contexts (e.g. Kryzanowski *et al.* 2023), it is in line with what was found by Bruno & De Marco (2021), who state that European banks were able to extensively use a series of public supports such as loan repayment moratoria to support their balance sheets during the most critical period, which could have contributed to delaying NPL recognition and does not exclude possible worsening in the future (Falagiarda & Köhler-Ulbrich 2021). At the same time, it is also important to consider that the quality and updating of NPL data depends on the country and that a realistic assessment of the soundness of current loans is necessary to ensure financial stability (Apergis 2022).

5.3. *Channels*

In this section, we explore different channels that may drive the effects identified in our baseline analysis. In particular, we focus on whether bank lending activities and risk portfolio management in the context of the pandemic show heterogeneous behaviors with respect to the level of bank capitalization, some of their most relevant characteristics (size, profitability, and listing status), and the access to public support such as public guarantees.

5.3.1. *Capital requirements and resilience of banking activities*

So far, we have shown that the pandemic had a significant impact on the European banking sector, with banks facing significant challenges affecting their loans and risks. At the same time, capitalization is a key factor that determines how a bank can respond to these challenges. Indeed, more capitalized banks might have a larger buffer to absorb losses, which potentially makes them more resilient to shocks, while less capitalized banks are more vulnerable to losses and may be forced to reduce lending or raise capital (Cao & Chou 2022). On the other hand, banks with a lower level of capital might have incentives to maintain or even increase their level of loans in a period of crisis in order to support weaker borrowers, thus providing zombie lending (Dursun-de Neef & Schandlbauer 2021).

We test these two alternative narratives by separately estimating Eq. (1) twice, splitting the sample into two groups: banks with a high versus low level of capitalization. To proxy this concept, we use two alternative measures based on the median

and the top 25% level of the tier 1 capital ratio in our sample. Following this approach for our five dependent variables for loans, we conduct a total of 20 estimations, as presented in Table 4, categorized into two panels (i.e. A — Median, B — Top 25%).

We observe that the reduction in total loans observed for the entire sample is mostly driven by less capitalized banks (according to both proxies), while more capitalized banks maintain their loan issuance rather constant. Additionally, for less capitalized banks the overall reduction in total loans is driven by a drastic reduction in corporate loans, associated with a substantial stability of mortgages and consumer finance. In contrast, more capitalized banks increase their mortgage issuance without significantly affecting their lending issuance mix.

Overall, highly capitalized banks are more likely to continue lending during a crisis, as they have a larger buffer to absorb potential losses (thus confirming H3). Less capitalized banks, on the other hand, may be more likely to reduce lending during a crisis, as they are more vulnerable to losses. This can lead to a credit crunch, which can further damage the economy. These results are in line with Cao & Chou (2022) and confirm the relevance of the attainment of financial requirements for bank resilience in times of crisis.

We follow a similar approach for our two risk-related dependent variables. Results are reported in Table 5 (Panel A — Median, Panel B — Top 25%). We find that the reduction in NPLs is not driven by bank capitalization, despite the decrease seemingly being larger for highly capitalized institutions. This result is qualitatively consistent with other research suggesting that banks with high levels of capitalization prior to the pandemic show less deterioration of their portfolio and are more risk-resilient (Anani & Owusu 2023, Kryzanowski *et al.* 2023).

5.3.2. *Bank characteristics*

We now explore particular characteristics of banks that could lead to heterogeneous behaviors compared to the overall banking system: size, profitability, and market exposure. The size of a bank can influence how it was affected by the COVID-19 pandemic in terms of lending and risk management. Larger banks often have certain advantages in terms of resources, access to capital, and risk-management capabilities, which can help them navigate the challenges posed by a crisis and leverage relevant public support (Giese & Haldane 2020). However, they may also face higher regulatory scrutiny (Kok *et al.* 2023) and greater market expectations (Boyd & Runkle 1993). Smaller banks may be more vulnerable to economic shocks (Cyree 2016) but could be nimbler in adapting to changing conditions (Berger & Udell 2002).

Profitability might also play a significant role in a bank's response to crises. Profitable banks often have a greater capacity to absorb losses and a willingness to extend credit to support businesses and individuals in times of economic stress (Martynova *et al.* 2020). However, there is a risk that banks pursuing higher profits

Table 4. Heterogeneous findings based on capital requirements and resilience in bank lending.

	Total loans		(o/w) Mortgages		(o/w) Corporate loans		(o/w) Consumer loans		Guarantees	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					Panel A — Tier 1 Median					
HighCOVID × *Post*	−0.023**	−0.005	−0.010	0.028***	−0.051***	−0.035***	0.016	−0.009	−0.001	−0.002
	(0.011)	(0.007)	(0.012)	(0.007)	(0.016)	(0.008)	(0.012)	(0.008)	(0.006)	(0.003)
Higher-than-the-median tier 1	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3710	5885	2688	4591	1642	3086	2828	4117	10849	10110
Adjusted R-squared	0.882	0.920	0.922	0.918	0.899	0.863	0.877	0.839	0.893	0.978
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
					Panel B — Tier 1 Top 25%					
HighCOVID × *Post*	−0.014**	0.006	0.007	0.039***	−0.045***	−0.021	0.003	−0.022	−0.003	−0.000
	(0.007)	(0.010)	(0.008)	(0.008)	(0.009)	(0.015)	(0.008)	(0.011)	(0.004)	(0.007)
Top 25% tier 1	No	Yes	No	Yes	No	Yes	No	Yes	No	

Table 5. Heterogeneous findings based on capital requirements and resilience in bank risk.

	NPLs		Written off loans	
Dependent variable	(1)	(2)	(3)	(4)
Panel A — Tier 1 Median				
HighCOVID × *Post*	−0.015***	−0.020***	0.012	0.001
	(0.005)	(0.003)	(0.015)	(0.002)
Higher-than-the-median tier 1	No	Yes	No	Yes
Observations	10263	9797	8899	7666
Adjusted *R*-squared	0.816	0.770	0.476	0.476
Controls	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes
Panel B — Tier 1 Top 25%				
HighCOVID × *Post*	−0.014***	−0.020***	0.006	−0.001
	(0.003)	(0.006)	(0.007)	(0.003)
Top 25% tier 1	No	Yes	No	Yes
Observations	15340	4720	13104	3461
Adjusted *R*-squared	0.819	0.750	0.531	0.531
Controls	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. Columns (1) and (3) report estimations on the sample of lower-than-the-median and below top 25% tier 1 ratio banks, while Columns (2) and (4) report estimations on the sample of higher-than-the-median and top 25% tier 1 ratio banks. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

might take excessive risk during a crisis. In an effort to maintain or boost profitability, some banks may relax their lending standards, extend credit to riskier borrowers, or engage in riskier investment activities, thus increasing the bank's exposure to excessive financial risks (Chang & Talley 2017).

Publicly traded or listed banks may behave differently from the overall banking system. Indeed, these banks have access to capital markets and benefit from transparency and regulatory oversight, which can enhance their resilience to crises (Bouvard *et al.* 2015, Goel *et al.* 2019). Moreover, they usually benefit from easier access to government support and the confidence of the market, facilitating capital acquisition and lowering borrowing costs (Ueda & Di Mauro 2013). At the same

time, regulatory enforcement was observed to have a greater impact on curbing risk-taking behavior among undercapitalized, publicly traded banks prior to the crisis, but this influence waned during the crisis due to ineffectual debtholder oversight (Tran *et al.* 2019). Moreover, if also among the systemically important financial institutions, listed banks may face heightened regulatory scrutiny, which influences their lending and risk strategies (Cappelletti *et al.* 2019).

To assess potential heterogeneous behaviors due to these factors, we separately estimate Eq. (1) three times, dividing the sample into two distinct groups based on the same factors each time. Specifically, in the first set of estimations we classify banks by size (above or below the median total assets), in the second set by profitability (above or below the median ROA), and in the third set based on whether they are listed or not. This results in six model specifications — two for each factor. Following this approach for our seven dependent variables, we conduct a total of 42 estimations, as presented in Table 6, categorized into three panels (i.e. A — size, B — profitability, and C — listed banks).

Regarding loans, we highlight how, following the pandemic, the overall reduction in lending volumes in banks in the countries most affected by COVID-19, compared to others, was primarily driven by larger banks (−0.033), with a modest increase by smaller banks (see Table 6, Panel A). This reduction is mainly due to decreased corporate loans (−0.039) and consumer loans (−0.024), while mortgage lending remained stable. In contrast, smaller banks increased their loans (0.018), primarily through an increase in mortgage volumes (0.053) and minor reductions in corporate and consumer loans. Profitability levels appear to be crucial in explaining the lending reduction (Panel B). Indeed, more profitable banks do not seem to have experienced a general decline in lending, which is instead limited to corporate loans (−0.038) and consumer loans (−0.012), although with less statistical significance. Conversely, during the crisis less profitable banks saw a decrease not only in aggregate lending (−0.021) but also in all its different components, including mortgages (−0.014), which contrasts with the behavior of most banks. Finally, the lending reduction seems to be less influenced by being a listed bank (Panel C), although listed banks exhibit more divergent behavior compared to the total system than unlisted banks. Indeed, there is no observed increase in mortgages for listed banks, nor a reduction in consumer loans, unlike unlisted banks, which are in line with the majority of financial institutions. Overall, we partially confirm H4, since we find that only size and the level of profitability (and not the listing status) heterogeneously affect bank behavior during the pandemic.

5.3.3. *Public support schemes*

In times of financial crises, the relevance of public support, particularly in the form of public guarantees, becomes paramount in sustaining financial stability and mitigating adverse impacts on lending activities. Public guarantees play a crucial role by enhancing the confidence of financial institutions to extend loans to businesses and

Table 6. Heterogeneous findings based on banks' characteristics.

	Total loans		(o/w) Mortgages		(o/w) Corporate loans		(o/w) Consumer loans		Guarantees		NPLs		Written off loans	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
						Panel A — Size								
HighCOVID × *Post*	0.018**	−0.033***	0.053***	−0.008	−0.021**	−0.039***	0.008	−0.024***	−0.000	−0.005*	−0.018***	−0.017***	0.003	0.004
	(0.007)	(0.006)	(0.006)	(0.008)	(0.010)	(0.007)	(0.008)	(0.007)	(0.010)	(0.003)	(0.004)	(0.003)	(0.002)	(0.004)
High size	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	6079	8651	4121	4965	3298	5007	4310	6058	14115	17079	11098	14204	8836	11587
Adjusted R-squared	0.910	0.896	0.934	0.909	0.887	0.910	0.818	0.856	0.936	0.800	0.810	0.766	0.761	0.769
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
						Panel B — Profitability								
HighCOVID × *Post*	−0.021***	−0.007	−0.014**	0.029***	−0.025*	−0.038***	−0.011	−0.012*	−0.002	−0.001	−0.019***	−0.012***	0.007	−0.000
	(0.008)	(0.005)	(0.007)	(0.007)	(0.013)	(0.006)	(0.009)	(0.006)	(0.006)	(0.006)	(0.004)	(0.003)	(0.006)	(0.001)
High profitability	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	6095	8635	4148	4938	2716	5589	4172	6196	17304	13890	13682	11620	11491	8932
Adjusted R-squared	0.885	0.910	0.927	0.916	0.894	0.903	0.825	0.862	0.821	0.931	0.813	0.786	0.352	0.643
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6. (*Continued*)

	Total loans		(o/w) Mortgages		(o/w) Corporate loans		(o/w) Consumer loans		Guarantees		NPLs		Written off loans	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
						Panel C — Listed Banks								
HighCOVID × *Post*	−0.010**	−0.033***	0.014**	−0.004	−0.032***	−0.046***	−0.011**	−0.014	−0.002	−0.005	−0.019***	−0.007	0.004	−0.003*
	(0.005)	(0.012)	(0.005)	(0.015)	(0.007)	(0.015)	(0.005)	(0.012)	(0.004)	(0.005)	(0.002)	(0.009)	(0.003)	(0.002)
Listed bank	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	13559	1171	8518	568	7420	885	9329	1039	29546	1648	23716	1586	19099	1324
Adjusted R-squared	0.893	0.933	0.911	0.939	0.891	0.920	0.836	0.886	0.910	0.887	0.759	0.796	0.355	0.611
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

individuals during periods of heightened uncertainty (Jiménez *et al.* 2022). The assurance provided by these guarantees might act as a risk-mitigation mechanism, alleviating concerns among lenders about potential borrower defaults, especially for small businesses (Craig *et al.* 2007). This, in turn, encourages banks to maintain their lending portfolios, supporting crucial economic activities.

The use of public guarantees can effectively address liquidity constraints faced by financial institutions, ensuring the continued flow of credit to productive sectors. Furthermore, such support measures can serve as a stabilizing force in the face of economic downturns, preventing a more severe credit crunch and fostering a more resilient financial system. The analysis of the impact of public guarantees on loan dynamics during crises is, therefore, pivotal for understanding the mechanisms through which government interventions contribute to sustaining economic activities and averting a deeper financial crisis.

To assess potential variation in lending behavior due to higher levels of public interventions supporting lending, we estimate Eq. (1) on two samples based on the impact on GDP exerted by public guarantees issued by countries' central governments to sustain banking loans. To build the two samples, we retrieve data from Eurostat[f] and consider as highly publicly supported those countries in the first

Table 7. Heterogeneous findings based on public support.

	Total loans		(o/w) Mortgages		(o/w) Corporate loans		(o/w) Consumer loans	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HighCOVID × *Post*	−0.013***	−0.001	0.024***	0.003	−0.045***	−0.040***	−0.000	0.024
	(0.003)	(0.016)	(0.007)	(0.021)	(0.008)	(0.014)	(0.007)	(0.019)
Top 25% public guarantees	No	Yes	No	Yes	No	Yes	No	Yes
Observations	9442	4229	6814	1751	4299	3418	6948	2730
Adjusted *R*-squared	0.881	0.917	0.893	0.961	0.896	0.896	0.804	0.878
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. Columns (2), (4), (6), and (8) report estimations on the sample of banks in the top 25% with public guarantees on financial loans as a percentage of GDP, while all the other columns report estimations on the other banks. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

[f]The data from Eurostat are available for two years (2020 and 2021) and encompass the EU27 countries, and we exclude the United Kingdom from the original sample. Given that the analysis of public guarantees is conducted solely on EU27 member states, we verified that the baseline findings hold when the UK is excluded from the sample, as is also evident from Sec. 6.1. The exclusion of the UK from the sample does not alter the baseline findings, thereby confirming the validity of the analysis.

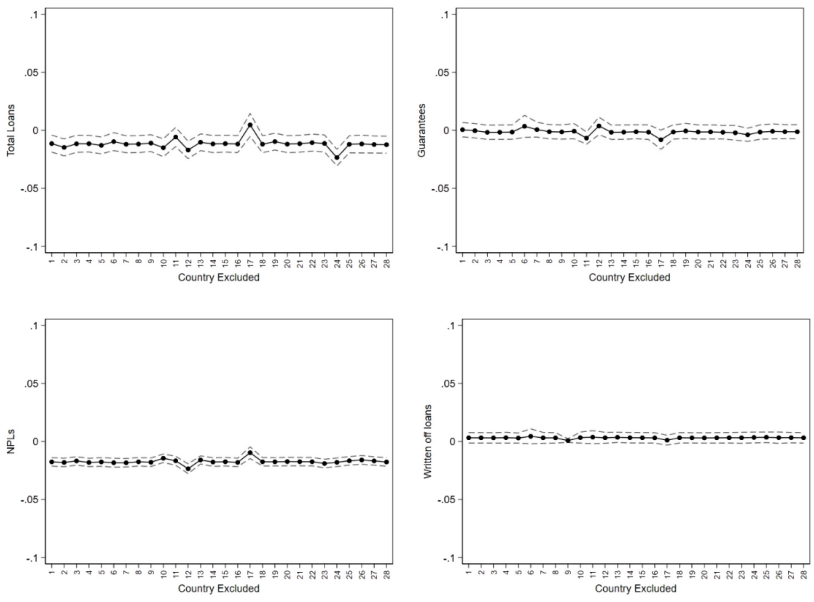
quartile of public guarantees as a percentage of GDP. Then, we estimate how the pandemic affects new total loans and its sub-components, based on the relevance of public support. Results are presented in Table 7.

We find a statistically significant reduction in total loans (−0.013) for banks located in the countries most affected by the pandemic, especially where public support in terms of loan guarantees was limited. In contrast, banks operating in affected countries with substantial public guarantee schemes do not see a significant reduction in total loans. When examining the sub-components of loans, the negative impact observed for banks in countries with fewer public guarantees is primarily driven by a reduction in corporate loans (−0.045), thus confirming H5. These results, which leverage differential behavior in public schemes within Europe to sustain banking lending, align with previous findings that emphasize the greater resilience of loans for government-supported financial institutions in different regions (e.g. Beck & Keil 2022, for the US).

6. Robustness

6.1. *Country exclusion*

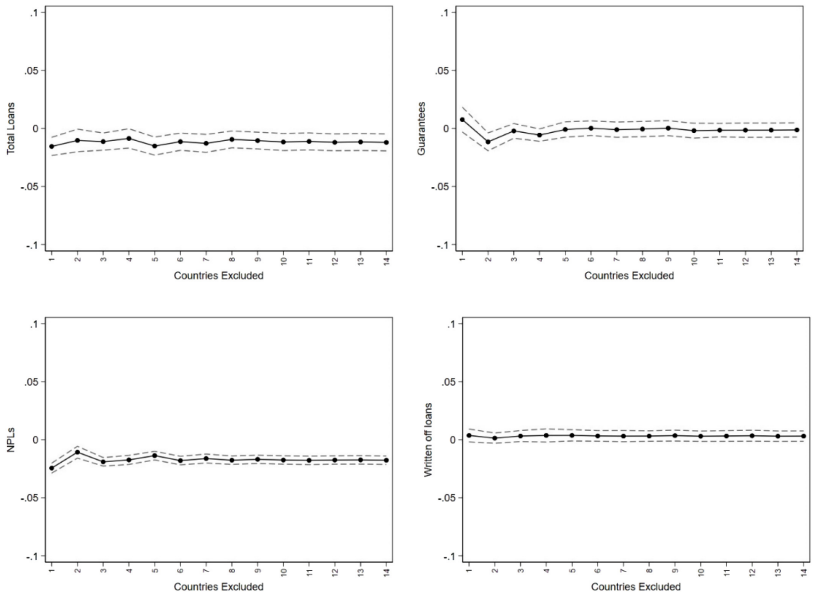
We aim to assess the robustness of our baseline results to the exclusion of a single country, given the relatively small number of countries in our sample. Accordingly,



(a)

Notes: The graphs plot coefficients and 10% confidence intervals of estimations of Eq. (1) for total loans, guarantees, NPLs, and written-off loans when dropping one country at a time (Panel A) or a pair of countries (one treated and one untreated) at a time (Panel B).

Fig. 1. Country excluded.



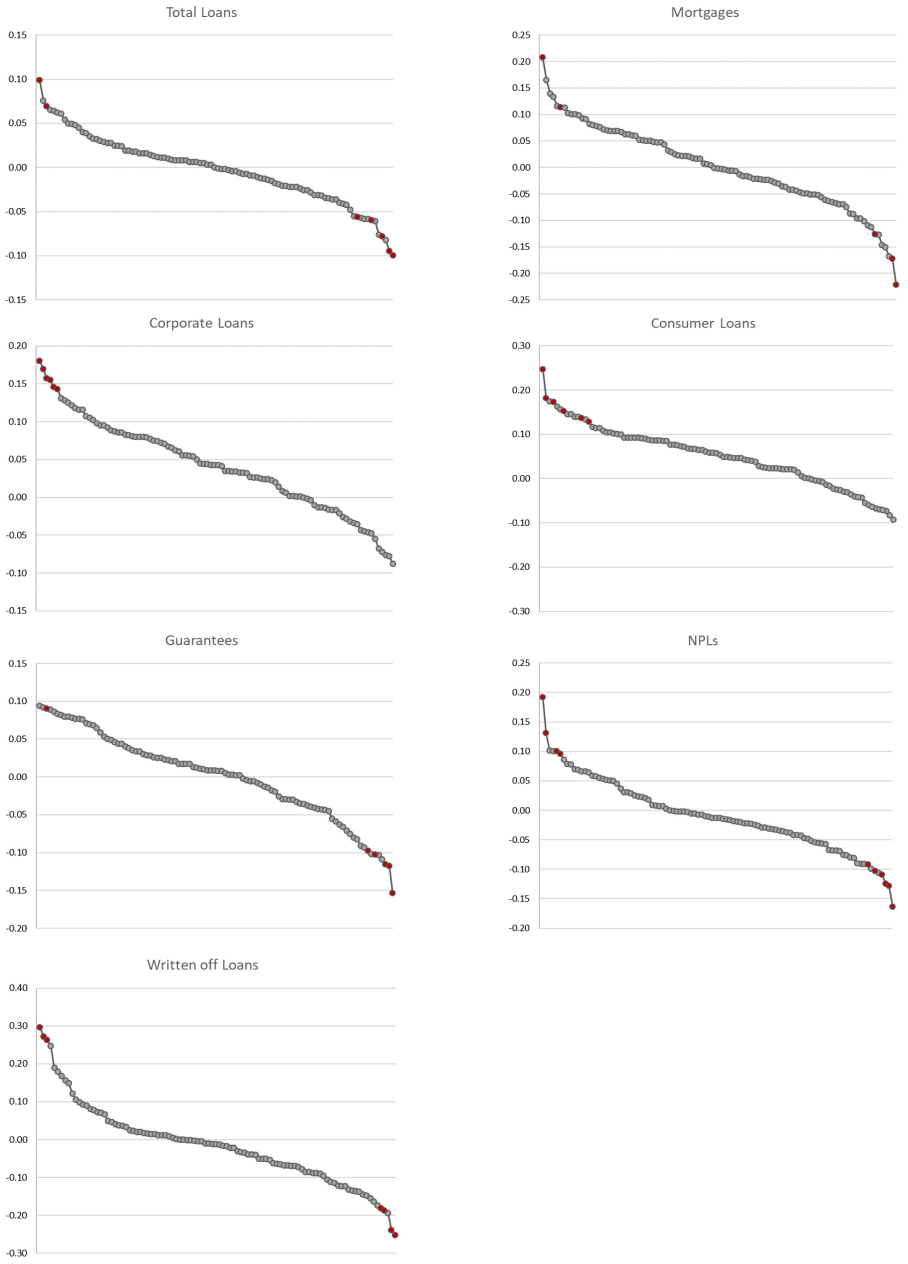
(b)

Fig. 1. (*Continued*)

we conduct estimations of Eq. (1) excluding one country at a time. The outcomes, including the estimated coefficient β and its 90% confidence interval, are presented in Fig. 1. These results closely align with those obtained in our baseline specifications. Therefore, we can confidently conclude that our main findings are not influenced by the exclusion of any particular country.

6.2. *Placebo treatment*

We conduct placebo tests by introducing the treatment at times other than the actual treatment period. Following the approach outlined in Christensen *et al.* (2016), we randomly assign a pseudo-treatment year before the onset of the pandemic (2020). We then replicate the estimation of Eq. (1) using these pseudo-treatment dates, employing the specifications involving all FEs and control variables. This process is repeated 100 times. Figure 2 presents a visualization of the coefficients of the DID estimates from these 100 estimations, along with their confidence intervals, for each of the outcome variables. Reassuringly, the estimated coefficients do not achieve statistical significance in at least 90% of these estimations. This test provides further support for our treatment identification strategy and for the validity of our empirical approach.



Notes: The graphs plot coefficients and confidence intervals of 100 estimations of Eq. (1) based on random pseudo-treatment dates. In each estimation, the pseudo-treatment date is randomized by the starting period subject to the requirement that it is not after 2020. The red dots are the statistically significant coefficients.

Fig. 2. Random placebo.

6.3. *Alternative treatment*

Our results depend on the identification of a group of treated countries defined based on the cumulative number of COVID-19 deaths per population. To check the robustness of the baseline results, we again test Eq. (1) by including an alternative treatment definition, *HighMortality*, obtained as a binary indicator that is equal to 1 when the country's cumulative excess mortality rate is greater than the median, and 0 otherwise.

Excess mortality is the difference between the total number of deaths during a health crisis situation such as a pandemic and those expected under normal conditions (Checchi & Roberts 2005). This measure is sometimes preferred for assessing the impact of the pandemic since it implicitly overcomes possible misclassifications in the assessment of the cause of death (Beaney *et al.* 2020) and only takes into account the total number of deaths during the pandemic compared to those expected before the pandemic emerged (Msemburi *et al.* 2023).

Table 8 documents the results of the baseline estimates that include all FEs and control variables, using *HighMortality* as a treatment. The results obtained are in line with those of the baseline in terms of the sign, magnitude, and significance of the coefficients, thus confirming our previous findings.

6.4. *Loan portfolio composition*

Our analysis of the lending aspect focuses on total loans and its components, that is, mortgages, consumer loans, and corporate loans, in terms of volume. We again estimate our baseline model, adopting as dependent variables three measures that consider the percentage contribution of each lending product to overall total loans. The first indicator is the ratio between mortgages and total loans, the second is the ratio between consumer loans and total loans, and the third is the ratio between

Table 8. Baseline findings with alternative treatment.

	Total loans	Mortgages	Corporate loans	Consumer loans	Guarantees	NPLs	Written off loans
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HighMortality × *Post*	−0.013***	0.012**	−0.032***	−0.013**	0.000	−0.019***	−0.001
	(0.004)	(0.005)	(0.006)	(0.005)	(0.004)	(0.002)	(0.002)
Observations	14730	9086	8305	10368	31194	25302	20423
Adjusted *R*-squared	0.895	0.913	0.893	0.841	0.909	0.759	0.364
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighMortality* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19 based on excess mortality, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9. Loan portfolio approach.

	Mortgages contribution	Corporate loans contribution	Consumer loans contribution
Dependent variable	(1)	(2)	(3)
HighCOVID × *Post*	0.055***	−0.047***	−0.024**
	(0.010)	(0.012)	(0.011)
Observations	9086	8305	10368
Adjusted *R*-squared	0.884	0.902	0.875
Controls	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

corporate loans and total loans. Table 9 shows that the estimated effects are consistent with the results obtained when the dependent variables are expressed as volumes.

6.5. *Exclusion of the European Sovereign Debt Crisis period*

The baseline analysis covers a relatively long time period (from 2010 to 2022) to try to exploit all the information available in the dataset. Nevertheless, one might have some concerns about the choice of using 2010 as the starting date for the analysis since in that period the financial systems of several European countries were severely affected by the sovereign debt crisis, which generated credit tightening from 2009 to 2011 (De Marco 2019). While we partially address this concern through the inclusion of year FEs, to further reduce these concerns we replicate our empirical analysis by restricting it to the 2012–2022 period, in the spirit of testing our model on a sample that excludes the impact of the sovereign debt crisis.

Table 10 reports the results of this test. We find that the estimates for all dependent variables are aligned with those of the baseline model in terms of sign, magnitude, and statistical significance. These findings provide further evidence of the robustness of our findings, even when shortening the time sample to exclude the sovereign debt crisis event.

6.6. *Post-2020 events*

The period following the outbreak of the pandemic was affected by a number of relevant and influential events for financial institutions and banks in particular, both negative (the Russian invasion of Ukraine in 2022) and potentially positive

Table 10. Exclusion of the European sovereign debt crisis period.

	Total loans	Mortgages	Corporate loans	Consumer loans	Guarantees	NPLs	Written off loans
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HighCOVID × *Post*	−0.011**	0.015***	−0.034***	−0.012**	−0.003	−0.018***	0.003
	(0.004)	(0.005)	(0.006)	(0.005)	(0.004)	(0.002)	(0.003)
Observations	13647	8461	7729	9659	28907	24030	19593
Adjusted *R*-squared	0.908	0.919	0.900	0.855	0.916	0.777	0.361
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The analysis covers 11 years (2012–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

(the NextGen EU program with the Recovery and Resilience Fund, the first tranches of which were released between 2020 and 2021). These could have exacerbated or mediated the impact of the pandemic on bank behavior, thereby affecting our baseline findings. To test whether this is the case, we modify the *Post* variable of Eq. (1) to take separate values for the three years of 2020 ($Post_{2020}$), 2021 ($Post_{2021}$), and 2022 ($Post_{2022}$). We then re-estimate the DID model using this modified version

Table 11. Post-2020 events.

	Total loans	Mortgages	Corporate loans	Consumer loans	Guarantees	NPLs	Written off loans
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HighCOVID × $Post_{2020}$	−0.015***	0.011**	−0.033***	−0.012**	−0.006	−0.016***	0.000
	(0.005)	(0.005)	(0.006)	(0.005)	(0.004)	(0.003)	(0.002)
HighCOVID × $Post_{2021}$	−0.009*	0.012**	−0.033***	−0.010*	0.001	−0.016***	0.002
	(0.005)	(0.005)	(0.007)	(0.005)	(0.004)	(0.002)	(0.002)
HighCOVID × $Post_{2022}$	−0.011**	0.018***	−0.042***	−0.014**	0.004	−0.021***	0.007
	(0.005)	(0.006)	(0.007)	(0.006)	(0.004)	(0.003)	(0.007)
Observations	14730	9086	8305	10368	31194	25302	20423
Adjusted *R*-squared	0.895	0.913	0.894	0.841	0.909	0.758	0.364
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* takes separate values for the three years of 2020 ($Post_{2020}$), 2021 ($Post_{2021}$), and 2022 ($Post_{2022}$) in country c, and 0 otherwise. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

of *Post*: the results of the interactions between *HighCOVID* and $Post_{2020}$, $Post_{2021}$, and $Post_{2022}$ provide insights into the pandemic-specific differential effects on banks in the countries most impacted by COVID-19 in the three different pandemic years.

The results of the analysis are shown in Table 11 and indicate that the effects estimated on average for the 2020–2022 period in our baseline model also apply to the individual years. Specifically, the average −1.2% pandemic impact on total loans at baseline is distributed between −1.5% in 2020, −0.9% in 2021, and −1.1% in 2022, with the coefficients being statistically significant in all three cases. Similar results emerge when we look at the other lending and risk outcome variables. Such insights provide further evidence of the robustness of our baseline findings.

6.7. *Lagged control variables*

Our baseline model includes a vector of control variables observed in the same year as the dependent variable. This choice may raise some concerns about the potential

Table 12. Lagged control variables.

	Total loans	Mortgages	Corporate loans	Consumer loans	Guarantees	NPLs	Written off loans
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HighCOVID × *Post*	−0.010**	0.016***	−0.034***	−0.010**	−0.002	−0.017***	0.002
	(0.004)	(0.005)	(0.006)	(0.005)	(0.004)	(0.002)	(0.002)
$Equity_{t-1}$	0.011**	0.010	−0.000	0.019***	−0.016	0.013***	−0.002
	(0.005)	(0.007)	(0.006)	(0.007)	(0.012)	(0.004)	(0.001)
$Size_{t-1}$	0.030***	0.031***	0.018**	−0.004	−0.015	−0.005	0.002
	(0.007)	(0.010)	(0.008)	(0.007)	(0.022)	(0.004)	(0.002)
$Liquidity_{t-1}$	−0.020***	−0.020***	−0.012***	−0.007***	0.002	−0.001	−0.002***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)
ROA_{t-1}	0.000	0.000	0.000	−0.000	0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$GDP\ Growth_{t-1}$	−0.000	0.002***	−0.001**	−0.000	0.000	−0.001***	0.000
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Financial\ Institutions_{t-1}$	0.010	−0.041	−0.026	0.067	−0.059*	0.000	0.006
	(0.054)	(0.042)	(0.064)	(0.063)	(0.035)	(0.024)	(0.007)
$Financial\ Markets_{t-1}$	−0.004	0.085**	−0.013	−0.054	−0.024	0.056***	0.012
	(0.038)	(0.035)	(0.031)	(0.040)	(0.043)	(0.015)	(0.011)
$Health\ Expenditure_{t-1}$	0.006*	0.018***	−0.001	−0.003	0.004	0.007***	−0.002
	(0.003)	(0.003)	(0.004)	(0.005)	(0.003)	(0.003)	(0.002)
Observations	13176	8058	7454	9367	28184	23105	18898
Adjusted *R*-squared	0.903	0.914	0.904	0.856	0.919	0.767	0.352
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The analysis covers 13 years (2010–2022) and 28 European countries. *HighCOVID* is an indicator that takes the value of 1 for banks based in countries highly affected by COVID-19, and 0 otherwise. *Post* is an indicator that takes the value of 1 for years after the beginning of the spread of COVID-19 (i.e. 2020–2022) in country c, and 0 otherwise. All the control variables are 1-year lagged. The table reports coefficient estimates followed by standard errors, clustered at bank level, in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

endogeneity and reverse causality of the estimations. To address this concern, we estimate a modified version of Eq. (1) that includes a 1-year-lagged vector of control variables. The results of these estimations are reported in Table 12. We show that the estimated DID coefficients are fully consistent with the baseline results, suggesting that our findings are not biased by endogeneity. We also document that, in most cases, the coefficients on the lagged control variables are close to those of the baseline analysis, thereby providing further robustness to our empirical model.

7. Conclusions and Policy Implications

We present a comprehensive examination of the repercussions of the COVID-19 pandemic on the European banking sector. Using a DID approach, this study compares the performance of banks in countries highly affected by the COVID-19 pandemic with that of countries in less affected regions. Analyzing both lending and risk-management dynamics from over 4000 European banks from 2010 to 2022, we find that the pandemic-induced economic shock significantly impacted banks, leading to a contraction in lending activities despite heterogeneous risk-taking in terms of products and duration. Notably, the reduction in total lending is primarily driven by less capitalized, less profitable, and larger banks, as well as those with limited access to public guarantee schemes. At the same time, the results indicate that risk portfolios showed a substantial resilience, with no increases in NPLs and written off loans observed in the period of analysis.

This work employs robust methodologies, incorporating country exclusion exercises and placebo tests, to substantiate the robustness of the findings. Moreover, our research augments the methodological toolkit for scrutinizing the interplay between pandemics and the behavioral dynamics of banking systems, through an exploration of alternative treatments and the refinement of treated group identification.

The analysis extends beyond the short-term impact — covering a timeframe up to the end of 2022 — and investigates channels through which the pandemic affects banks, such as capital requirements and the access to public support schemes. Additionally, our study scrutinizes the role of bank characteristics, including size, profitability, and listing status, in shaping responses to the crisis. Through the exploration of these factors, our research not only contributes to the understanding of heterogeneity within the banking sector but also offers insights into the potential differential impacts of regulatory measures.

In light of these findings, policymakers might consider differential impacts on banks based on their characteristics, as less capitalized banks appear more vulnerable. Moreover, the role of public support, especially through guarantee schemes, is crucial in mitigating a decline in total loans, seen particularly in the countries most affected by the pandemic. Ensuring the long-term effectiveness of these temporary support mechanisms can help maintain financial stability and support economic recovery, preventing abrupt declines in the event of their removal. Moreover, these public support mechanisms could be one of the reasons why a deterioration of bank

risk portfolios has not yet clearly occurred. Therefore, identifying tools that can assist banks in preventing such material deterioration is a relevant policy objective.

Despite these insights, this study comes with some limitations. First, the initial conclusions drawn from the analysis of credit-portfolio deterioration require further investigation, as deterioration may emerge after a longer time period than the one considered here, particularly when the effects of financial support coming from the public sphere (e.g. moratoria) diminish or cease. Future research avenues could explore the longer-term effects of the pandemic on the European banking system, considering potential delayed impacts and evolving patterns, especially in the context of credit-portfolio deterioration. Second, our findings regarding the effectiveness of public support measures for the resilience of the banking system's lending performance are conducted from a macro-perspective, mainly differentiating publicly supported banks based on the overall contribution of the public sphere to the banking system at the country level. Deeper investigations into the effectiveness of specific public support measures (such as guarantee schemes) that leverage information at the loan level, could offer valuable insights into optimal policy responses during crises. Finally, while our findings refer to the impact of the COVID-19 pandemic, we should acknowledge the presence of other possible shocks that could at least partially influence our results. This is particularly relevant to the last year in our dataset, when geo-political tensions in Europe led to an increase in the price of raw materials and robust responses from central banks, affecting the level of the interest rate. While we have partially addressed this issue by disentangling the impact of the pandemic in each year since 2020 to see if there are heterogeneous effects over time, studying the cumulative impacts of concurrent or subsequent crises in Europe and globally would be helpful to examine how these events can affect the resilience and functionality of the European banking system. Overall, understanding the multifaceted impacts of the pandemic on the European banking sector is crucial for developing resilient financial systems and effective policy frameworks in the face of unprecedented challenges.

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