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Impact of COVID-19 and PEPP on the profitability and lending heterogeneity across euro area banking systems.

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Abstract

This dissertation assesses the economic impact of the Coronavirus Disease 2019 (COVID-19) and the Pandemic Emergency Purchase Programme (PEPP) on the euro area banks' heterogeneity, focusing on their profitability and lending behavior. The dataset includes information about 95 banks headquartered in 10 euro area countries, and it is combined with the quarterly country-specific GDP and liquidity injections under the PEPP. After adopting a difference-in-differences approach, the credit supply and returns on average assets in periphery banking systems are compared to those in core banking systems. The study finds that while the credit supply of periphery banking systems has undergone a more pronounced credit contraction, the implementation of PEPP allowed the same banking systems to benefit more, resulting in a smoother recovery. Concerning banks' profitability, the COVID-19 pandemic alone triggered an adverse effect for periphery countries. However, when the pandemic-related UMP is integrated into the specification, the effects are canceled out, and the inner business model appears to shape banks' profitability. Indeed, banks' characteristics play a fundamental role in defining credit supply and profitability, with the NPL level being a predominant element of effectiveness in banks' performance. A possible way to tackle the cross-country heterogeneities and make the monetary policy effective could be the implementation of new regulations regarding bank-specific characteristics to address the features that undermine bank performance.

Keywords: Banks, COVID-19, European Central Bank, Heterogeneity, Non-Performing Loans Unconventional Monetary Policy.

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Furthermore, I would like to dedicate this work to the memory of Carla, who has always been present for my family and me. We miss you.

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List of abbreviations

ABSPP	Asset-Backed Securities Purchase Programme
APP	Asset Purchase Programme
COVID-19	Coronavirus Disease 2019
EAPP	Expanded Asset Purchase Programme
ECB	European Central Bank
ECS	Enhanced Credit Support
EMU	European Monetary Union
FRFA	Fixed Rate And Full Allotment
GDP	Gross Domestic Product
GFC	Global Financial Crisis
LTRO	Long-Term Refinancing Operations
NCB	National Central Bank
NPL	Non-Performing Loans
OMT	Outright Monetary Transaction
PELTRO	Pandemic Emergency Longer-Term Refinancing Operations
PEPP	Pandemic Emergency Purchase Programme
QE	Quantitative Easing
ROAA	Return On Average Assets
SMP	Securities Market Programme
TLTRO	Targeted Longer-Term Purchase Programme
UMP	Unconventional Monetary Policy
US	United States
VIX	Chicago Board Options Exchange (CBOE) Volatility Index
WHO	World Health Organization

Contents

I. Introduction

After the Global Financial Crisis (GFC, 2008), the heterogeneous development of euro area economies has been identified as one of the main weaknesses in the single framework of the European Monetary Union (EMU). As discussed in Leroy & Lucotte (2014), Asimakopoulos et al. (2018), and others, this problem has been largely ignored before the financial shock, and it amplified due to the existence of cross-country differentials. The persistence of heterogeneity in the Eurozone throughout the post-crisis decade can be evaluated via multiple approaches: the most general procedure assesses the evolution of the major macroeconomic indicators, such as GDP-per-capita and unemployment rate. By looking at these two measures, a fracture between the commonly named core and periphery economies has been created. The division between the two groups of countries has been a conventional framework in the post-GFC period, as in Altavilla et al. (2016) and Asimakopoulos et al. (2018), presented in Table A.1. For both macroeconomic indicators, the cross-country trends highlight profound disparities. Greece, Ireland, Italy, Portugal, and Spain register the lowest GDP-per-capita and the highest unemployment rates, while Austria, Belgium, France, Germany, and the Netherlands perform in the opposite direction. This difference is even more visible when looking at the group-specific average values, as figures 1 and 2 in the empirical framework section show. Similar developments can be observed in other fundamental macroeconomic indicators, such as inflation and debt level.

In conjunction with the study of the real economy, there is a more specific process that consists of the analysis of the Eurozone countries' financial conditions, focusing on their banking systems. Unlike the United States, one of the distinguishing features of the European economy is its bank-based structure, where banks represent the primary source of funding for households and corporations. Hence, assessing the efficiency and economic differentials across euro area countries can be executed utilizing banks' performance measures. As in the macroeconomic indicators' evaluation, there is a country-specific divergence in the banks' performance. When looking at two typical banks' balance sheet items (Kenourgios et al., 2019), banking systems in core countries display more efficient management, with lower levels of non-performing loans (NPL) and a steady increase of the credit supply; in opposition, banks in the periphery economies run riskier businesses, with higher levels of NPL and a broad contraction of the credit supply that is still below the pre-GFC levels.

By focusing on more recent events, the year 2020 started with the emergence of the coronavirus disease 2019 (COVID-19), a deadly virus that spread from Wuhan (China) and rapidly diffused worldwide, creating dramatic consequences. Overall, the coronavirus evolution can be seen as a threefold event. Firstly, it commenced as a health crisis with the number of contagions amplified by the mobility of people and the collapse of hospitals. After the World Health Organization (WHO) declared the global state of pandemic and governments realized the gravity of the situation, countries began to shut down all the economic activities, creating disruption in supply chains and hoarding for the demand of necessary goods. Lockdown measures transformed the pandemic into an economic shock,

determining a recessionary period with increasing unemployment rates and low inflation. Lastly, these extreme economic conditions immediately spread to financial markets via contagion, causing a rapid fall in asset prices and generating an increased risk aversion among international investors, which came on top of the heightened risks and amplified the sell-off across an extensive range of assets (Ampudia et al., 2020). In such a precarious situation, central banks saw the necessity to react to limit the damage of the shock quickly. Their main objective was to inject liquidity to boost bank lending and provide support to households and corporations. The ECB implemented a new unconventional monetary policy (UMP) named Pandemic Emergency Purchase Programme (PEPP) that provides an additional amount of € 1,850 billion to lower sovereign spreads and borrowing costs and increase lending in the euro area. This unconventional instrument complements the already existing APP and TLTRO that have been enhanced from March 2020. These mechanisms are accompanied by other extra measures, such as temporary capital and operational reliefs and increased flexibility for banks, such as the Pandemic Emergency Longer-Term Refinancing Operations (PELTRO) program. The pandemic-related UMPs aims are threefold: ensuring a sufficiently accommodative monetary policy, stabilizing the financial markets to make these actions effective, and providing the liquidity required to boost bank lending. As mentioned, the primary threat to the success of the UMP is the heterogeneity across euro area economies and the different reactions to the shock. Therefore, the research question of this paper is: *how did the COVID-19 pandemic and subsequently the ECB's PEPP shape the heterogeneity amongst European countries in terms of lending behavior and banks' profitability?*

In other words, this thesis aims at verifying whether the COVID-19 shock has generated more heterogeneity across euro area banking systems, as during the GFC, and if this is the case, whether the UMP adopted by the ECB has been successful in reducing the impact. Unlike some of the monetary policy tools adopted during the GFC, the purchase of public sector securities within the PEPP is based on the Eurosystem capital key of the national central banks (NCB)[1]. This measure reflects the share of each NCB in the ECB's total capital. It is determined by the respective countries' shares in the total population and GDP of the European Union (Capital Subscription, *ECB*, 2020). Given that the purchases are proportional to a country's economy, the primary aim of the ECB is to simultaneously reduce the impact of the shock by addressing the cross-country economic differences. The consequence of these actions should produce a homogeneous environment in which the single monetary policy would smoothly work and, therefore, ensure a future for the existence of the EMU. As the research question suggests, the ultimate objective of this study is to determine whether the ECB has succeeded on this front.

As a starting point, the dissertation will briefly describe the reaction of the euro area countries to the GFC to compare the nature and effects of COVID-19. In the subsequent years, economies and banks in financially distressed European countries have been more constrained when compared to core

[1] Even though they are conducted in a flexible way, based on the market conditions, to prevent a damaging effect on the European inflation level (Pandemic Emergency Purchase Programme, *ECB*, n.d.).

economies in the same region, accentuating the cross-country divergencies. This separation will be employed for the more recent times marked by the pandemic in a modified[2] triple difference-in-differences approach, which intends to analyze both the impact of COVID-19 and the introduction of the PEPP on some of the most representative euro area banking systems. The study uses a novel dataset assembled from different sources, which contains quarterly data regarding bank-specific variables, economic indicators, and measures for the liquidity injected by the ECB during the COVID-19 pandemic via the PEPP. In this way, the dissertation will determine whether the heterogeneity across core and peripheral countries has been accentuated in the post-COVID-19 period and if the monetary policy has effectively reduced its impact.

This dissertation finds that while the outbreak of the COVID-19 pandemic seems to have triggered the heterogeneity in the profitability between core and periphery banks, with the latter group performing worse, the implementation of the pandemic-related UMP, namely PEPP, might have reduced this effect, making banks' profits reliant on their internal business. However, in terms of lending behavior, COVID-19 worsened the performance of banking systems in periphery countries. At the same time, the banks in these countries appear to have benefitted more from the liquidity injections under the PEPP, which allowed for a smoother economic recovery. Lastly, banks' characteristics play a fundamental role in shaping credit supply and profitability, with the NPL level being a predominant element of effectiveness in banks' performance.

The rest of the thesis is organized as follows: the next section will briefly describe the post-GFC economic developments and the UMP adopted by the ECB to create a bridge with the policies implemented during the COVID-19 shock. Afterward, the existing works about heterogeneity in euro area banking systems, core-periphery countries and NPL, and ECB's pandemic UMP are presented in the theoretical framework section. The other sections will cover the data and methodology exploited to perform the analysis, the results, and the conclusion, answering the research question.

[2] Modified due to the different use of the interaction terms with respect to a traditional triple difference-in-differences as in Olden et al. (2020). See methodology part.

II. Empirical framework

From 2008 onwards, the evolution of the GFC has accentuated the heterogeneous economic features of euro area countries, posing a threat for the transmission of the ECB's single monetary policy and creating a fracture amongst northern and southern countries[3]. The initially claimed stability in GDP growth, unemployment rates, stable and low inflation, and sustainable debt levels is still a mirage for the EMU, and economic disparities widened the net separation between the two groups of countries. The ECB has been put in a desperate position throughout the post-GFC period due to these economic differentials. While core countries demanded a stronger euro and higher interest rates to foster economic growth, the opposite was needed for periphery countries. Opting for an accommodative monetary policy aiming to support, or better said, save the southern countries came with criticisms, and its results were not wholly effective (Wortmann et al., 2016). To have a complete understanding of the history of the UMP implemented by the ECB and analyze its impact on widening the core-periphery differentials, the following part will present the central policies adopted during the past decade and show the evolution of specific macroeconomic and banking indicators. Further on, a comparison with the monetary policy decisions during the COVID-19 pandemic will be made. By contrasting the nature and the effects of the two shocks, together with the evaluation of the rationale behind the crisis-specific UMPs, this section provides a general framework in which the two events may have widened the spreads among northern and southern countries are described. In this context, the role of the ECB is to reduce the differentials by using specific unconventional tools, to adapt to the different post-shock economic developments. In the author's view, this link is fundamental, as it provides a careful analysis of the effectiveness of the UMPs, considering that some of them have been implemented in both events. Overall, the final evaluation will provide some insights for future policy implications. Moreover, since stability is the principle on which the EMU has been created, reducing the cross-country differentials is fundamental to ensure its future existence.

GFC (2008) and core-periphery separation

During the first phases of the GFC, euro area economies entered into a recessionary period with the banking systems being severely hit. In such a distressed situation, the ECB undertook both conventional and unconventional policies. Starting with the expansion of the acceptable collaterals in the operations inside the Euro system, to ease the injection of liquidity, the ECB extended its measures with the provision of US dollar liquidity through swaps after an agreement with the Federal Reserve and reduced the central interest rates, through which it conventionally operated before the crisis. Given

[3] Throughout the dissertation, the words core, non-distressed, and northern will be used interchangeably. The same holds for periphery, distressed and southern.

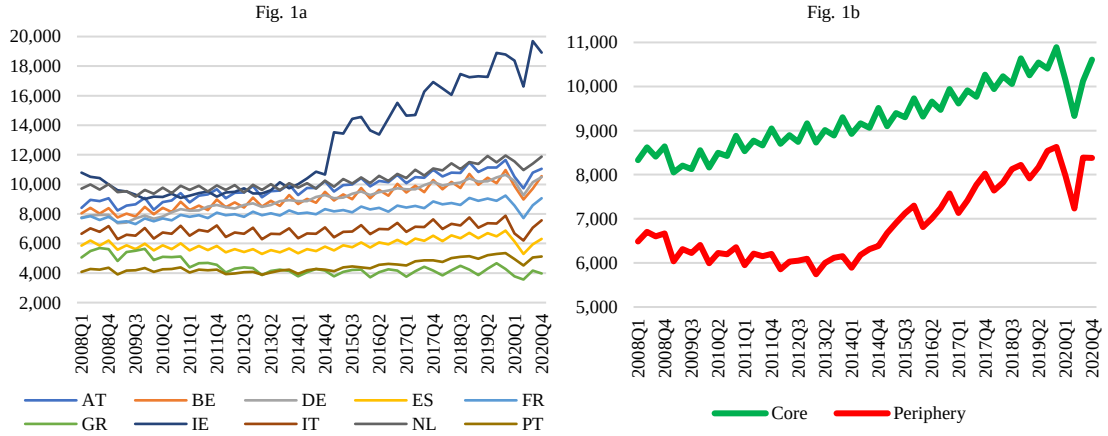
the gravity of the shock, a vast injection of liquidity and the introduction of expansionary programs were necessary. Accordingly, the ECB moved towards three directions, introducing credit easing measures, sovereign bond purchases, and a mechanism to influence market players' behavior. This plan has been accompanied by the (un)conventional decision to bring the deposit facility rate to negative levels to make the above measures more effective. Representative of the significative response of the ECB to the crisis, the words of the former ECB president Mario Draghi during the Global Investment Conference (London, 2012) are worth to be cited:

"Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough."

Concerning the first set of operations, an initial package of measures named Enhanced Credit Support (ECS) have been launched, and they included an unlimited provision of credit to banks at a fixed interest rate (FRFA), with the maturity of this provision and the list of eligible collaterals being considerably extended. Moreover, the ECB started to increase the maturity of its refinancing operations, which later became multiple LTRO and TLTRO programs, allowing the long-term interest rates to decrease and guarantee liquidity to banks. Another unconventional instrument initiated in two different periods is the Covered Bond Purchase Programme (CBPP), which injected in the European economy approximately € 60 billion in the first period and € 40 billion during the second. A third CBPP started in November 2019 and is still in place to purchase covered bonds. Within the second set of operations, the focus of the ECB shifted towards more distressed economies. The first instrument of this series was the Securities Market Programme (SMP), which consisted of purchasing bonds issued by sovereigns. Through fine-tuning operations, it absorbed the liquidity by increasing the deposits in the ECB itself. Once the program terminated, it has been substituted by the Outright Monetary Transactions (OMT) program to purchase government bonds with maturity ranging from one to three years and sterilize them to avoid inflationary risks. The Asset-Backed Securities Purchase Programme (ABSPP) was the last and more comprehensive instrument, which differentiated from the previous because it enlarged the list of collateralized securities and issuers, involving governments and agencies or European institutions. From March 2015, the ECB started the Expanded Asset Purchase Programme (EAPP), or more commonly known as Quantitative Easing (QE), which became part of the more extensive Asset Purchase Programme (APP) that includes some of the measures mentioned above. The QE represented an innovative, unconventional instrument because it was directed to the public and private sector, with the outright purchase of long-term securities in favorable terms. Overall, the announcement in January 2015 led to an improvement in the expected macroeconomic conditions, and this positive outlook has also been replicated in the euro area banking systems. Lastly, the ECB introduced a form of public communication named forward guidance, which involves the transparent transmission of information to the market to influence the market players' expectations.

Overall, these measures have positively affected the European economy, improving all the major macroeconomic indicators. By looking at the developments in a more detailed perspective, one can analyze the trends that distinguished the single countries to verify whether all the economies benefited from the UMP uniformly. In figures 1 and 2, two major macroeconomic indicators have been selected to confirm the presence of cross-country differentials: GDP-per-capita and unemployment rates.

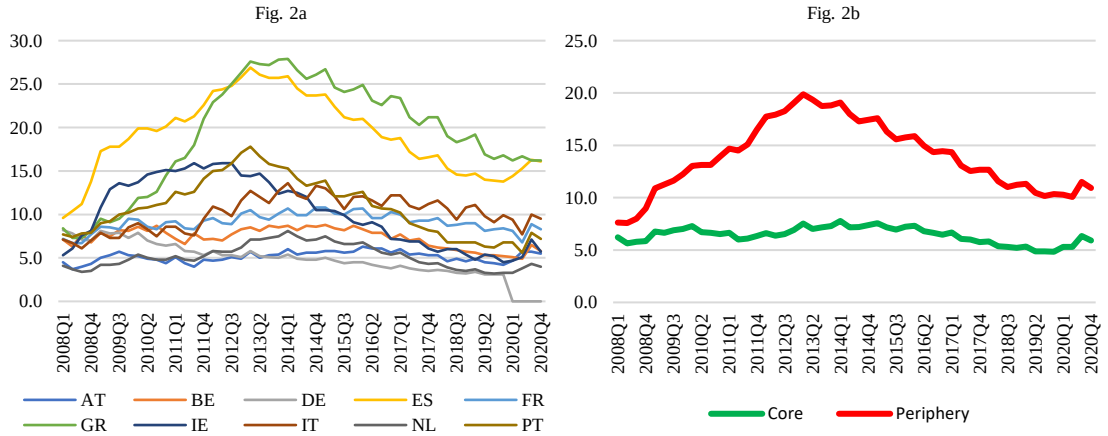
Figure 1: (a) Quarterly gross domestic product per capita at market prices (€) per country. (b) Average values based on the core-periphery country group division.



Source of the data: Eurostat.

Notes: Data has been collected from 2008Q1 to 2020Q4. Countries: Austria (AT), Belgium (BE), France (FR), Germany (DE), Greece (GR), Ireland (IR), Italy (IT), Netherlands (NL), Portugal (PT), Spain (ES). Core countries: AT, BE, DE, FR, NL. Periphery countries: ES, GR, IE, IT, PT.

Figure 2: (a) Quarterly unemployment rates (as a % of the total citizens) per country. (b) Average values based on the core-periphery country group division.



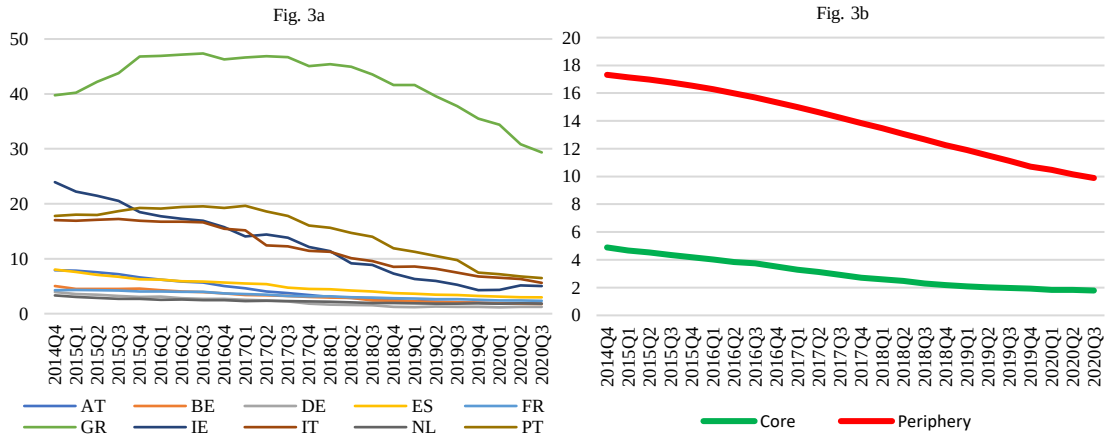
Source of the data: Eurostat.
Notes: Data has been collected from 2008Q1 to 2020Q4, and it is representative of the population with age included between 15 and 74 years.

Figures 1 and 2 respectively depict the quarterly GDP-per-capita and the unemployment rates from the outbreak of the GFC to the present period. Figures 1a and 2a portray wide cross-country differentials, and they show the low GDP growth for most periphery countries, which also register the highest unemployment rates. A fracture is even more visible when the countries are grouped between core and

periphery, where the average values for each group and quarter are calculated (figures 1b and 2b). These figures present a general overview of the trends in euro area countries' economic outlook and emphasize the heterogeneity during the last decade from an aggregate perspective. Although the two curves have narrowed in the last five years for both variables, the differences are still considerable. As mentioned in the introduction, similar trends have been registered in the inflation and debt level[4].

A more specific way to analyze the cross-country differentials is the study of their banking systems. The rationale of this approach is that one of the distinguishing features of the European economy, as opposed to the United States economy, is its bank-based structure, where banks represent the primary source of funding for households and corporations. Moreover, banks play a fundamental role in the monetary policy transmission since an ineffective pass-through of interest rates makes it hard for a central bank to regulate the economic dynamics (Altavilla et al., 2016). Hence, an assessment of the euro area countries can be implemented employing banks' performance indicators. As an overview of the post-GFC developments, a good measure of banks' efficiency is the ratio of non-performing loans and advances (NPL) on the total gross loans and advances. A non-performing loan is a loan in which the borrower defaults and therefore faces difficulties making the contractual payments (Segal, 2021). NPL represents an essential metric for banks' performance because they reflect the credit quality of the loan portfolio, therefore, the riskiness of the banks' business. In addition, this variable serves as a proxy for the economy-wide probability of default of the banking sector's overall loan exposure. Figure 3 depicts the trends in NPL[5].

Figure 3: (a) Quarterly gross non-performing loans and advances (% of total gross loans and advances) per country. (b) Average values based on the core-periphery country group division.



Source of the data: ECB Statistical Data Warehouse.

Notes: Quarterly non-performing loans and advances expressed in % of total gross loans and advances for domestic banking groups and stand-alone banks based on consolidated data from 2014Q4 to 2020Q3.

[4] See appendix, figures A.1 and A.2.

[5] The reduced availability of the data, with respect to figures 1 and 2, is due to the fact that the ECB started to collect data on NPLs on 2014, and the last available quarter at the time this thesis is being written is 2020Q3.

Overall, the NPL ratios have been decreasing after the financial shock provoked by the GFC, but the evolution across euro area countries has been rather heterogeneous. Periphery banking systems have noticeably registered higher ratios throughout the last decade, with Greece being a solid outlier, while banks from the core group performed better, with lower ratios. The different trends between these groups of countries are even more visible in figure 3b, where the average per-group-values are calculated. They denote a widespread which kept narrowing in the recent years, giving signs of a reducing heterogeneity. However, these differences across countries represent a threat to the single monetary policy adopted by the ECB: as Huljak et al. (2020) prove in their research, a high level of NPL reduces banks' profits because they require higher provisions than usual, and this leads to lower interest income. Moreover, they require higher capital needs, and they can divert significant managerial resources away from the core and more profitable activities. While core countries appear to have the situation under control due to the efficiency of their banking systems, peripheral countries distinguish themselves for their distressed banking systems. Considering the critical role of bank lending for the functioning of the euro area economy and given that the behavior and performance of banks in the credit market amplify the economic consequences of the market turmoil, there are concerns on how the ECB can effectively manage the heterogeneity with an undifferentiated monetary policy. Similar trends are registered in the banks' credit supply, visible in figure A.3, for which periphery countries have seen a contraction that led the current level of outstanding loans to be lower than the 2008 levels, while banks in core countries recorded a strong recovery. Comparably, the trends in the banks' ROAA, higher for core countries, and total banks' debt, higher for periphery banking systems, reflect the existence of a fracture. Several studies have questioned the single framework in the Eurozone in the presence of this heterogeneous environment[6]. Ciccarelli et al. (2013) showed how conventional and unconventional policies had affected different dimensions of the heterogeneity across banking systems by analyzing the credit channel and considering changes during the GFC, both from a cross-country and a banking systems' perspective. The main finding is that the transmission mechanism of the single monetary policy is time-varying and influenced by the financial fragility of the sovereign, the characteristics of the banking sector, and the types of non-financial borrowers. These differentials among countries have been partly alleviated with the liquidity provided by the first two unconventional instruments used by the ECB, FRFA policy, and LTROs. However, the banks' size and the country's economy's status still contribute to the pre-existing heterogeneity. The disparity has been persistent in the last years, reflecting the fragility of periphery banking systems.

[6] For further details see Blot & Labondance (2013), Ciccarelli et al. (2013), Wortmann & Stahl (2016).

COVID-19 pandemic and core-periphery separation

Throughout the writing of this study, people are still being affected by COVID-19, a highly contagious virus that led the WHO to declare the state of pandemic on March 11, 2020. The first reported case has been registered in Wuhan city (China) in late December 2019, and since then, it has rapidly spread worldwide, causing an impressive number of deaths. Overall, the disease created disruption and subsequent economic shock that can be seen as the evolution of a threefold event: firstly, it commenced as a crisis in all national health systems due to the high infection rates that caused the treatment capacity of hospitals to become overwhelmed in many countries, like Italy and Spain. Moreover, different elements created a state of fear across the population, from the lack of knowledge about COVID-19 symptoms to the shortages of protection equipment and inadequate technology. In this context, governments reacted differently to the spread of the virus. However, their measures were all converging in a general shut down of economic activities creating disruption in supply chains and hoarding for the demand of necessary goods. Given the ease of transmissibility of the virus, such policies aimed to flatten the contagion curve by limiting human interactions. From an economic point of view, the consequences of the measures have been deleterious: rising unemployment rates, economies entering into a recessionary period, with tourism and hospitality business being one of the most hit sectors (Bratianu, 2020). Moreover, countries started turning into red zones of the COVID-19 pandemic, closing their borders for public transport and introducing quarantine measures for people abroad. In a situation where uncertainty was extraordinary and the short-term outlook for the trends in the Covid cases was negative, the crisis spread into financial markets, causing significant and rapid declines in asset prices across all sectors. Albulescu's (2020) study shows how the financial markets volatility index (VIX) was positively affected by the new cases reported outside China, the increasing death ratio, and the rising number of COVID-19 countries. The higher uncertainty increased risk aversion among international investors, which came on top of heightened risks and amplified the sell-off across an extensive range of assets.

As in the case of the GFC, central banks have been in the frontline to reduce the impact of COVID-19 on the economy. In Europe, the ECB immediately intervened after the declaration of the pandemic status and the lockdown imposed by most governments by extending the already existing unconventional programs. In particular, the APP, which started in March 2015 and registered the last net purchases in September 2019, has been rehabilitated with an increased amount of assets acquired within the program by € 120 billion. Accompanying this instrument, also the TLTRO was granted at more favorable conditions for banks to stimulate credit and new long-term operations. Although the extension of already existing measures, the sovereign debt market registered an increase in bonds' spreads. The ECB understood that it was time to avoid any heterogeneity in the monetary policy transmission (Blot et al., 2020). A new asset purchase program was launched under the name of PEPP, which was intended to initially provide a total envelope of € 750 billion from March, extended to €

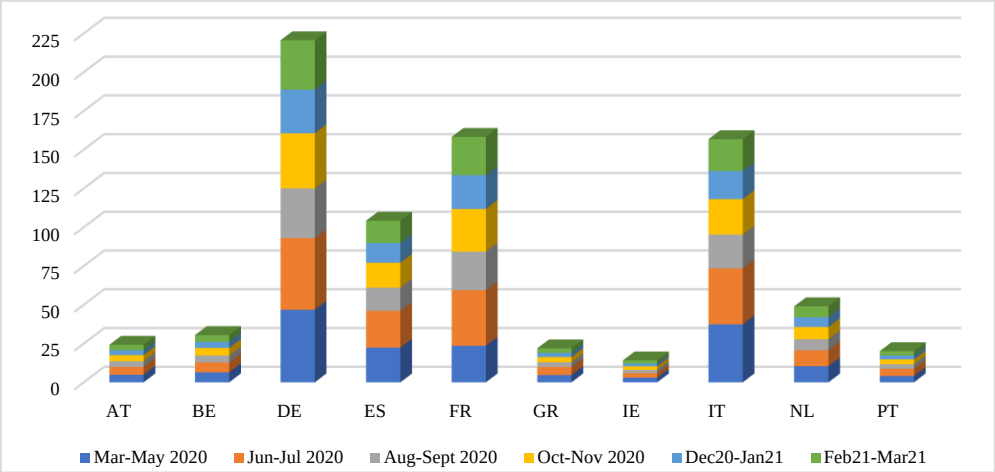
1.35 trillion in June 2020 and € 1.850 in December 2020. The PEPP is a temporary instrument that involves purchasing private and public sector securities for all asset categories eligible for the APP. The Governing Council of the ECB publicly declared that the program would terminate once the pandemic is over (under its judgment) and, in any case, not before the end of March 2022 (Pandemic Emergency Purchase Programme, *ECB*, n.d.). The weekly purchases of public sector securities are based on the Eurosystem capital key of the NCBs. As defined in the introductory section, this measure reflects the share of each NCB in the ECB's total capital. It is determined by the respective countries' shares in the total population and GDP of the European Union (Capital Subscription, *ECB*, 2020). Since the purchases are proportional to a country's economy, the primary aim of the ECB is to simultaneously reduce the impact of the shock by addressing the cross-country economic differences in order to create a homogeneous environment in which the single monetary policy would smoothly work. However, as for the APP, the operations were initially meant to be flexibly conducted, allocating more liquidity to those countries in a more distressing situation (i.e., countries with higher sovereign spreads) and avoiding fragmentation. Interestingly, up to March 2021, the purchases have been in line with the Eurosystem capital keys. Germany, France, Italy, and Spain received the majority of the aid due to significant contributions of NCBs to the ECB's capital. In table 1, the euro area NCBs' contributions to the ECB's capital are presented. They can be compared to the bimonthly amount of net purchases under PEPP in figure 4.

Table 1: Euro area national central banks' contributions to the ECB's capital (% of the total ECB's capital).

Country	Capital key contribution
Austria (AT)	2.927
Belgium (BE)	3.643
Germany (DE)	26.362
Spain (ES)	11.925
France (FR)	20.424
Greece (GR)	2.474
Ireland (IE)	1.693
Italy (IT)	16.989
Netherlands (NL)	5.860
Portugal (IT)	2.341

Source of the data: ECB.
Notes: The values reported in the table refer to the latest available data reported on February 1, 2020. As of December 29, 2020, the capital of the ECB collected from the national central banks of all EU Member States amounts to € 10,825,007,069.61. The percentages in the table do no sum up to 100% because not all countries are included.

Figure 4: Bimonthly net purchases under the PEPP in billion €, divided by country.



Source of the data: ECB.

In addition to PEPP, a new LTRO program named Pandemic Emergency Longer-Term Refinancing Operations (PELTRO) has been announced in April 2020, with the provision of liquidity ranging from May to December in the same year. The rationale behind these pandemic-UMP differs from the reasons for the implementation of the APP in 2015. If in the second case, the main objective was to reduce the inflation spreads across countries to bring it to the ECB's target of 2%, the COVID-19 related measures are more related to the closure of spreads across different countries' sovereign debt. The two measures diverge in their objectives due to the economic developments in euro area countries after the shock. The APP has been introduced in a period of solid deflation, persistently high unemployment rates, and negative expectations for the outlook of the subsequent years. In contrast, the PEPP has been implemented when inflation was uncertain due to the mix of demand, supply, and uncertainty risks in the market (Blot et al., 2020).

With the implementation of PEPP, the policymakers have been focusing on the big picture, i.e., the reduction of sovereign spreads and the prevention of further rising unemployment rates and declining GDP to avoid cross-country fragmentation. Based on the statements published by the ECB, the three primary goals of these UMP are: ensuring a sufficiently accommodative monetary policy, stabilizing the financial markets to make the monetary policy effective, and providing the liquidity required to boost bank lending. Regarding this last aspect, how are banks performing from a profitability and credit supply viewpoint? Has the UMP undertaken during COVID-19 times affected the heterogeneity across euro area banking systems? Did the COVID-19 shock produce the same effects as the GFC? To provide an answer to all these questions, this paper will focus on euro area banks' profitability and lending behavior to verify whether the shock amplified the already existing core-periphery banking systems' fracture and if the ECB has effectively reduced the country-specific gaps. If that is the case, the central goal of avoiding fragmentation across the Eurozone has been achieved from a banking system perspective.

III. Theoretical framework

Before delving into the analysis concerning the impact of the pandemic-UMP on banks' profitability and lending behavior, a review of the existing literature on related topics is conducted. One of the most important lessons learned from the GFC is the influence of banks' behavior in amplifying economic shocks and their essential role in transmitting the central banks' monetary policy. In the euro area, the activity of the banking sector has displayed fragility with a cross-country heterogeneity that caused the transmission of the single monetary policy to be unevenly efficient, leading to segmentation in the financial market. This section focuses on the three major topics: heterogeneity across eurozone banking systems after the GFC shock and UMP implementation, the core-periphery division linked with NPL levels, and the ECB's monetary policy during the COVID-19 pandemic.

GFC, monetary policy, and heterogeneity

Studies about the heterogeneity across euro area banking systems are well established. The paper on which this dissertation is inspired is by Kenourgios et al. (2021). In this paper, the authors assess the impact of the ECB's UMP on bank lending supply and performance in the euro area by comparing bank-specific variables before and after the policy implementation. The major findings are that bank lending decisions and performance in the euro area are not UMP-driven, highlighting the limited effectiveness of the ECB's policies during distressed periods. Further findings suggest that banks in weaker economies underestimated the impact of liquidity risk on their lending activity under UMP. This study will use some of the variables included in this research work, and the analysis will be conducted so that pre-and post-treatment periods are evaluated but adapted to a difference-in-differences approach. Reichlin (2013) verifies that despite the increased liquidity provided via the LTRO program, the credit supply of euro area banks remained weak throughout the distressed period despite the lengthening of its horizon. In contrast with this result, but referring to another policy measure, Salachas et al. (2017) demonstrate that banks can reduce their dependence on external finances when the ECB increases the net purchases in APP, positively impacting the credit growth after 2007. Carpinelli et al. (2017) run a study on the Italian banks, showing that while the credit supply decreased before the ECB's intervention, it started to grow after the injection of liquidity with the UMP. Specifically, they find that the loans provided by Italian banks have been positively impacted by 2% after the initiation of the programs. Ciccarelli et al. (2013) analyze the effects of the modifications of the interest rates during the GFC to verify whether the transmission mechanism is smooth. Their work explores various dimensions of the heterogeneity, including data on credit conditions and standards and the analysis of different moments of the crisis. The main results describe how the pass-through is influenced: via the fragility of the financial system of a country, its banking sector, and the characteristics of non-financial borrowers. Moreover, it splits the euro area countries into two country groups based on the divergent patterns in the credit default swaps

of the 10-year sovereign bonds: countries under sovereign distress and the other countries. In the context of monetary policy transmission, Altavilla et al. (2016) show that heterogeneity of interest rates pass-through depends on banks' balance sheets, and UMP has been essential to normalize their lending capacity. Before their implementation, banking systems in distressed countries (same country division as in this paper) have registered a more pronounced reduction in lending rates concerning core economies. After their usage, they helped to reduce cross-country dispersions and to restore an efficient interest rate pass-through. Another remarkable work on the heterogeneous effects of monetary policy is Brissimis et al. (2010), where heterogeneity is studied on a banking systems-level based on banks' characteristics: liquidity, capitalization, and market power. The aim is to determine the role of monetary policy in shaping banks' profitability, lending, and risk-taking behavior. The goal of this dissertation is similar, but it will use a different set of variables to study the impact of a specific treatment. Regarding the effects of the GFC on single countries, Asimakopoulos et al. (2018) assess the impact of the financial crisis on the Eurozone banking sectors' efficiency by considering the asymmetries in the performance of banks in core and peripheral economies, both in the pre-and post-crisis period. While their study indicates a convergence in the efficiency of core and peripheral banking systems in the pre-crisis period, after the outbreak of the GFC, core banks outperformed peripheral banks even in the presence of specific UMP directly aimed at supporting the more distressed countries. Similarly, Burriel et al. (2018) evaluate the impact of the UMP amongst all euro area economies and considers cross-country interdependencies. The benefits of the measures implemented by the ECB are evident, but with considerable heterogeneity that peaked with the sovereign-debt crisis. Interestingly, countries with more fragile banking systems benefit the least from UMP, and the effects on the real economy of the whole Eurozone get dampened. More generally, Wortmann et al. (2016) analyze the core-periphery structures within the European Union to verify how well current EMU members fit in the single currency area by using the Macroeconomic Imbalance Procedure indicator, which has been designed to capture the most relevant elements responsible for the smooth functioning of EMU. This study finds that while core countries[7] plus the United Kingdom, Denmark, and Sweden could easily be part of a common currency area, the GIIPS[8] countries need a different treatment due to their considerable economic disparities in competitiveness, indebtedness, and economic performance. These differences cause problems for the euro area's stability as a whole, and in the authors' view, they could pose a threat to its future existence.

All the studies mentioned in this section align with the significant assumption that the heterogeneity across euro area banking systems has been widening since the GFC outbreak, which leads to a separation between core and periphery countries. The ECB's monetary policy helped reduce these divergencies by specifically directing instruments to more distressed banking systems, but the spreads are still present. This dissertation will add perspective and new insights about the development of heterogeneity in the euro area more recently, deploying some variables and findings from the literature mentioned above to

[7] Same division as in existing literature.
[8] Greece, Ireland, Italy, Portugal, Spain as in the periphery countries group.

understand whether banking systems' differentials have been accentuated after the COVID-19 shock. Moreover, the assessment will include a variable showing whether the ECB's response has effectively reduced the heterogeneity of the euro area. As mentioned in the introductory paragraph of the empirical framework section, the stability of the EMU as a whole requires sustainable levels of GDP growth, unemployment rates, stable and low inflation, and debt (Wortmann et al., 2016). Since the cross-country differentials pose a threat to this stability, the priority of the ECB is to close these gaps. Indeed, the single monetary policy adopted by the ECB can effectively work only in a homogeneous economic environment, where uniform interest rate pass-through would take place. If the ECB were able to achieve a solid economic recovery by smoothening the imbalances across the euro area countries, the EMU's sustainability would be ensured and its future existence. Additionally, the absence of heterogeneity would eliminate the asymmetric responses to shocks in euro area countries, making it easier for policy makers.

A critical clarification must be made. In most cases, the related literature assesses the effects of the GFC or the monetary policy throughout multiple years. In this thesis, the timeframe in which banks will be analyzed describes the short-term impact of the economic shock and monetary policy. For obvious reasons, this is the only available data both from a time and geographical perspective. This study will probably not be representative of the effects in the future years; however, this thesis intends to show whether countries have rapidly absorbed the shock and if the quick response of the ECB produced immediate effects. Future researchers should focus on expanding the analysis to the whole Eurozone since the ECB's monetary policy is addressed to all of them. Moreover, a multi-year study would be more suitable to validate the findings in this work, and more broadly, the effectiveness of the pandemic-related UMP.

Core-periphery division and NPL

Many papers have tried to identify the causes of such differences regarding the core-periphery euro area countries division. In the context of monetary policy and banking systems efficiency, several works study the impact of non-performing loans (NPL) ratios on the aggregate banking sector and macroeconomic variables. Credit risk assessment is a critical part of a proper macro-prudential analysis, and NPL is one of the best proxies to assess the credit quality of the loan portfolio of a banking sector in a country (Ozili, 2019). In this framework, the related literature generally distinguishes high-and low-NPL banking systems according to the historical NPL levels registered in the data. In general, euro area countries have registered an average post-GFC NPL ratio of 8%, with a net separation in the development of this indicator between the two groups of countries. The data and related literature show that banks in periphery countries registered an average NPL ratio well above 10%, with Greece being a strong outlier (between 40-50%). In opposition, banks in core economies obtained a lower NPL ratio,

with an average value between 4-5%[9]. As the following papers focus on the importance of NPL levels on the efficiency of the banking system and a country's economy, these values are fundamental to draw a general portrait of the situation in the euro area.

Espinoza et al. (2010) examine the connection between the real economy and banks among the most relevant studies. They demonstrate that the NPL ratio rises when economic growth slows down and risk aversion decreases, denoting an inverse relation between NPL and GDP growth. The relationship between these two variables will be considered in the technical analysis when the GDP-per-capita will be used as a country-specific control variable. In addition, Anastasiou et al. (2019) analyze the determinants of NPL in the euro area for the period 2003Q1 to 2016Q1 to investigate the fragmentation between core and periphery banking systems. They find that NPL ratios have faced an upward trend after 2008 due to worsening economic conditions, with a more pronounced effect in periphery countries. Moreover, they reveal another aspect of the fragmentation between the two groups of countries: the higher vulnerability of the periphery compared to the core. Another remarkable contribution is from Huljak et al. (2020) find that an increase in the change of NPL ratios produces a depression of bank lending volumes, widens bank lending spreads, and leads to a fall in real GDP growth. The study shows that, at the end of 2017, the NPL ratio of the most distressed countries was still above 10%, while it was below 5% for more stable countries. High NPL ratios have consequences also for banks' profitability, capital needs, and the dedication of resources from core activities to regulatory requirements. Again, Huljak et al. (2020) released a recent note concerning the paper mentioned above. They assess the macroeconomic impact of NPLs in euro area countries, making assumptions about their evolution in COVID-19 times. The authors state that COVID-19 is likely to trigger an increase in NPLs, which can negatively affect the soundness of a banking system and its ability to lend to the real economy. As for the GFC, monetary policies should be focused on restoring lower NPL levels and reducing the gap between core and periphery countries. In line with their findings, Balgova et al. (2016) compare three scenarios following a rise in NPL: active measures to reduce them, a decline in NPL due to credit growth, and periods in which high NPL persist. They find that reducing NPL has a beneficial impact on the economy, and countries that experience an influx of new credit grow the fastest. In contrast, if the level of NPL keeps being high, the economy suffers from foregone growth. Nkusu (2011) and Klein (2013) obtain comparable results, adding possible policy implications in their analysis. While NPL is a constant feature of banks' financials, the policies and reforms should be directed to avoid increases that set into motion the adverse feedback loop between macroeconomic and financial shock.

This dissertation employs a triple difference-in-differences regression (Olden et al., 2020), which entails analyzing lending behaviors and profitability across euro area banks, dividing them among core and periphery countries. In this setup, the control-treatment groups will be formed, respectively, on a core-periphery division determined by NPL level in the countries included in the sample. Given the

[9] The values range depending on the source of the data and on the related literature.

interlinkages between NPL, banks' performance, and economic developments, the assumption is that the COVID-19 shock led to an increase in NPL for both groups of countries, but with a more pronounced impact in periphery countries that were already distressed from the previous crisis (as predicted by Huljak et al., 2020). Additionally, the trends in NPL levels are expected to influence the profitability and lending behavior of banks.

Unconventional monetary policy in COVID-19 times

Concerning the monetary policy implemented during the COVID-19 pandemic and its effects on the banking system in the euro area, the literature is still lacking since the pandemic is recent, and it is still an ongoing event. For this reason, few research works have evaluated the effects that ECB's pandemic monetary policy has had on the euro area banking system. Among the recent literature, Wei et al. (2021) employ an event-study methodology to assess the impact of COVID-19 on the transmission of the monetary policy to the financial market, showing that it has been weakened and that central banks should implement more expansionary monetary policy to bring the financial market back to recovery in the long term. However, this study analyzes 37 countries worldwide, and the measures implemented by the central banks are slightly different. Moreover, the financial market is directly not analyzed from a bank-level perspective. The authors measure the impact on government bonds, stock, exchange rate, and credit default swap markets. Aguilar et al. (2020) focus on the euro area, presenting a brief overview of the pre-pandemic situation and the outbreak of the virus to analyze the impact of PEPP subsequently. Also, in this research work, the authors analyze the effects on the financial markets and the real economy without targeting the banking systems. They conclude that monetary policies have a short-term impact on real economies. Hence, similarly to Wei et al. (2021), ECB's expansionary and extraordinary monetary policy should be persistent over the short-medium term. Other papers, including Cavallino et al. (2020), and Pinshi (2020), analyze the monetary policy decisions of the major central banks and their spillovers on the real economy. Both works agree on the sizable footprint of the central banks' UMPs and their fundamental role in the recovery of the worldwide economies. In the authors' view, the central banks should keep purchasing large amounts of assets, and these programs should stay in place, at least for the near future. In opposition to these views, a paper from Beckmann et al. (2020) presents the empirical evidence on the effects of asset purchases, assessing the potential effects of the PEPP and future policy decisions for the ECB. Interestingly, they agree on the QE's effectiveness in stabilizing financial market conditions during distressed times (i.e., the peak of the crisis). However, there are tendencies of decreasing usefulness over time. The effects on output and inflation are uncertain but more significant for periphery countries.

To the best of my knowledge, this is one of the first research papers to analyze the effects of COVID-19 and the ECB's monetary policy on the banks' profitability and lending behavior differentials in the euro area.

IV. Data & Methodology

This section will describe the construction of the dataset and the methodology employed in the study. The intent of this section is two-fold: firstly, it should make the reader aware of the type of analysis conducted with the available data, as well as how the variables should be interpreted; secondly, it aims at presenting hypotheses based on the assumptions made in the previous section, in order to compare them to the actual results. In this way, the comprehension of the results and the conclusion should be more straightforward.

Data

Throughout the technical analysis, this paper will make use of information from different sources. The final dataset contains bank-specific data related to credit institutions headquartered in the euro area, and it has been gathered from the Orbis Bank Focus database. In addition, to capture macroeconomic conditions, the quarterly country-specific GDP-per-capita has been collected from the Eurostat database and incorporated in the more extensive dataset. The data regarding the PEPP, expressed in bimonthly net purchases of public and private sector securities in billion euros, has been collected from the ECB Statistical Data Warehouse. Lastly, in the empirical framework section, some evidence about the heterogeneity in NPL ratios and lending behavior has been presented, and the data has been collected again from the ECB Statistical Data Warehouse, while the data about unemployment rates has been gathered from Eurostat.

The analyzed period encompasses the whole development of the COVID-19 pandemic, describing the evolution of the bank-specific variables from the pre-shock period, throughout its outbreak, to the most recent updates. The data has been collected quarterly, including seven quarters between 2019Q3 and 2021Q1, given that the event started in March 2020. The sample includes ten of the nineteen euro area countries (i.e., Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain). The selection of these specific countries follows the northern-southern separation adopted in Altavilla et al. (2016) and Asimakopoulos et al. (2018) and other related papers. The remaining nine countries[10] have been dropped either because of the unavailability of the bank-specific data, as for Cyprus, Estonia, Latvia, Malta, and Slovenia, or because they represent strong outliers, as in the case of Luxembourg, which would alter the results of the analysis. Additionally, this is the most traditional outline in the existing literature mentioned in the theoretical framework section. Thus, Austria, Belgium, France, Germany, and the Netherlands are classified as euro area core countries with 46 banks. In contrast, Greece, Italy, Ireland, Portugal, and Spain are classified as euro area periphery with 49 banks.

[10] Cyprus, Estonia, Finland, Latvia, Lithuania, Luxembourg, Malta, Slovakia, and Slovenia.

The banks have been screened under the following criteria. Firstly, they must be active banks operating in one of the ten selected countries, narrowing the number of financial institutions from 3,521,951 to 5,616. Moreover, they must have available data for every quarter regarding non-performing loans/gross loans ratio, returns on average assets (ROAA), liquid assets/total assets ratio, net loans & advances to customers, total debt, and solvency ratio (equity/total assets). Lastly, only unconsolidated balance sheet data has been collected to make the banks comparable to each other. This rigorous selection narrowed the number of final banks to 95, which have available data for all these variables throughout the whole timeframe. Given that the data is analyzed for seven quarters, the total number of observations is 665. To provide summary statistics regarding these banks, a variable named $lnSIZE_{i,t}$ is created as the natural logarithm of a bank's total assets, according to the definition provided in Leaven et al. (2016). In addition, its average value has been calculated in order to create a dummy variable that distinguishes big and small banks. Specifically, the financial institutions with a size above the mean are defined as big, while the banks with a value below the average are considered small. This separation allows the readers to understand the different sizes of banks included in the sample and which of them are predominant in the selected countries. Table 2 provides an overview of the number of big and small banks and the country separation based on the aforementioned approach.

Table 2: Big and small banks in the sample, divided by country.

Country	Small	Big	*Country total*
Austria (AT)	4	3	*7*
Belgium (BE)	0	2	*2*
Germany (DE)	5	7	*12*
Spain (ES)	5	6	*11*
France (FR)	4	12	*16*
Greece (GR)	5	1	*6*
Ireland (IE)	2	2	*4*
Italy (IT)	16	8	*24*
Netherlands (NL)	4	5	*9*
Portugal (IT)	2	2	*4*
Size total	*47*	*48*	*95*

The table shows that the countries that present most banks with available data for all the required variables are Italy, France, Germany, and Spain. Regarding the size of banks, the only noticeable difference is the presence of bigger banks in France, while in Italy and Greece, smaller banks are predominant. The total number of small and big banks is almost equal, denoting an overall homogeneity

within the dataset. However, this reduced sample may not be representative of a country's banking system. Table 3 provides a general overview of the ten largest banks by total assets.

Table 3: Top 10 banks by bank size in billion €.

Bank	Country	Size
BNP Paribas	FR	2668
Crédit Agricole	FR	1860
Banco Santander	ES	1517
Deutsche Bank	DE	1393
Societe Generale	FR	1363
ING Groep	NL	944
Unicredit	IT	860
Intesa Sanpaolo	IT	788
Banco Bilbao Vizcaya Argentaria	ES	710
Crédit Mutuel Alliance Fédéral	FR	708

Notes: The size is measured as banks' total assets in billion € and calculated as an average value for the examined period, therefore, between 2019Q3 and 2021Q1.

Noticeably, the largest financial institutions in the euro area are concentrated in countries where the NCBs contribute more to capital reserves in the ECB's balance sheet (see table 1), with a slightly higher presence in core countries. This aspect also explains the more considerable amount of liquidity from the ECB via the PEPP to the French, German, Italian, and Spanish banking systems. As the banks' size considerably varies across the different financial institutions, the variable $lnSIZE_{i,t}$ must be included in the specification as a control variable. Table 3 shows a significant difference between the first bank, BNP Paribas, and the others in the list. Moreover, the banks in the higher part of the table present an average amount of total assets that is approximately two times higher than those in the lower part. Considering that the smallest financial institution in the sample presents an average value of total assets of 2.3 billion € for the analyzed quarters, its inclusion is necessary. Likewise, for the data related to the banks' liquidity, solvency, and debt. The following sub-section will provide more details regarding these variables, which describes the methodology employed to conduct the analysis.

Methodology

The starting assumption on which this dissertation is based is that euro area banking systems present vast cross-country differences and do not react uniformly nor to economic shocks, neither to monetary policy measures, as it occurred after the GFC in 2008. Given that these differences across countries have been persistent throughout the last decade, the aim is to verify whether the COVID-19 shock contributed to significant heterogeneity in banks' profitability and lending behavior and, in this case, if the extraordinary measures adopted by the ECB helped in alleviating the effect. The statistical technique employed in the dissertation is similar to a triple difference-in-differences regression (Olden et al., 2020), which entails the analysis during the pre-and post-COVID-19 shock of lending behaviors and profitability across euro area banks, dividing them among core and periphery countries. Additionally, this approach considers the introduction of PEPP in response to the worsening economic condition due to the outbreak of COVID-19, which is assumed to be the treatment that might have alleviated the spread of cross-country differentials. Therefore, two regression specifications will be used, and the following two structures will be assessed. The difference between the first and second regression is that while the first one only considers the impact of COVID-19 shock, used as the separating event in a simple difference-in-differences approach, the second specification assesses the influence of two treatments: the outbreak of COVID-19 and the implementation of PEPP. In this way, given the disruption due to the pandemic, the paper will examine whether the ECB has effectively reduced the impact of the COVID-19 shock between the two countries. However, a note about the statistical technique employed in the second specification must be made. It cannot be considered a proper triple difference-in-differences as in Olden et al. (2020) because the triple interaction between the dummy variable defining the country groups, the COVID-19 variable, and the PEPP variable is not included. From an evaluation perspective, the correlation between these variables is high; hence it would be omitted. Moreover, the focus of this study is on the impact of single treatments in the short term. Instead of drawing conclusions based on the triple interaction, it is preferred to compare the coefficients on the single interactions and look at how they impacted banks' credit supply and profitability.

Regarding the expected trends in terms of heterogeneity, countries still had heterogeneities in place in the pre-COVID-19 and pre-PEPP months. However, the empirical evidence has proven that banks' profitability and credit supply were going in the same direction with reduced cross-country spreads. In the post-COVID-19 period, the heterogeneity across euro area banking systems is expected to increase, with core countries performing better than periphery countries and different developments in the two groups (Huljak et al., 2020). Therefore, the intervention of the ECB (post-PEPP) should instead alleviate the effects of the shock, keeping the heterogeneity among the two groups of countries at similar levels. According to these expectations, the first specification is a difference-in-difference regression of the following form:

$$y_{i,t} = \alpha + \beta_1 * post2020Q1_t + \beta_2 NPL\_LVL_i + \beta_3 * post2020Q1_t * NPL_i + \gamma X_{i,t} + \theta lnGDP_{i,t} + \eta_i + \delta_t + \epsilon_{i,t} \quad (1)$$

This is the specification that will be used to evaluate the impact of the COVID-19 for two outcome variables ($y_{i,t}$): bank lending behavior measured as the natural logarithm of net loans and advances to customers over the banks' total assets in € ($lnLOANS_{i,t}$)[11], and banks profitability measured as return on average assets ($ROAA_{i,t}$). Figure A.3 shows the trend in credit supply after the GFC, and the divergence between the two groups of countries has been widening throughout the years. Similar trends can be noticed for ROAA, with core banking systems registering higher profitability than periphery banks. The goal is to verify whether this is also the case for the COVID-19 shock. The variable $post2020Q1_t$ is a dummy variable that assumes the value of 1 for the period following the economic shock[12], while the variable NPL_i denotes the country in which the bank operates, generating the core-periphery distinction and representing control and treatment groups. An interaction between these two variables ($post2020Q1_t * NPL_i$) will be created, and it will define the coefficient of interest in the first regression. Namely, the value and statistical significance of the interaction term will allow to conclude whether the heterogeneity between country groups has spread or not. As shown in Figure 3 in the empirical background section, peripheral countries registered higher levels of NPL during the post-GFC period compared to the core countries. Since this has been a distinguishing feature of the euro area banking systems for years, it will differentiate the two groups of countries. In particular, the variable $NPL_i = 1$ will denote those banking systems in which financial institutions operate at high NPL ratios (periphery) and vice versa for countries with a low NPL ratio (core). This specification is compatible with the assumption that peripheral countries have more distressed banking systems, marked by the higher level of NPL, and are subject to a sizeable increase in NPLs ratios in a post-shock period. At the same time, banks in a more resilient economy register lower and more stable NPL ratios. Additionally, this follows Huljak et al. (2020) hypothesis and will be tested with the regression specification.

[11] The original data contained information about total net loans & advances to customers in €. To make the variables comparable among each other, the loans have been scaled by calculating the natural logarithmic transformation. Likewise for the banks' total debt, banks' total assets, countries' quarterly GDP and PEPP's liquidity injections.

[12] From 2020Q2 (included).

Figure 5: Average NPL ratios for the core and periphery banks throughout the analyzed timeframe.

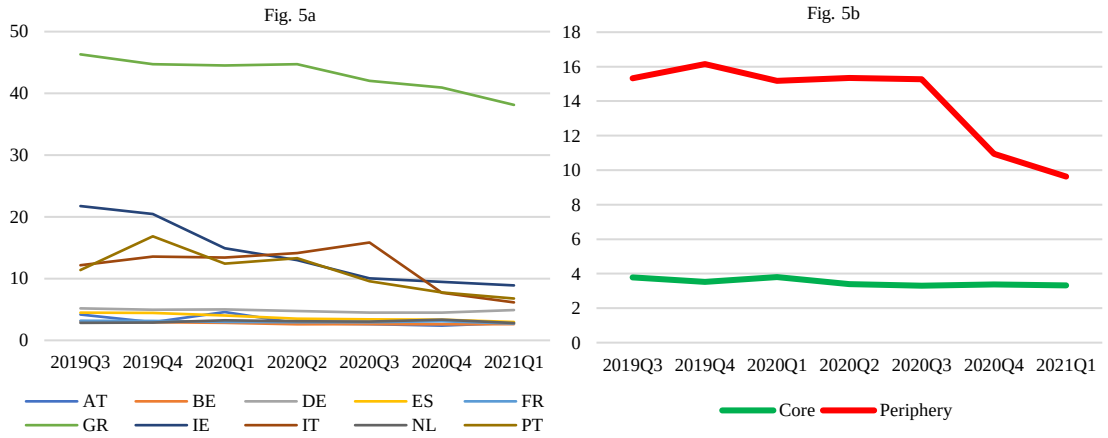


Figure 5 confirms the trends of the post-GFC shock. Moreover, the assumption about NPL ratios for core and periphery banking systems is verified since there is a visible group-specific differential. Interestingly, after the PEPP implementation, the NPL ratios for periphery banking systems decreased, reducing the differential with the core banking systems from an NPL perspective. In the regression, another variable named $NPL\_LVL_{i,t}$ will be employed as it contains the values of the actual quarterly bank-specific NPL ratios, the same values used to calculate the averages in figure 5. $X_{i,t}$ is a vector containing four bank-specific control variables: capitalization ($SOLV_{i,t}$, equity/total assets), liquid assets ($LIQ_{i,t}$, liquid assets/total assets), size ($lnSIZE_{i,t}$, the natural logarithm of banks' total assets in €), and indebtedness ($lnDEBT_{i,t}$, the natural logarithm of banks' total debt in €). These four indicators have been widely used in the existing literature. They can control several banks' characteristics to provide a more precise result about the analysis that this work intends to conduct. The data presented shows that the specific banks' characteristics considerably vary from cross-sections and time-series perspectives. The variable $lnGDP_{i,t}$ denotes the country-specific quarterly GDP, which is correlated with the economic shock caused by the COVID-19 pandemic and relates to NPL trends. Also, in this case, the natural logarithmic transformation will be considered for the same reason mentioned in the banks' total loans, size, and debt. This is a fundamental variable in the model, as the related literature mentioned in the theoretical framework section denoted the relationship between a country's economic outlook and the banks' performance. It will be used as a country-specific control variable since the analysis is focused on the banking system and not on the effects on the total output of a country. The variables η_i and δ_t respectively represent country and time fixed effects. The last element in the specification is $\epsilon_{i,t}$ and denotes the error term.

In the second and main regression specification, the variable $lPEPP_{i,t}$ is introduced as a quantitative variable describing the recursive injections of liquidity from the ECB into the euro area banking systems. Also in this case, its values have been scaled with a natural logarithmic transformation to have a more precise analysis in terms of comparability. $lPEPP_{i,t}$ interacts with the dummy variable NPL_i, to verify

whether the program produced different effects in core and periphery banking systems. As previously indicated, with a proper triple difference-in-differences approach also an interaction between $lPEPP_{i,t}$, NPL_i, and $post2020Q1_t$ should be included. However, from a practical viewpoint, this variable would be highly correlated with the other interactions, hence omitted. This study is intended to draw conclusions on the single "treatments" and combine them without asserting which prevailed. A conclusion based on the triple interaction element in such a short time would be deviant in the author's view. Regarding the collection of the data about the PEPP, the dataset contains the amount of liquidity injected from the ECB within countries and quarters. Since the country-specific data was only available on a bimonthly basis[13] and in million euros, the net purchases have been adjusted quarterly, taking half of the value for those bimesters that contain months belonging to different quarters. This may not be the most precise solution, but it is the closest approximation to the amount injected in a single quarter. The other solution would have consisted of using the total amount of liquidity injected without country distinction. The variable $lPEPP_{i,t}$ is a lagged variable as it is assumed that the liquidity injected from the ECB in a specific quarter does not immediately produce its effects, but banks can benefit from the aid in the future quarters. However, further robustness check withs the natural logarithm of the actual $PEPP_{i,t}$ (not lagged) will be conducted to verify whether the effects have been immediate.

$$y_{i,t} = \alpha + \beta_1 NPL\_LVL_i + \beta_2 * post2020Q1_t * NPL_i + \beta_3 * lPEPP_{i,t} + \beta_4 * lPEPP_{i,t} * NPL_i + \gamma X_{i,t} + \theta lnGDP_{i,t} + \eta_i + \delta_t + \epsilon_{i,t} \quad (2)$$

Table 4: Overview of the variables of interest.

Name	Description	Type
$lnLOANS_{i,t}$	Natural logarithm of bank's net loans and advances to customers in €	Outcome (bank)
$ROAA_{i,t}$	Returns on average assets (net income / total assets)	Outcome (bank)
$post2020Q1_t$	Dummy variable = 1 from 2020Q2, 0 otherwise	1st Treatment
NPL_i	Dummy variable =1 if periphery country, 0 otherwise	Separation
$NPL\_LVL_{i,t}$	NPL ratio (non-performing loans / total gross loans)	Separation
$SOLV_{i,t}$	Solvency ratio (equity / total assets)	Control (bank)
$LIQ_{i,t}$	Liquid assets ratio (liquid assets / total assets)	Control (bank)
$lnDEBT_{i,t}$	Natural logarithm of bank's total debt in €	Control (bank)
$lnSIZE_{i,t}$	Natural logarithm of bank's total assets in €	Control (bank)
$lnGDP_{i,t}$	Natural logarithm of country's GDP-per-capita	Control (country)
$lPEPP_{i,t}$	Lagged variable for the natural logarithm of PEPP in €, one quarter lag	2nd treatment
$PEPP_{i,t}$	Natural logarithm of PEPP in €	2nd treatment
η_i	Country-fixed effects, one dummy for each country	Control (country)
δ_t	Time-fixed effects, one dummy for each quarter	Control (time)

[13] Starting from March 2020, following April-May 2020, June-July 2020 and so on.

Notes: The table reports the name of the variable used in the regression equation, as well as a brief description. In the last column, the role of the variables is explained: "Outcome" stands for the dependent variable, "1st Treatment" and "2nd Treatment" indicate the two events that might have triggered the heterogeneity, which are the critical elements in the difference-in-differences approach. "Separation" stands for the variable that identifies the two countries groups, and "Control" indicates all the control variables.

Table 4 provides an overview of the main variables employed in the regression technique, with a description and the role they play in the regression equation. The testable assumption is that the two groups of countries reacted similarly to the economic shock. The coefficient of interest in specification (1) is represented by β_3 and it will prove whether the heterogeneity in banks' profitability and lending behavior has increased. Moreover, in the second set of regressions, the coefficient β_4 will determine whether the PEPP has helped in reducing the cross-country differences across the two groups, which must be analyzed combined with coefficient β_3. The expected outcome of this specification is that more resilient banking systems (core) do not perform worse in terms of credit behavior and profitability due to the slight modification in the NPL ratios. In opposition, banks in peripheral countries should display a downward shift in their credit supply, combined with lower profitability and higher NPL ratios. If this is the case, the COVID-19 pandemic shock has produced a higher level of heterogeneity across euro area banking systems. Moreover, the coefficient β_4, regarding the impact of the pandemic-related UMP is expected to be positive and significant because the liquidity injected via the PEPP should improve the indicators of banks' performance, and it should also reduce the heterogeneity across the two groups of countries. In fact, due to the influence of PEPP, the coefficient β_3 is expected to decrease both in value and significance. In that case, the coefficients should display the same signs but lower incidence on the profitability and lending behavior after the introduction of PEPP.

Table 5: Summary statistics for each variable of interest.

Variable	Observations	Mean	Standard Dev.	Minimum	Maximum
$lnLOANS_{i,t}$	665	24.360	1.715	17.249	27.559
$ROAA_{i,t}$	665	0.305	1.125	-13.197	3.894
$NPL\_LVL_{i,t}$	665	0.089	0.135	0.000	1.810
$SOLV_{i,t}$	665	0.083	0.087	0.015	0.892
$LIQ_{i,t}$	665	0.249	0.122	0.023	0.722
$lnDEBT_{i,t}$	665	22.886	2.015	17.013	26.484
$lnSIZE_{i,t}$	665	24.982	1.704	20.888	28.595
$lnGDP_{i,t}$	665	26.367	0.896	24.364	27.510
$PEPP_{i,t}$	665	16.767	10.647	0.000	24.734

Notes: The values for the variables are all provided in units, for those expressed in natural logarithm and percentages. The summary statistics of $lPEPP_{i,t}$ are not provided since it is a lagged variable, while the other excluded variables are simply dummy variables. $lnLOANS_{i,t}$ measures the natural logarithm of bank's net loans and advances to customers in €. $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). $NPL\_LVL_{i,t}$ is the non-performing loans ratio (non-performing loans / total gross loans). $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes

the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP. $PEPP_{i,t}$ represents the natural logarithm of the PEPP in €.

In table 5 the descriptive statistics for the variables of interest are presented. From 2019Q3 to 2021Q1, the sample containing the entirety of banks has an average NPL ratio of 8.9%, which is slightly higher with respect to the post-GFC level. The increase may be due to the restriction to few quarters when the COVID-19 pandemic occurred and represent a highly distressed period, while the average 8% NPL during the post-GFC has been measured throughout an entire decade (approximately). Moreover, the measure for banks' debt presents higher volatility than the other variables due to the different levels of indebtedness of the single banks. Lastly, the euro area banks included in the sample display a discrete level of profitability (30.5%), which is a positive performance indicator despite the distressed period. Regarding the variable $PEPP_{i,t}$, its minimum value is equal to 0 because in the first two quarters of analysis (2019Q3 and 2019Q4), the measure was still not in place.

Since this work is intended to prove the cross-country heterogeneity, table 6 provides the descriptive statistics based on the core-periphery separation. This table displays interesting insights about the two country groups, presenting a t-test for each variable to verify whether the difference between the average values per country group is statistically significant. Firstly, even though the amount of net loans and advances is expressed in the natural logarithm transformation, it is possible to see that banks in the core group provide a larger amount of loans. This difference may be explained by the bigger size in the northern countries, as the variable $lnSIZE_{i,t}$ denotes. To substantiate this statement, the average total net loans and advances in € and the total assets in € are presented in table A.2, confirming what has been described. Moreover, the differences across the two groups are statistically significant, both for loans and banks' size. Regarding banks' profitability, there is a sizable discrepancy throughout the analyzed period. While banks in core countries register an average ROAA of 36.4%, periphery banks are performed worse, with an average ROAA of 25.1%. Contrary to the case of the loans, the difference between the two groups is not statistically significant. Another key indicator is the variable that identifies the core and periphery groups, which is the NPL ratio level. The difference is substantial and statistically significant, with periphery banks registering an average NPL ratio four times higher than that of core countries (14% versus 3.5%). Concerning the bank-specific control variables, there are differences, mainly about the solvency ratio, indebtedness, and size, which display larger average statistics for core countries. Lastly, the average quarterly GDP in the core countries is larger, while the amount of liquidity injected with the PEPP does not significantly differ between the two groups, as proven by the low t-score. Again, the data about banks' total debt, country's quarterly GDP, and the quarterly injection of liquidity with the PEPP program can be evaluated in table A.2, confirming the results obtained in table 6.

Table 6: Average values for each variable of interest, based on the core-periphery division.

Variable	Core	Periphery	t-score	p-value
$lnLOANS_{i,t}$	24.720	24.022	5.353	0.000***
$ROAA_{i,t}$	0.364	0.251	1.294	0.196
$NPL\_LVL_{i,t}$	0.035	0.140	-10.853	0.000***
$SOLV_{i,t}$	0.080	0.086	-0.982	0.326
$LIQ_{i,t}$	0.277	0.222	5.943	0.000***
$lnDEBT_{i,t}$	23.705	22.106	11.099	0.000***
$lnSIZE_{i,t}$	25.452	24.540	7.159	0.000***
$lnGDP_{i,t}$	26.639	26.111	7.929	0.000***
$PEPP_{i,t}$	16.834	16.704	0.158	0.875***

Notes: The values for the variables are all provided in units, not in %. The t-test is conducted at a 95% confidence level and is constructed as follows: the average value for the periphery country group is subtracted to the average value for the core country group. Therefore, if the t-score is positive (negative), the average value for the core group is superior (inferior) to that of the periphery group. The p-value follows the null hypothesis, which considers the average values of the two groups being equal, thus the difference being equal to 0. Significance levels: *** $p < 0.001$, ** $p < 0.05$, * $p \leq 0.1$.

V. Results

This section presents the main results from the empirical analysis and is divided into three subsections. In the first and second, the impact of the COVID-19 shock and the ECB's PEPP on the two dependent variables is analyzed; lastly, a series of robustness checks are run to verify the consistency of the regression outcomes. Overall, the regressions for both dependent variables and events[14] are implemented as follows: the first (1) is a basic analysis and considers the treatment in the periphery countries group (coefficient of interest), together with the impact of the NPL level and the influence of the event alone. The following regressions are more detailed, and they include bank-specific control variables and fixed effects alone (2), the addition of country fixed-effects only (3), the addition of time fixed-effects only (4), all the mentioned fixed-effects (5), and the addition of the country-specific quarterly GDP (6). In the second subsection, another interaction term will be integrated and will measure the impact of the PEPP. Following this approach, the analysis should capture any hidden effect in the panel data. In the robustness checks section, the specification will be modified to verify whether the findings are consistent. Table 7 presents the general structure of the regressions for the three sub-sections.

Table 7: Structure of the regressions implemented for both dependent variables and events.

Regression	(1)	(2)	(3)	(4)	(5)	(6)
Basic diff-in-diff	YES	YES	YES	YES	YES	YES
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Quarterly GDP						YES

[14] The two dependent variables refer to banks' lending behaviour and profitability. The two events are the treatments in the regression, hence, the outbreak of the COVID-19 and the implementation of the PEPP.

Impact of the COVID-19 shock

Table 8 displays the results for the regression regarding the effects of the COVID-19 shock on banks' lending behavior. Here the dependent variable $y_{i,t}$ is $lnLOANS_{i,t}$ represents the natural logarithm of net loans and advances to customers in euro bank i in quarter t.

Table 8: Impact of the COVID-19 shock on banks' lending behavior.

Dependent variable	$lnLOANS_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$post2020Q1_t$	0.087	-0.046**	-0.046**	-0.099***	-0.099***	-0.081***
	(0.165)	(0.018)	(0.018)	(0.032)	(0.032)	(0.029)
$NPL\_LVL_{i,t}$	-4.323***	-0.504***	-0.504***	-0.535***	-0.535***	-0.535***
	(0.571)	(0.118)	(0.118)	(0.115)	(0.115)	(0.116)
$post2020Q1_t * NPL_i$	-0.276	0.009	0.009	0.003	0.003	0.003
	(0.174)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
$SOLV_{i,t}$		-3.299**	-3.299**	-3.496**	-3.496**	-3.494**
		(1.590)	(1.590)	(1.627)	(1.627)	(1.625)
$LIQ_{i,t}$		-0.770***	-0.770***	-0.734***	-0.734***	-0.735***
		(0.180)	(0.180)	(0.171)	(0.171)	(0.171)
$lnDEBT_{i,t}$		0.037**	0.037**	0.023	0.023	0.023
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
$lnSIZE_{i,t}$		0.706***	0.706***	0.762***	0.762***	0.762***
		(0.104)	(0.104)	(0.099)	(0.099)	(0.100)
$lnGDP_{i,t}$						-0.022
						(0.134)
Bank FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.130	0.996	0.996	0.996	0.996	0.996

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of banks' net loans and advances to customers in €. The variable $post2020Q1_t$ is a dummy variable denoting the pre-and post-COVID-19 period. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

The basic regression in the first column returns a negative, but not statistically significant coefficient for the treatment effect, which is denoted by the interaction between the dummy variable indicating if a country belongs to core or periphery group (NPL_i) and the dummy variable representing the post-COVID-19 outbreak ($post2020Q1_t$). Interestingly, while the effect of COVID-19 alone indicates an irrelevant influence on the percentage change in outstanding loans and advances to customers, the impact of the banks' specific NPL level is highly significant and has a negative influence. In economic

terms, the value of -4.323 indicates that a unit increase in the NPL produces an average decrease by more than 4% on banks' loans since the dependent variable is expressed as a natural logarithm. However, these results do not allow to draw any representative conclusion, given that many variables are omitted, and the model returns a low R^2. Once the bank-specific controls and fixed-effects are included, the model suits the analysis more precisely. In particular, the coefficient on the interaction term is barely positive but not statistically significant, meaning that no inference can be drawn regarding the heterogeneity between core and periphery countries in terms of lending behavior. The banks' capitalization (solvency ratio) and liquid assets (liquid assets ratio) negatively influence the credit supply for the banks in the entire sample. In contrast, their size produces the opposite effect. All the coefficients are statistically significant at a 95% confidence level. In addition, also the coefficient describing the impact of banks' NPL on loans and net advances is still statistically significant but reduced to an approximate value of -0.5. Lastly, the effect of COVID-19 alone, with no distinction between core and periphery banks, turns negative and statistically significant. These results hold for all the remaining regressions, with similar estimated coefficients when country and time fixed-effects are introduced, as well as for the country-specific GDP.

The outcome of the analysis suggests that the COVID-19 pandemic might have triggered an overall negative effect on the credit supply in the euro area without spreading the differentials between core and periphery banks in terms of lending behavior. These results are in line with Huljak et al. (2020) and the literature related to the negative role of NPLs on the soundness of a banking system and the ability to lend to the real economy. The combined effect of the pandemic and core-periphery division is not statistically significant, and this may be due to the time-limitedness of the sample. In the research conducted in Brissimis et al. (2010), Ciccarelli et al. (2013), and Burriel et al. (2018), the authors verify the considerable impact of the GFC shock in the heterogeneity on the credit supply between core and periphery banking systems over several years and (as shown in figure A.3). They discovered a considerable contraction in the lending supply of periphery banking systems after various quarters from the outbreak of the GFC (almost three years). This work is constrained to analyze the short-term impact of the pandemic. However, since the core banks have registered lower average NPL levels than banks in periphery countries throughout the analyzed time frame, the reduction in credit supply is expected to be more sizable for the latter group indicating possible heterogeneity. Lastly, a remarkable observation must be made: these results are driven by the bank-specific variables and fixed-effects, as they return statistically significant results in almost all the regressions. This implies that the COVID-19 outbreak alone does not explain the differentials in credit supply in the pre-and post-shock period. The characteristics of a financial institution, such as capitalization, size, indebtedness, liquidity, or quality of loans (in terms of NPL), define how the banks perform in terms of lending behavior, even in financially distressed times. The importance of banks' characteristics in shaping the banks' lending behavior was already expressed by several works studying the impact of the GFC. Among the many, Gambacorta et al. (2011) concluded that banks' business models considerably impacted the credit supply

in the post-shock period. In particular, balance sheet items such as short-term funding and securitization activity or bank capital (measured using the Tier I ratio) determine the loans supply shifts. Therefore, in terms of banks' characteristics, table 8 confirm what has already been discovered from existing literature.

The impact of the COVID-19 on banks' profitability is analyzed in table 9. In this case, the dependent variable $y_{i,t}$ is $ROAA_{i,t}$, which labels the banks' return on average assets as a ratio between net income and total assets of bank i in quarter t.

Table 9: Impact of the COVID-19 shock on banks' profitability.

Dependent variable	$ROAA_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$post2020Q1_t$	-0.352***	-0.137	-0.137	-0.217*	-0.217*	-0.280**
	(0.101)	(0.083)	(0.083)	(0.116)	(0.116)	(0.118)
$NPL\_LVL_{i,t}$	-3.501***	-5.988***	-5.988***	-6.084***	-6.084***	-6.143***
	(1.161)	(0.982)	(0.982)	(0.904)	(0.904)	(0.884)
$post2020Q1_t * NPL_i$	0.092	-0.284**	-0.284**	-0.297**	-0.297**	-0.367***
	(0.115)	(0.121)	(0.121)	(0.118)	(0.118)	(0.141)
$SOLV_{i,t}$		19.568***	19.568***	19.201***	19.201***	19.374***
		(5.121)	(5.121)	(5.212)	(5.212)	(5.219)
$LIQ_{i,t}$		-0.654	-0.654	-0.703	-0.703	-0.736
		(0.720)	(0.720)	(0.775)	(0.775)	(0.783)
$lnDEBT_{i,t}$		0.116	0.116	0.076	0.076	0.061
		(0.112)	(0.112)	(0.113)	(0.113)	(0.113)
$lnSIZE_{i,t}$		0.491	0.491	0.672*	0.672*	0.615
		(0.407)	(0.407)	(0.404)	(0.404)	(0.405)
$lnGDP_{i,t}$						-2.244*
						(1.353)
Bank FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.182	0.614	0.614	0.628	0.628	0.631

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). The variable $post2020Q1_t$ is a dummy variable denoting the pre-and post-COVID-19 period. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

The first column refers to the basic regression. Again, the difference-in-differences coefficient, i.e., the interaction between the treated group and post-COVID-19, is not statistically significant, whereas both the economic shock and the level of a bank's NPL significantly reduce its profitability. In order to improve the model, the bank-specific control variables and fixed-effects are included in the second

regression, and they produce appealing results based on the assumptions made. As in the case of the credit supply, banks' profitability is highly influenced by the NPL level, where a unit increase produces an approximate reduction of the ROAA by 6%. This reflects the importance of the NPL management to achieve better profitability and reveals a profound disparity between the two country groups, given the different average NPL ratios between 2019Q3 and 2021Q1 presented in table 5. However, differing from the credit supply results and in line with the assumptions made in the methodology section, the difference-in-difference coefficient confirms the heterogeneity across core and periphery banking systems. The interaction term is negative and statistically significant at a 95% confidence level, meaning that banks in periphery countries suffer more than those in core countries in terms of profitability. Together with the coefficient on the variable $NPL\_LVL_{i,t}$, the interaction term verifies the assumption that an economy-wide shock determines a discrepancy in the loss of profitability between the two country groups. Another noticeable result is the coefficient related to the solvency ratio, which is highly positive and significant, meaning that banks with higher capitalization produce higher returns on average assets. This finding confirms the positive relationship between bank capitalization and profitability estimated in Cheng (2015). A possible reason is provided in Breger (1995) that shows that banks with higher capital ratios tendentially have lower funding costs, hence, larger profitability margins. Similarly, other related papers confirm these findings and agree on the positive influence of banks' capitalization. By including the country fixed-effects in regression 3, the results do not substantially change. When considering time fixed-effects only in regression 4, and then all control variables and fixed effects in regression 5, also the variable related to the outbreak of the COVID-19 ($post2020Q1_t$) and the banks' size obtain some explanatory power. This means that the impact of the economic shock alone is negative and statistically significant, partially explaining the losses in banks' balance sheets. Regarding the size variable, bigger banks seem to be more profitable than smaller banks. As shown in table 3, the biggest banks in the sample are concentrated among core countries and, therefore, this confirms that there is a gap with banks in periphery countries due to their smaller size, increasing the heterogeneity in profitability between the analyzed banking systems. To conclude, the last regression shows a higher explanatory power of variable $post2020Q1_t$, and the incidence of the country-specific quarterly GDP.

By looking at the regression outcomes in table 9 and comparing them to the existing literature, two remarkable aspects are verified: first, the NPLs management is a crucial component that defines the profitability of a bank, as in the case of the credit supply; secondly, when an extraordinary event as the COVID-19 pandemic produces an economic shock, not only the profitability of banks is negatively impacted, but also the heterogeneity between financially distressed and non-financially distressed banking systems increases. This is a fundamental result in congruence with the assumption that COVID-19 widened the cross-country differentials from a banking system profitability perspective in the short term. This does not happen for the credit contraction. As the regressions show, the ROAA of banks headquartered in Greece, Ireland, Italy, Portugal, and Spain have been impacted more severely than the more resilient banks in Austria, Belgium, France, Germany, and the Netherlands. As mentioned, this is

also proven by the negative coefficient on the variable $NPL\_LVL_{i,t}$ and the difference in the size of the banks operating in those countries.

Impact of PEPP

The focus of this subsection shifts from the impact of the COVID-19 pandemic alone to the combined effects of the emergency monetary policy adopted by the ECB in response to the economic shock. As anticipated, the regressions will have an analogous structure. However, the statistical method used here is similar to a triple difference-in-differences approach, with the omission of the triple interaction term. The reason for implementing such a method lies in the presence of two "treatments": the outbreak of the pandemic and the implementation of the PEPP. Therefore, the two coefficients of interest will be based on the following variables: firstly, the interaction between the dummy variable defining core and periphery banks based on the NPL classification and the dummy variable indicating the pre-and post-COVID-19 shock ($post2020Q1_t * NPL_i$); secondly, the interaction between the dummy identifying the country group and the lagged variable for the natural logarithm of PEPP in €. This last element is denoted as $lPEPP_{i,t} * NPL_i$ in tables 10 and 11 will be fundamental to verify whether the heterogeneities caused by the pandemic, as highlighted in the previous sub-section, have been reduced to some extent with the UMP. A vital aspect of this set of regressions is the decision to use a lagged variable for the PEPP since it is assumed that the effects are not produced in the same quarter in which the liquidity is injected into the banking systems.

Table 10: Impact of PEPP on banks' lending behavior.

Dependent variable	$lnLOANS_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-4.463***	-0.502***	-0.502***	-0.540***	-0.540***	-0.541***
	(0.647)	(0.118)	(0.118)	(0.117)	(0.117)	(0.117)
$post2020Q1_t * NPL_i$	3.790	-1.093***	-1.093***	-1.025***	-1.025***	-1.033***
	(3.512)	(0.326)	(0.326)	(0.313)	(0.313)	(0.322)
$lPEPP_{i,t}$	0.032	-0.032***	-0.032***	-0.021*	-0.021*	-0.021*
	(0.117)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
$lPEPP_{i,t} * NPL_i$	-0.173	0.047***	0.047***	0.044***	0.044***	0.044***
	(0.151)	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)
$SOLV_{i,t}$		-3.286**	-3.286**	-3.495**	-3.495**	-3.490**
		(1.569)	(1.569)	(1.612)	(1.612)	(1.608)
$LIQ_{i,t}$		-0.739***	-0.739***	-0.709***	-0.709***	-0.710***
		(0.174)	(0.174)	(0.168)	(0.168)	(0.168)
$lnDEBT_{i,t}$		0.037***	0.037***	0.026*	0.026*	0.025*
		(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
$lnSIZE_{i,t}$		0.716***	0.716***	0.755***	0.755***	0.754***
		(0.102)	(0.102)	(0.099)	(0.099)	(0.099)
$lnGDP_{i,t}$						-0.052
						(0.134)

Bank FE		YES	YES	YES	YES	YES
Time FE			YES		YES	YES
Country FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.132	0.996	0.996	0.996	0.996	0.996

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of bank's net loans and advances to customers in €. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Following the structure presented in the precedent sub-section, the banks' lending behavior is primarily analyzed. The first column represents the basic specification and estimates the effects of both COVID-19 and PEPP without considering control variables and fixed effects. The two coefficients of interest do not offer insightful findings, and the single variable related to the implementation of the PEPP in lagged natural logarithm terms does not have a relevant influence. The only statistically significant regressor is $NPL\_LVL_{i,t}$, which harms the lending behavior of the banks in the whole sample. Again, this represents a first indicator of heterogeneity since the average NPL levels in the two country groups have been different, with core countries displaying better risk management regarding loan quality. By introducing the bank-specific control variables and fixed-effects in the second specification, both the precision of the model and the estimations provide noteworthy results. Regarding the impact of the COVID-19 shock, the coefficient on the first interaction term assumes a statistically significant and negative value (-1.093), in opposition to the same coefficient in the second regression in table 8. This means that the model including the pandemic-related UMP displays different credit supply trends between core and periphery countries due to the outbreak of COVID-19, while in the previous specification, the divergencies were not relevant. The coefficient validates the assumption that the pandemic has increased heterogeneity across core and periphery banking systems due to the different NPL levels. Hence, the latter group is experiencing a broader contraction in its loans supply. Regarding the coefficient of interest on the interaction term $lPEPP_{i,t} * NPL_i$, the regression produces a positive and statistically relevant value which is in line with the assumption that the PEPP should be aiming at reducing the divergencies across countries in order to adopt a homogeneous monetary policy and ensure the stability of the European economy. In this sense, the positive value should be interpreted as more extensive support for periphery banks' credit supply, which reduces the heterogeneity with the core banks. This result makes economic sense: if the cross-country differentials have been triggered by the shock, with distressed countries experiencing a more tightening credit supply, the monetary policy

should be directed more towards the distressed countries, and in this specific case, it should aim at boost bank lending. Additionally, the coefficient on the NPL level is still negative and statistically significant. However, it is reduced from -4.463 to -0.502, implying that the banks' loans are less dependent on the level of NPLs. The effect of the PEPP alone is negative and statistically significant. However, it will assume a reduced value in the further regressions and have lower explanatory power. Regarding the bank-specific control variables, they are all statistically significant at a 99% confidence level and, in specific, banks' capitalization and liquidity of the assets produce a negative effect on the credit supply, while indebtedness and size boost bank lending. These findings hold in all the other regressions, with the only difference that the coefficients on banks' capitalization and indebtedness level lose explanatory power. The existing literature on the role of bank-specific variables on loans supply presents contrasting opinions. Generally, in long-term studies, the increase in lending is positively associated with the level of liquidity, but only for large banks, and capital exerts a positive effect on lending only if banks possess a large percentage of liquid assets (Kim et al., 2017). However, the results obtained in table 10 are based on short-term analysis. The sign of the coefficients may not represent the actual effects of these banks' characteristics. Interestingly, by including time fixed-effects only, all controls and fixed-effects, and finally, the country-specific quarterly GDP, the interaction variables are still highly significant and keep similar values. Lastly, the effect of the natural logarithm of the GDP is negative but not statistically significant.

Table 10 provides two results in line with the assumptions made in the methodology section. Firstly, the banks operating in periphery countries have been more severely hit, and, therefore, they have registered a significant contraction in bank loans. The regression result finds confirmation in the data since the credit contraction during the GFC and the post-pandemic period has been more prominent for periphery countries. The NPL level marks this difference and decreases the supply, but the impact has been more pronounced for the distressed banking systems when considering the interaction term. This finding runs counter the literature on the effects of an economic shock in the credit supply since there should be no or little short-term influence. However, introducing the monetary policy measure in the specification might have improved the explanation of the determinants of the banks' loans fluctuations, displaying an immediate short-term effect. Secondly, the interaction term between the implementation of PEPP and the dummy variable defining the two country groups returns a positive and statistically significant coefficient, validating the starting assumption. As anticipated in the empirical framework section, two of the priorities of the UMPs implemented by the ECB are to create a homogeneous economic environment and avoid a credit crunch, which can be partly achieved by injecting considerable amounts of liquidity in the European banking systems. This process started after the GFC and is still ongoing, with already existing programs and the PEPP. Since periphery countries are considered more distressed, both from a real and bank-specific perspective, the differentials should be addressed by providing more financial support to this country group. While this occurred in the years following the GFC, the PEPP is a distribution program based on the capital key contribution of each country to the

ECB's capital. However, these purchases have been conducted flexibly, without a substantial difference between the overall liquidity injected in the two groups, and periphery banks seem to have benefitted more throughout the whole time frame. This contrasts what happened in the years following 2008, according to Asimakopoulos et al. (2018), who find that core banks have benefitted more than periphery banks from the crisis[15].

The last regression set is presented in table 11 and analyzes the impact of PEPP on banks' profitability.

Table 11: Impact of PEPP on banks' profitability.

Dependent variable	$ROAA_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-3.525***	-5.924***	-5.924***	-6.202***	-6.202***	-6.250***
	(1.241)	(0.970)	(0.970)	(0.892)	(0.892)	(0.878)
$post2020Q1_t * NPL_i$	-0.897	0.355	0.355	0.701	0.701	0.344
	(3.133)	(2.097)	(2.097)	(2.057)	(2.057)	(2.143)
$lPEPP_{i,t}$	-0.072**	-0.046	-0.046	0.106	0.106	0.093
	(0.035)	(0.048)	(0.048)	(0.079)	(0.079)	(0.080)
$lPEPP_{i,t} * NPL_i$	0.042	-0.028	-0.028	-0.042	-0.042	-0.030
	(0.131)	(0.087)	(0.087)	(0.086)	(0.086)	(0.088)
$SOLV_{i,t}$		19.707***	19.707***	18.690***	18.690***	18.898***
		(5.184)	(5.184)	(5.184)	(5.184)	(5.207)
$LIQ_{i,t}$		-0.660	-0.660	-0.651	-0.651	-0.682
		(0.717)	(0.717)	(0.790)	(0.790)	(0.799)
$lnDEBT_{i,t}$		0.100	0.100	0.076	0.076	0.062
		(0.109)	(0.109)	(0.112)	(0.112)	(0.111)
$lnSIZE_{i,t}$		0.593	0.593	0.614	0.614	0.562
		(0.421)	(0.421)	(0.411)	(0.411)	(0.413)
$lnGDP_{i,t}$						-2.166
						(1.366)
Bank FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.183	0.615	0.615	0.629	0.629	0.632

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's

[15] As mentioned in several parts of this section, the analysis has a short-term horizon. In the existing papers it extends for multiple years, creating a discrepancy between the results. This might explain the outcome of the regression specification.

total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Starting with the first column, two elements have a relevant influence on banks' profitability throughout the seven quarters in the analysis. Consistently, a negative and statistically significant coefficient on the variable $NPL\_LVL_{i,t}$ is returned, highlighting the importance of having low NPL levels in order to achieve better profitability margins. The second statistically significant coefficient is related to the lagged natural logarithm of the PEPP only, which assumes a negative value and indicates that the country-specific liquidity injected in each quarter has diminished banks' profitability. Although the negative influence, this model is again too basic to infer relevant conclusions. Additionally, both the coefficients of interest are not empirically relevant, which does not indicate the country groups' heterogeneity developments. Therefore, in the second column, the bank-specific control variables and fixed effects have been added. From regression (2) to (6), the results are relatively consistent. The essential finding is that neither the interaction between the outbreak of COVID-19 and the country-group dummy variable nor the interaction between the same dummy variable and the implementation of the PEPP produce statistically significant results. Hence, when they are both employed to analyze the banks' profitability, their effect on the ROAA cancels out, removing the heterogeneity created by the COVID-19 alone, as seen in table 9. The only two factors that impact the banks' profitability are inherent to their core businesses: NPL level and solvency ratio. On the one hand, the NPL findings are consistent with table 9 and display a highly negative coefficient, indicating that their profitability is considerably lower if banks keep having high NPLs. This is the only indication that banks in the periphery countries have been more hit in the presence of such an emergency event due to higher levels of NPLs, as shown in the empirics. On the other hand, the bank's capitalization is positively related to the banks' ROAA, as discussed in the previous subsection and in line with Breger's (1995) and Cheng's (2005) studies. In opposition, the other bank-specific control variables and the country-specific quarterly GDP seem not to have produced relevant effects on the banks' profitability included in the sample.

These findings do not satisfy the initial assumptions regarding the increase in differentials due to the pandemic and their reduction with the adoption of the extraordinary monetary policy measures. Hence, the combined effect of COVID-19 and policy implementation appears not to influence banks' profitability. However, the second interaction term provides a result in line with the existing literature. The paper on which this dissertation is inspired, Kenourgios et al. (2019), examines the ECB's unconventional monetary policy and bank supply and performance in the euro area. In this paper, the authors infer that the UMPs adopted in the years following the GFC-shock display either a very weak or no impact on banks' profitability. Similarly, Brissimis et al. (2010) suggest that a parametric model shows no effect of the monetary policy on banks' profits. In the author's view, a financial institution's profitability is not significantly affected by a monetary policy intervention for two reasons. Firstly, the ability of a bank to have positive profit margins is more related to the business model and strategies that

the bank itself implements. Moreover, as discussed in the empirical framework section, the goals of a monetary policy are more oriented towards general economic stability. While one of the main objectives related to the liquidity injections with programs such as the APP and the PEPP is to boost bank lending to ensure a fast economic recovery, the banks' profitability relies more on the ability of the employees to make the business profitable even in distressed times, with the provision of loans, the launch of innovative products and at the same time the minimization of the losses. Therefore, while it has been found that PEPP had a positive impact on periphery countries' credit supply, in line with the mentioned goals, the banks' profitability margins might not have been impacted by both events, and the group differentials remained unaltered. Additionally, if there would be an influence in this last regression, the negative impact of the COVID-19 outbreak might be counterbalanced by the positive effect of the PEPP.

Robustness checks

The last sub-section presents a series of robustness tests to verify whether the results are consistent with modifications in the methodology exploited to perform the analysis. Since the heteroskedasticity in the results errors has already been accounted for using robust standard errors, the robustness tests will consist of mere modifications of the regression specification.

The first test refers to the assumption made in the regression equation (2), where a lagged variable for the PEPP has been used as a regressor due to the non-immediate effect of the monetary policy in the same quarter of implementation. The exact specification will be employed to verify whether the quarter-lag has improved the results, but it will be using a non-lagged variable for the PEPP. Hence, in this robustness test, the pandemic-related UMP is assumed to produce an instant effect on lending behavior and profitability of the banks in the sample. The regression outcomes can be found in tables A.3 and A.4. Concerning the triple difference-in-differences approach on the banks' lending behavior, there is a discrepancy when the non-lagged variable is employed. By looking at the interaction terms in table A.3, they are both not statistically significant, in opposition to what has been found in table 10. This result shows the importance of using the lagged variable since the original specification can capture the increase in the heterogeneity between core and periphery banking systems due to the outbreak of COVID-19 and the beneficial effect that the ECB's PEPP has had on the more distressed banking systems. In turn, when using a non-lagged variable, the credit supply decline and the liquidity injected with the PEPP program are not captured by the model, producing any statistically significant effects. Given that the data shows a change in the amount of liquidity injected and the credit supply, the non-lagged PEPP variable does not provide a realistic picture of the event series during the post-COVID-19 quarters. The coefficient on the NPL level assumes similar values and is always statistically significant, while the bank-specific control variables maintain the same effects on the loans supply, with an identical explanatory power in each regression as in table 10. In table A.4, the non-lagged PEPP variable is utilized to verify the effects on banks' profitability. The results do not substantially differ from the ones

obtained when the lagged variable is employed. Again, the two interaction terms do not influence the banks' ability to make a profit. The only statistically significant coefficients refer to the variables $NPL\_LVL_{i,t}$ and $SOLV_{i,t}$, which respectively have a negative and positive impact on the ROAA. The difference with table 11 is that the coefficient on the variable $PEPP_{i,t}$ turns positive and statistically significant when time-fixed effects are introduced, as well as for regressions (5) and (6). This may indicate an immediate favorable effect of the UMP on the banks' ROAA, but the percentage change is low. Moreover, the country-specific quarterly GDP coefficient has some explanatory power, but no relevant conclusion can be drawn on its influence on the profitability of single banks. In sum, the author's view is confirmed: a bank's profitability does not primarily depend on the amount of liquidity injected by the ECB with its UMPs. The business model and strategies adopted by the bank define the bank's profits, especially in financially distressed times. Again, this conclusion is compatible with the ECB's objectives, oriented towards economic stability achievable by boosting bank lending. In this context, the bank's profitability can be seen as a consequence of its resilience to economic downturns, and the resilience itself may be related to the effective management of the liquidity provided by the central bank.

The second set of tests run in this sub-section refers to constructing the specification equations to capture the heterogeneity changes. Equation (1) analyzes the impact of the COVID-19 pandemic, while the second refers to both COVID-19 and the PEPP implementation. One way to prove whether the results regarding the introduction of the emergency monetary policy are consistent with the effects on lending behavior and profitability in the second specification is to use a difference-in-differences approach that only takes into consideration the implementation of the UMP and validate whether this diminished the heterogeneity across core and periphery countries. In other words, only the interaction between the lagged natural logarithm of the PEPP and the dummy variable defining the country group will be employed. The results are visible in tables A.5 and A.6. Concerning the lending behavior, the interaction term assumes a null value, and it is statistically irrelevant, as for the interaction between COVID-19 and the country dummy variable (table 8). This finding confirms that, in order to validate the assumptions about the increasing and decreasing heterogeneity between core and periphery countries, both events should be considered as in table 10. The variable $PEPP_{i,t}$ alone is not statistically significant, as well as the coefficient on the country-specific quarterly GDP. Coherent with the triple difference-in-differences regression, the bank-related variables[16] have some explanatory power, with a negative impact caused by banks' NPL levels, capitalization and amount of liquid assets, and a positive correlation with their size. With regard to banks' profitability, the results are majorly consistent with table 11 that shows the highly significant influence of NPL level and banks' capitalization to explain the modifications in the ROAA measurement. However, as visible in table A.6, the coefficient of interest

[16] NPL level, solvency ratio, liquidity ratio, indebtedness (even though its explanatory power vanishes in regressions (4) to (6)), and size.

becomes more statistically significant after bank controls and fixed effects are added. The negative values imply that periphery banking systems have performed worse than the core due to the PEPP implementation. The reliability of this result must be confronted again with the causes of profitability fluctuations, which the author believes to be intrinsic in the bank business model. Altogether, the outcome of this second robustness check confirms the importance of the joint study of COVID-19 and PEPP implementation to draw reliable conclusions for both lending behavior and profitability. The only relevant difference in using a single difference-in-differences approach is the negative impact of the PEPP on banks' profitability, which is not to be intended as a remarkable discovery due to the omission of the COVID-19 "treatment". Finally, considering the implementation of an emergency policy without including the event that caused the shock would not be explanatory.

The third robustness check involves using clustered standard errors on a country level to verify whether the results vary due to the correlation of some variables at a country level, given the similarities across countries belonging in core or periphery groups. By clustering standard errors, one expects to capture a different effect of both occurrences, with a reduced impact for COVID-19 and PEPP since these differentials are accounted for. This test is run for regression equation (2), as it provides the final result. The findings in table A.7 are comparable to those in table 10. The only difference is the statistical significance of the two interaction terms, which is reduced. This implies that when the standard errors are clustered, the effect of both events on banks' credit supply is less explanatory. It makes economic sense given the similarities across the countries that belong to a specific group. The change in the explanatory power of banks' capitalization and indebtedness are not economically relevant to infer different conclusions. The banks' profitability is analyzed in table A.8 and does not display any change from table 11.

A further test involves the use of specification (2) without considering banks headquartered in Greece. Greek banks have registered extreme levels in the majority of the bank-related variables. In this analysis, especially in the NPL levels, which have been disproportionately higher than those in periphery countries. Therefore, the aim of these checks is twofold: first, it aims at verifying whether the results found in tables 10 and 11 are consistent even with the elimination of this outlier. Second, it is used to evaluate whether the statistically significant coefficient on the variable $NPL\_LVL_{i,t}$ for both dependent variables still have an influence even if the highest-NPL banks are excluded from the sample. When looking at tables A.9 and A.10, the regression outcomes confirm the findings previously obtained. There are no modifications in the regression coefficients, confirming the robustness of the results in terms of heterogeneity.

The last robustness test aims to analyze the single country groups, thus without using a difference-in-differences approach. Therefore, these regressions will evaluate the impact of both events and the other variables included in the previous specifications without distinguishing between country groups. Therefore, the effect of COVID-19 will be analyzed only with the dummy variable $post2020Q1_t$. In the first analysis, only the banks belonging to the core banking group are evaluated, while in the second,

the periphery banks will be chosen as the subject of assessment. This last set of robustness checks will also substantiate the primary role of the NPL level on banks' credit supply and profitability for periphery banks, fundamental to define the two country groups. Tables A.11 and A.12 present the regression outcomes for the core banks. Concerning their credit supply, banks seem only to be affected by their capitalization and amount of liquid assets (negatively), while their size has a positive influence. In the author's understanding, core banking systems are resilient and do not drastically respond to economic shocks as the periphery ones. The same can be inferred about the core banks' profitability, where the only influential element is bank capitalization. These results can be compared to periphery countries presented in tables A.13 and A.14. In the case of loans supply, other than liquid assets ratio, bank indebtedness, and size, the NPL level has a negative and highly statistically significant coefficient for all the regressions. By looking at the banks' ROAA, the same variable plays again a relevant role in defining banks' profitability, together with the capitalization and size. Moreover, the variables $post2020Q1_t$ and $lPEPP_{i,t}$ have some explanatory power, with the first registering a negative coefficient, while the impact of the second is positive. However, this linear regression cannot be explicitly considered precise as the regression equation (2).

Altogether, these robustness checks have confirmed the validity of the methodology employed in this dissertation. Specifically, using a lagged variable for the PEPP's liquidity injections proved to be more adapted in a crisis since the effects on the credit supply cannot be immediately visible. Employing a regression equation that only considers the impact of PEPP does not provide the complete picture of the series of events that triggered the modifications in the two dependent variables. Clustering the standard errors on a country level seems not to affect the regression outcomes. The elimination of the outliers (Greek banks) does not modify the results. Lastly, the core-periphery separation based on the different NPL levels is supported by the data on the average values for the country groups and the last set of robustness checks.

VI. Conclusions

During the post-GFC years, the heterogeneity across euro area countries and their banking systems has been identified as one of the main weaknesses of the EMU, and it has posed several threats to the single monetary policy adopted by the ECB. With the outbreak of the COVID-19 pandemic, the European economy finds itself in a similarly distressed situation, with a considerable output loss and increasing unemployment rates. The same patterns are reflected in the countries' banking systems. However, this situation might have triggered wider cross-country differentials depending on the banking system's pre-existing (in)stability. Therefore, this paper analyzes the impact of the COVID-19 pandemic, as first, and of the PEPP on the euro area banks' heterogeneity, with a specific focus on the banks' profitability and lending behavior. The paper's research question is: *how did the COVID-19 pandemic and subsequently the ECB's PEPP shape the heterogeneity amongst European countries in terms of banks' lending behavior and profitability?*

To answer this research question, a comprehensive dataset has been constructed. It contains quarterly data relative to bank-specific characteristics, liquidity injections under the PEPP, and country-specific GDP throughout a seven-quarters time frame, between 2019Q3 and 2021Q1. The dataset comprises 95 banks headquartered in 10 euro area countries and involves a core-periphery division, based on the average NPL level of the banks per country. Given the already persistent heterogeneity between the core and periphery countries regarding NPLs, credit supply, and profitability in the post-GFC years, the significant hypotheses on which the thesis is based are two. First, the outbreak of the COVID-19 pandemic from an economic perspective caused an increase in heterogeneity. Second, the implementation of the PEPP program in response to the financially distressed period reduced the impact of the shock in terms of country-group heterogeneity. To perform this analysis, a difference-in-differences estimation technique has been adopted. The first regression specification includes an interaction term between the variable indicating the period following the COVID-19 outbreak and the dummy variable specifying the bank's country-group. The second regression includes an additional interaction term between the same dummy variable and the regressor indicating the lagged natural logarithm of the liquidity injected via the PEPP quarterly and divided per country. In this case, the estimation technique resembles a triple difference-in-difference approach as in Olden et al. (2020). The coefficients on both interaction terms become relevant to explain the heterogeneity level across core and periphery countries.

The results of this study can be divided into two scenarios based on the regression specifications that have been used. First, the assessment of the impact of COVID-19 alone on banks' lending behavior and profitability return results are in line with the predictions in Huljak et al. (2020). The pandemic outbreak triggered an overall negative effect on the credit supply of euro area banks without amplifying the cross-country differentials between core and periphery countries. The possible reason for this is that the effects of an economic shock (considered alone, without monetary policy implementations) on the lending

behavior are not immediately visible, whereas the study is constrained to limited data at the time being written. Brissimis et al. (2010), Ciccarelli et al. (2013), and Burriel (2010) prove the heterogeneity across these country groups thanks to a multi-year analysis. However, given the considerable impact of the NPL level on banks loans and the differentials across the two groups, there is an indication of heterogeneity that produces a more pronounced contraction of the periphery group's credit supply. Regarding banks' profitability, the NPL management plays a considerably more critical role in achieving higher profits. Moreover, it has been found that the interaction between the COVID-19 variable and the country dummy variable produces a negative and statistically significant effect, denoting an increase in the heterogeneity between core and periphery banking systems, where the latter underperformed in terms of profits. Additionally, the banks' size might be explaining part of the divergencies in the banks' ROAA since northern banks are generally larger than periphery ones. In these first two regressions, banks characteristics play a fundamental role, and the majority of the associated variable has explanatory power, especially in the case of credit supply. Within the second scenario, in which the impact of both COVID-19 and PEPP implementation are evaluated, a more precise picture of the events that occurred from March 2020 is provided. In terms of lending behavior, the two events influenced the heterogeneity across the country groups. On the one hand, COVID-19 triggered a negative effect on banks' loans overall, with a higher reduction for periphery banking systems. On the other hand, the introduction of PEPP as emergency UMP again created a statistically significant positive effect, which can be explained with the will of the ECB to conduct the purchases flexibly. Such a monetary policy measure reduced the country-group differential and limited the impact of COVID-19 overall. Again, the bank-specific characteristics have considerable explanatory power in the credit supply fluctuations. Concerning banks' profitability, there are no indications that the COVID-19 outbreak and the PEPP implementation might have triggered the heterogeneity across banking systems. Again, a bank's ROAA is proven to be highly dependent on two bank-specific characteristics, i.e., NPL level and capitalization. Regarding the first specification, it might be the case that the PEPP program limited the effect of the economic shock, making the inner business model of a bank the primary driver of its profitability. Moreover, the monetary policies are not generally aimed at supporting the ability to make profits. Central banks are more focused on the broader picture, boosting bank lending and speeding up economic recovery. Lastly, the importance of bank-specific characteristics can be verified with the R^2 of every regression table: it increases when the bank-specific controls are introduced and then remains unaltered. This is proof of their relevance.

The results are robust to modifications in the methodology employed. First, using a lagged variable for the PEPP both makes economic sense and produces more relevant results. Second, assessing the impact of the policy implementation alone does not provide a correct picture of the events that followed the first quarter of 2020. If the impact of COVID-19 is not accounted for, the regression outcomes deviate from what has previously been found, producing an unrealistic explanation. Third, when standard errors are clustered on a country level, the results do not significantly vary, as in the case in

which the Greek banks are omitted. Lastly, the choice of using the NPL level as a proxy to distinguish between core and periphery banking systems has been proven to be suitable, as the existing literature and the third set of robustness checks demonstrate.

Notwithstanding the significant results of this study, there are some limitations. Foremost, the timeframe in which banks have been analyzed describes the short-term impact of the economic shock and monetary policy. This is due to the limited availability of data at the time the work has been written. This analysis may probably not be representative of the effects in the future years. However, this thesis intends to show whether countries have rapidly absorbed the shock and if the quick response of the ECB produced immediate effects. I believe this study could be the starting point for future research on the validity of monetary policy implementation. Based on the results obtained, when an economic shock occurs, banks in less resilient countries must react quickly to avoid significant losses. In this sense, the regulation introduced with Basel III gave more stability to banks in the euro area, given that their profitability is highly dependent on the internal capital. In this short-term analysis, it appears that banks have absorbed the shock from the beginning. Regarding lending behavior, the credit supply of banking systems in the euro area has been significantly boosted thanks to the liquidity injections under the PEPP. This shows that, differently from the GFC, the flexibility of the purchases conducted from the ECB addressed the cross-country heterogeneity that distinguishes the European economy. A similar study conducted on a longer-term perspective could ultimately prove the effectiveness of the monetary policy. Other limitations are linked to the availability of bank-specific data. Many banks have been omitted from the sample because they were not included in the original database or because their financial statements were not available yet. Moreover, this study does not represent the Eurozone's financial situation since nine countries have not been included in their financial data unavailability.

Future researchers should focus on expanding the analysis to the whole Eurozone since the ECB's monetary policy is addressed to all of them, and it should aim to obtain the most homogeneous environment to operate effectively. Additionally, a multi-year study would be more suitable to validate the findings in this work, and more broadly, the effectiveness of the pandemic-related UMP. Lastly, given the importance of the NPL on banks' performance, regulators and policymakers should act in a way to reduce the persistently high levels, especially in periphery countries. As proven in the regressions, higher loans quality makes the banks healthier and more resilient in financially distressed times. Therefore, from the ECB's perspective, trying to reduce the bank-specific elements that constitute heterogeneity could help to smooth the transmission of its monetary policy, reducing the gap between core and periphery countries.

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VIII. Appendix

Tables

Table A. 1: List of countries divided by group.

Core Countries	Periphery Countries
Austria (AT)	Greece (GR)
Belgium (BE)	Ireland (IE)
France (FR)	Italy (IT)
Germany (DE)	Portugal (PT)
Netherlands (NL)	Spain (ES)

Table A. 2: Additional summary statistics related to table 6 (expressed in billion €).

Statistic	Core	Periphery	t-score	p-value
Total net loans and advances	148	84	4.844	0.000***
Bank size	340	145	6.250	0.000***
Total debt	54	19	8.349	0.000***
Quarterly GDP	485	291	10.843	0.000***
Quarterly PEPP injections	18	15	2.260	0.024*

Notes: The table provides the average value for the two country groups. The bank size is denoted as the amount of total assets in the bank's balance sheet. The t-test is conducted at a 95% confidence level and is constructed as follows: the average value for the periphery country group is subtracted to the average value for the core country group. Therefore, if the t-score is positive (negative), the average value for the core group is superior (inferior) to that of the periphery group. The p-value follows the null hypothesis, which considers the average values of the two groups being equal, thus the difference being equal to 0. Significance levels: *** $p < 0.001$, ** $p < 0.05$, * $p \leq 0.1$.

Table A. 3: Impact of PEPP on banks' lending behavior, non-lagged PEPP variable.

Dependent variable	$lnLOANS_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-4.271***	-0.502***	-0.502***	-0.533***	-0.533***	-0.532***
	(0.571)	(0.115)	(0.115)	(0.117)	(0.117)	(0.118)
$post2020Q1_t * NPL_i$	-0.016	-0.015	-0.015	-0.019	-0.019	-0.020
	(0.375)	(0.024)	(0.024)	(0.024)	(0.024)	(0.025)
$PEPP_{i,t}$	0.004	-0.002*	-0.002*	-0.000	-0.000	0.000
	(0.012)	(0.001)	(0.001)	(0.009)	(0.009)	(0.009)
$PEPP_{i,t} * NPL_i$	-0.011	0.001	0.001	0.001	0.001	0.002
	(0.014)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$SOLV_{i,t}$		-3.272**	-3.272**	-3.501**	-3.501**	-3.508**
		(1.577)	(1.577)	(1.627)	(1.627)	(1.627)
$LIQ_{i,t}$		-0.804***	-0.804***	-0.741***	-0.741***	-0.740***

		(0.178)	(0.178)	(0.172)	(0.172)	(0.172)
$lnDEBT_{i,t}$		0.037**	0.037**	0.024	0.024	0.024
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
$lnSIZE_{i,t}$		0.708***	0.708***	0.761***	0.761***	0.762***
		(0.101)	(0.101)	(0.101)	(0.101)	(0.101)
$lnGDP_{i,t}$						0.059
						(0.150)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.131	0.996	0.996	0.996	0.996	0.996

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of bank's net loans and advances to customers in €. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $PEPP_{i,t}$ denotes the variable for the natural logarithm of PEPP in €. The interaction $PEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 4: Impact of PEPP on banks' profitability, non-lagged PEPP variable.

Dependent variable				$ROAA_{i,t}$		
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-3.630***	-5.986***	-5.986***	-6.260***	-6.260***	-6.316***
	(1.156)	(0.971)	(0.971)	(0.882)	(0.882)	(0.861)
$post2020Q1_t * NPL_i$	-0.461	-0.318	-0.318	-0.299	-0.299	-0.258
	(0.320)	(0.255)	(0.255)	(0.256)	(0.256)	(0.252)
$PEPP_{i,t}$	-0.023**	-0.013	-0.013	0.146**	0.146**	0.136*
	(0.011)	(0.009)	(0.009)	(0.070)	(0.070)	(0.070)
$PEPP_{i,t} * NPL_i$	0.024*	0.002	0.002	0.002	0.002	-0.006
	(0.014)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
$SOLV_{i,t}$		19.836***	19.836***	18.482***	18.482***	18.747***
		(5.193)	(5.193)	(5.080)	(5.080)	(5.127)
$LIQ_{i,t}$		-0.901	-0.901	-0.650	-0.650	-0.655
		(0.767)	(0.767)	(0.787)	(0.787)	(0.792)
$lnDEBT_{i,t}$		0.110	0.110	0.078	0.078	0.057
		(0.110)	(0.110)	(0.112)	(0.112)	(0.112)
$lnSIZE_{i,t}$		0.520	0.520	0.579	0.579	0.532
		(0.411)	(0.411)	(0.411)	(0.411)	(0.411)
$lnGDP_{i,t}$						-2.358*
						(1.339)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660

R-squared	0.194	0.620	0.620	0.631	0.631	0.633

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $PEPP_{i,t}$ denotes the variable for the natural logarithm of PEPP in €. The interaction $PEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 5: Impact of PEPP on banks' lending behavior, no COVID-19.

Dependent variable	$lnLOANS_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-4.377***	-0.494***	-0.494***	-0.536***	-0.536***	-0.527***
	(0.600)	(0.117)	(0.117)	(0.115)	(0.115)	(0.116)
$lPEPP_{i,t}$	-0.053	-0.008	-0.008	0.002	0.002	0.001
	(0.073)	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)
$lPEPP_{i,t} * NPL_i$	-0.012	0.000	0.000	0.000	0.000	0.001
	(0.007)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$SOLV_{i,t}$		-3.269**	-3.269**	-3.497**	-3.497**	-3.470**
		(1.577)	(1.577)	(1.624)	(1.624)	(1.612)
$LIQ_{i,t}$		-0.769***	-0.769***	-0.733***	-0.733***	-0.740***
		(0.179)	(0.179)	(0.172)	(0.172)	(0.172)
$lnDEBT_{i,t}$		0.036**	0.036**	0.024	0.024	0.026*
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
$lnSIZE_{i,t}$		0.718***	0.718***	0.760***	0.760***	0.761***
		(0.104)	(0.104)	(0.100)	(0.100)	(0.103)
$lnGDP_{i,t}$						0.045
						(0.148)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.131	0.996	0.996	0.996	0.996	0.996

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of bank's net loans and advances to customers in €. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 6: Impact of PEPP on banks' profitability, no COVID-19.

Dependent variable	$ROAA_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-3.545***	-5.927***	-5.927***	-6.205***	-6.205***	-6.252***
	(1.179)	(0.971)	(0.971)	(0.894)	(0.894)	(0.878)
$lPEPP_{i,t}$	-0.051	-0.053	-0.053	0.090	0.090	0.085
	(0.066)	(0.046)	(0.046)	(0.076)	(0.076)	(0.076)
$lPEPP_{i,t} * NPL_i$	0.004	-0.013**	-0.013**	-0.012**	-0.012**	-0.015***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
$SOLV_{i,t}$		19.701***	19.701***	18.691***	18.691***	18.900***
		(5.179)	(5.179)	(5.180)	(5.180)	(5.201)
$LIQ_{i,t}$		-0.650	-0.650	-0.634	-0.634	-0.674
		(0.724)	(0.724)	(0.796)	(0.796)	(0.806)
$lnDEBT_{i,t}$		0.101	0.101	0.078	0.078	0.063
		(0.109)	(0.109)	(0.112)	(0.112)	(0.112)
$lnSIZE_{i,t}$		0.593	0.593	0.611	0.611	0.560
		(0.421)	(0.421)	(0.411)	(0.411)	(0.414)
$lnGDP_{i,t}$						-2.179
						(1.335)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.183	0.615	0.615	0.629	0.629	0.632

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 7: Impact of PEPP on banks' lending behavior, clustered standard errors on a country level.

Dependent variable	$lnLOANS_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-4.463***	-0.502***	-0.502***	-0.540***	-0.540***	-0.541***
	(0.642)	(0.147)	(0.147)	(0.161)	(0.161)	(0.162)
$post2020Q1_t * NPL_i$	3.790	-1.093*	-1.093*	-1.025*	-1.025*	-1.033*
	(3.132)	(0.533)	(0.533)	(0.493)	(0.493)	(0.495)
$lPEPP_{i,t}$	0.032	-0.032	-0.032	-0.021	-0.021	-0.021
	(0.112)	(0.023)	(0.023)	(0.025)	(0.025)	(0.025)
$lPEPP_{i,t} * NPL_i$	-0.173	0.047*	0.047*	0.044*	0.044*	0.044*
	(0.135)	(0.024)	(0.024)	(0.022)	(0.022)	(0.022)
$SOLV_{i,t}$		-3.286	-3.286	-3.495	-3.495	-3.490

		(3.474)	(3.474)	(3.588)	(3.588)	(3.585)
$LIQ_{i,t}$		-0.739***	-0.739***	-0.709***	-0.709***	-0.710***
		(0.164)	(0.164)	(0.159)	(0.159)	(0.159)
$lnDEBT_{i,t}$		0.037**	0.037**	0.026***	0.026***	0.025***
		(0.012)	(0.012)	(0.006)	(0.006)	(0.006)
$lnSIZE_{i,t}$		0.716***	0.716***	0.755***	0.755***	0.754***
		(0.110)	(0.110)	(0.101)	(0.101)	(0.100)
$lnGDP_{i,t}$						-0.052
						(0.129)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.132	0.996	0.996	0.996	0.996	0.996

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of bank's net loans and advances to customers in €. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 8: Impact of PEPP on banks' profitability, clustered standard errors on a country level.

Dependent variable			$ROAA_{i,t}$			
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-3.525*	-5.924***	-5.924***	-6.202***	-6.202***	-6.250***
	(1.849)	(1.065)	(1.065)	(0.953)	(0.953)	(0.922)
$post2020Q1_t * NPL_i$	-0.897	0.355	0.355	0.701	0.701	0.344
	(3.092)	(3.116)	(3.116)	(2.722)	(2.722)	(2.813)
$lPEPP_{i,t}$	-0.072***	-0.046	-0.046	0.106	0.106	0.093
	(0.015)	(0.076)	(0.076)	(0.096)	(0.096)	(0.106)
$lPEPP_{i,t} * NPL_i$	0.042	-0.028	-0.028	-0.042	-0.042	-0.030
	(0.125)	(0.129)	(0.129)	(0.112)	(0.112)	(0.114)
$SOLV_{i,t}$		19.707***	19.707***	18.690***	18.690***	18.898***
		(4.017)	(4.017)	(3.859)	(3.859)	(3.972)
$LIQ_{i,t}$		-0.660	-0.660	-0.651	-0.651	-0.682
		(0.711)	(0.711)	(0.845)	(0.845)	(0.877)
$lnDEBT_{i,t}$		0.100	0.100	0.076	0.076	0.062
		(0.138)	(0.138)	(0.167)	(0.167)	(0.155)
$lnSIZE_{i,t}$		0.593	0.593	0.614	0.614	0.562
		(0.393)	(0.393)	(0.354)	(0.354)	(0.345)
$lnGDP_{i,t}$						-2.166*
						(1.037)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES

Time FE				YES	YES	YES
Observations	665	660	660	660	660	660
R-squared	0.183	0.615	0.615	0.629	0.629	0.632

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 9: Impact of COVID-19 and PEPP on banks' lending behavior, without Greece.

Dependent variable			$lnLOANS_{i,t}$			
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-5.014***	-0.573***	-0.573***	-0.599***	-0.599***	-0.606***
	(1.316)	(0.126)	(0.126)	(0.127)	(0.127)	(0.130)
$post2020Q1_t * NPL_i$	2.625	-0.996***	-0.996***	-0.936***	-0.936***	-0.952***
	(3.441)	(0.322)	(0.322)	(0.312)	(0.312)	(0.319)
$lPEPP_{i,t}$	0.034	-0.032***	-0.032***	-0.026**	-0.026**	-0.027**
	(0.117)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
$lPEPP_{i,t} * NPL_i$	-0.124	0.043***	0.043***	0.040***	0.040***	0.041***
	(0.148)	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)
$SOLV_{i,t}$		-3.945**	-3.945**	-4.069**	-4.069**	-4.087**
		(1.843)	(1.843)	(1.867)	(1.867)	(1.875)
$LIQ_{i,t}$		-0.739***	-0.739***	-0.726***	-0.726***	-0.724***
		(0.180)	(0.180)	(0.176)	(0.176)	(0.176)
$lnDEBT_{i,t}$		0.033**	0.033**	0.022	0.022	0.020
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
$lnSIZE_{i,t}$		0.719***	0.719***	0.755***	0.755***	0.752***
		(0.104)	(0.104)	(0.101)	(0.101)	(0.102)
$lnGDP_{i,t}$						-0.181
						(0.184)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	623	618	618	618	618	618
R-squared	0.098	0.996	0.996	0.996	0.996	0.996

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of bank's net loans and advances to customers in €. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's

total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 10: Impact of COVID-19 and PEPP on banks' profitability, without Greece.

Dependent variable	$ROAA_{i,t}$					
Regressor	(1)	(2)	(3)	(4)	(5)	(6)
$NPL\_LVL_{i,t}$	-5.727***	-6.166***	-6.166***	-6.482***	-6.482***	-6.562***
	(1.141)	(0.901)	(0.901)	(0.808)	(0.808)	(0.792)
$post2020Q1_t * NPL_i$	-3.388*	-0.351	-0.351	-0.222	-0.222	-0.395
	(1.995)	(2.109)	(2.109)	(2.032)	(2.032)	(2.049)
$lPEPP_{i,t}$	-0.062*	-0.045	-0.045	0.116	0.116	0.099
	(0.037)	(0.047)	(0.047)	(0.078)	(0.078)	(0.081)
$lPEPP_{i,t} * NPL_i$	0.150*	0.002	0.002	-0.005	-0.005	0.000
	(0.084)	(0.088)	(0.088)	(0.085)	(0.085)	(0.085)
$SOLV_{i,t}$		19.748***	19.748***	18.791***	18.791***	18.596***
		(5.202)	(5.202)	(5.159)	(5.159)	(5.113)
$LIQ_{i,t}$		-0.408	-0.408	-0.255	-0.255	-0.224
		(0.724)	(0.724)	(0.792)	(0.792)	(0.790)
$lnDEBT_{i,t}$		0.042	0.042	0.004	0.004	-0.016
		(0.100)	(0.100)	(0.100)	(0.100)	(0.096)
$lnSIZE_{i,t}$		0.527	0.527	0.596	0.596	0.563
		(0.421)	(0.421)	(0.416)	(0.416)	(0.417)
$lnGDP_{i,t}$						-1.995*
						(1.193)
Bank controls and FE		YES	YES	YES	YES	YES
Time FE			YES		YES	YES
Country FE				YES	YES	YES
Observations	623	618	618	618	618	618
R-squared	0.280	0.680	0.680	0.694	0.694	0.696

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The interaction $post2020Q1_t * NPL_i$ is used to verify whether the COVID-19 shock had an impact on the treated group. The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The interaction $lPEPP_{i,t} * NPL_i$ is used to verify whether the PEPP program had a significant impact on the treatment group. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 11: Impact of COVID-19 and PEPP on lending behavior in core countries.

Dependent variable	$lnLOANS_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$post2020Q1_t$	-0.041	-0.012	-0.012	0.321	0.321	0.454
	(0.292)	(0.018)	(0.018)	(0.338)	(0.338)	(0.339)
$NPL\_LVL_{i,t}$	-9.915***	-1.288	-1.288	-1.758	-1.758	-1.863

	(1.345)	(1.259)	(1.259)	(1.237)	(1.237)	(1.237)
$lPEPP_{i,t}$	0.000	-0.002*	-0.002*	-0.015	-0.015	-0.020
	(0.013)	(0.001)	(0.001)	(0.014)	(0.014)	(0.014)
$SOLV_{i,t}$		-18.376***	-18.376***	-18.744***	-18.744***	-18.995***
		(3.440)	(3.440)	(3.348)	(3.348)	(3.345)
$LIQ_{i,t}$		-0.751***	-0.751***	-0.639***	-0.639***	-0.621***
		(0.182)	(0.182)	(0.161)	(0.161)	(0.152)
$lnDEBT_{i,t}$		0.038	0.038	0.001	0.001	0.011
		(0.047)	(0.047)	(0.046)	(0.046)	(0.046)
$lnSIZE_{i,t}$		0.353**	0.353**	0.473***	0.473***	0.484***
		(0.177)	(0.177)	(0.172)	(0.172)	(0.171)
$lnGDP_{i,t}$						0.907**
						(0.367)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	322	322	322	322	322	322
R-squared	0.053	0.997	0.997	0.997	0.997	0.997

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of bank's net loans and advances to customers in €. The variable $post2020Q1_t$ is a dummy variable denoting the pre-and post-COVID-19 period. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 12: Impact of COVID-19 and PEPP on profitability in core countries.

Dependent variable	$ROAA_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$post2020Q1_t$	0.104	0.110	0.110	-2.156	-2.156	-2.393
	(0.243)	(0.195)	(0.195)	(1.868)	(1.868)	(1.851)
$NPL\_LVL_{i,t}$	-2.303	-7.010	-7.010	-7.553	-7.553	-7.366
	(1.445)	(6.416)	(6.416)	(6.675)	(6.675)	(6.513)
$lPEPP_{i,t}$	-0.013	-0.013	-0.013	0.080	0.080	0.088
	(0.010)	(0.009)	(0.009)	(0.076)	(0.076)	(0.075)
$SOLV_{i,t}$		22.403**	22.403**	21.445*	21.445*	21.893*
		(11.210)	(11.210)	(11.118)	(11.118)	(11.454)
$LIQ_{i,t}$		-0.997	-0.997	-0.855	-0.855	-0.888
		(1.024)	(1.024)	(1.043)	(1.043)	(1.067)
$lnDEBT_{i,t}$		0.021	0.021	-0.008	-0.008	-0.024
		(0.138)	(0.138)	(0.139)	(0.139)	(0.130)
$lnSIZE_{i,t}$		0.006	0.006	0.117	0.117	0.098
		(0.542)	(0.542)	(0.554)	(0.554)	(0.541)
$lnGDP_{i,t}$						-1.618
						(1.829)
Bank controls and FE		YES	YES	YES	YES	YES

Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	322	322	322	322	322	322
R-squared	0.031	0.455	0.455	0.464	0.464	0.465

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). The variable $post2020Q1_t$ is a dummy variable denoting the pre-and post-COVID-19 period. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

Table A. 13: Impact of COVID-19 and PEPP on lending behavior in periphery countries.

Dependent variable	$lnLOANS_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$post2020Q1_t$	-0.030	-0.010	-0.010	-0.250	-0.250	-0.254
	(0.236)	(0.009)	(0.009)	(0.160)	(0.160)	(0.163)
$NPL\_LVL_{i,t}$	-3.839***	-0.275***	-0.275***	-0.294***	-0.294***	-0.293***
	(0.538)	(0.047)	(0.047)	(0.046)	(0.046)	(0.046)
$lPEPP_{i,t}$	-0.003	-0.001**	-0.001**	0.009	0.009	0.010
	(0.011)	(0.000)	(0.000)	(0.007)	(0.007)	(0.007)
$SOLV_{i,t}$		0.023	0.023	-0.107	-0.107	-0.110
		(0.370)	(0.370)	(0.360)	(0.360)	(0.360)
$LIQ_{i,t}$		-0.817***	-0.817***	-0.777***	-0.777***	-0.777***
		(0.134)	(0.134)	(0.137)	(0.137)	(0.137)
$lnDEBT_{i,t}$		0.030**	0.030**	0.027**	0.027**	0.027**
		(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
$lnSIZE_{i,t}$		0.901***	0.901***	0.914***	0.914***	0.915***
		(0.044)	(0.044)	(0.047)	(0.047)	(0.047)
$lnGDP_{i,t}$						0.028
						(0.097)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	343	338	338	338	338	338
R-squared	0.163	0.999	0.999	0.999	0.999	0.999

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $lnLOANS_{i,t}$ corresponds to the natural logarithm of bank's net loans and advances to customers in €. The variable $post2020Q1_t$ is a dummy variable denoting the pre-and post-COVID-19 period. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

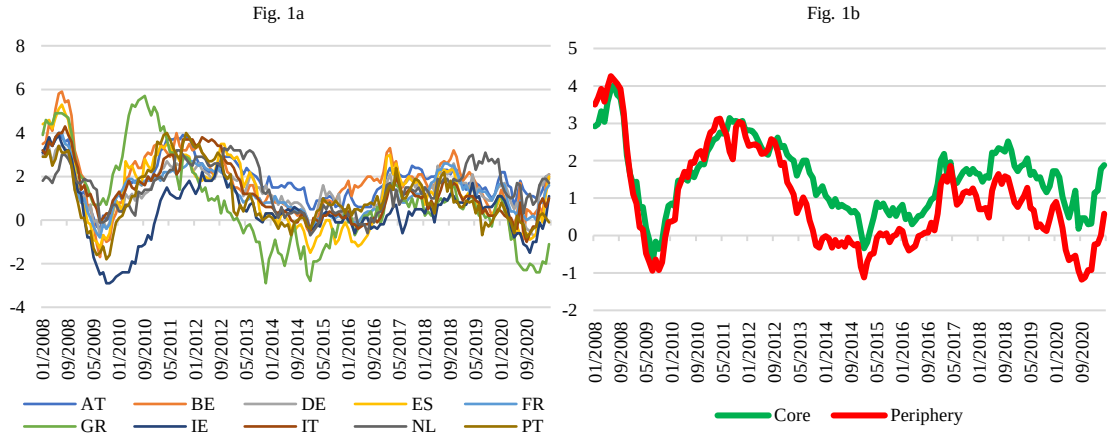
Table A. 14: Impact of COVID-19 and PEPP on profitability in periphery countries.

Dependent variable	$ROAA_{i,t}$					
Regression	(1)	(2)	(3)	(4)	(5)	(6)
$post2020Q1_t$	-0.347*	-0.266*	-0.266*	-4.490*	-4.490*	-4.164
	(0.203)	(0.161)	(0.161)	(2.607)	(2.607)	(2.614)
$NPL\_LVL_{i,t}$	-3.992***	-5.471***	-5.471***	-5.853***	-5.853***	-5.914***
	(1.206)	(1.073)	(1.073)	(0.982)	(0.982)	(0.973)
$lPEPP_{i,t}$	-0.010	-0.011*	-0.011*	0.181*	0.181*	0.150
	(0.008)	(0.006)	(0.006)	(0.109)	(0.109)	(0.111)
$SOLV_{i,t}$		19.253***	19.253***	17.100***	17.100***	17.305***
		(5.984)	(5.984)	(5.790)	(5.790)	(5.811)
$LIQ_{i,t}$		-1.115	-1.115	-0.788	-0.788	-0.758
		(1.190)	(1.190)	(1.192)	(1.192)	(1.196)
$lnDEBT_{i,t}$		0.146	0.146	0.073	0.073	0.060
		(0.144)	(0.144)	(0.146)	(0.146)	(0.146)
$lnSIZE_{i,t}$		1.383*	1.383*	1.485**	1.485**	1.418*
		(0.751)	(0.751)	(0.725)	(0.725)	(0.732)
$lnGDP_{i,t}$						-2.190
						(1.614)
Bank controls and FE		YES	YES	YES	YES	YES
Country FE			YES		YES	YES
Time FE				YES	YES	YES
Observations	343	338	338	338	338	338
R-squared	0.264	0.680	0.680	0.695	0.695	0.697

Notes: The table reports the regression coefficients and the robust standard errors in parenthesis. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable $ROAA_{i,t}$ indicates the banks' returns on average assets (net income / total assets). The variable $post2020Q1_t$ is a dummy variable denoting the pre-and post-COVID-19 period. $NPL\_LVL_{i,t}$ represents the non-performing loans ratio (non-performing loans / total gross loans). The variable $lPEPP_{i,t}$ denotes the lagged variable for the natural logarithm of PEPP in € with one-quarter lag. The following are used as bank-specific control variables: $SOLV_{i,t}$ is the solvency ratio (equity / total assets); $LIQ_{i,t}$ represents the liquid assets ratio (liquid assets / total assets). $lnDEBT_{i,t}$ denotes the natural logarithm of the bank's total debt in €. $lnSIZE_{i,t}$ is the natural logarithm of the bank's total assets in €. Lastly, $lnGDP_{i,t}$ identifies the natural logarithm of a country's quarterly GDP.

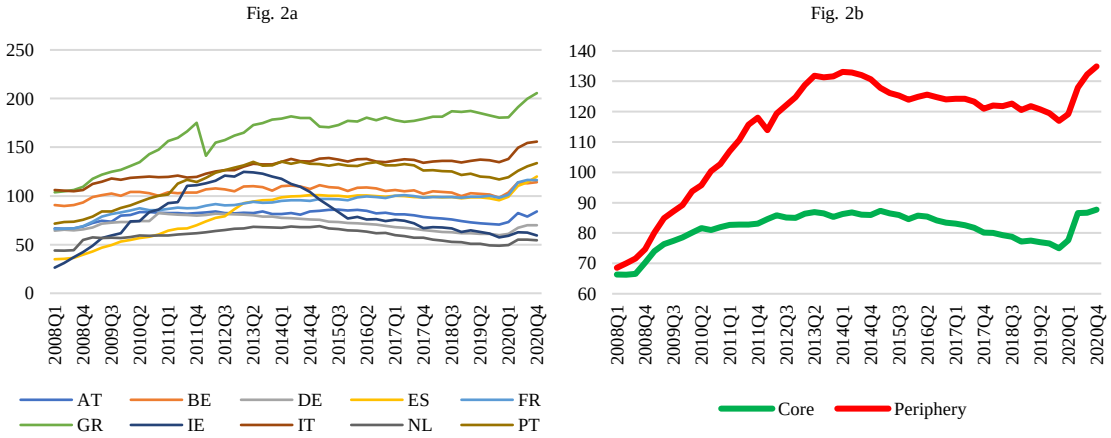
Figures

Figure A. 1: (a) Monthly HICP calculated as the annual rate of change (%) per country. (b) Average monthly HICP is calculated as the annual rate of change (%) based on the core-periphery country group division.



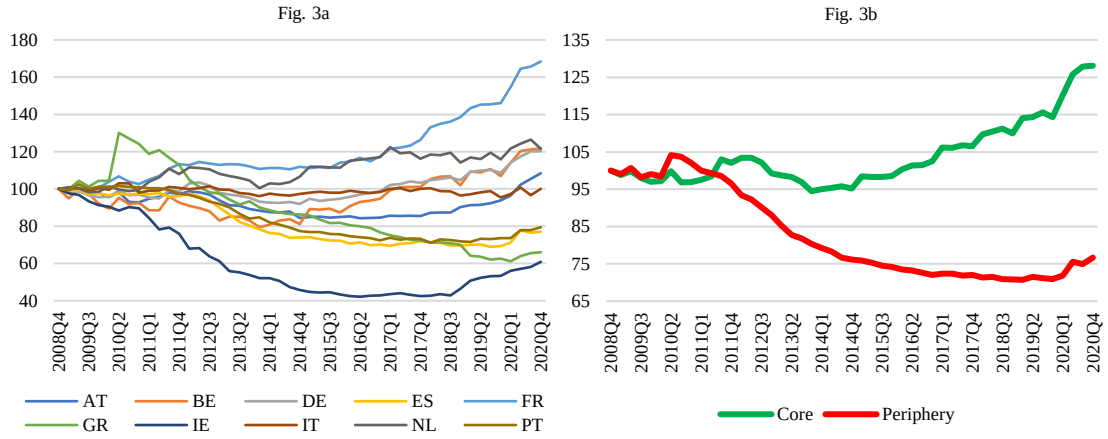
Source of the data: ECB Statistical Data Warehouse.

Figure A. 2: (a) Quarterly government debt as a % of the country-specific GDP per country. (b) Average quarterly government debt as a % of the country-specific GDP, based on the core-periphery country group division.



Source of the data: ECB Statistical Data Warehouse.

Figure A. 3: (a) Quarterly credit supply change in basis points (base quarter = 2008Q1) per country. (b) Average quarterly credit supply change in basis points (base quarter = 2008Q1) based on the core-periphery country group division.



Source of the data: ECB Statistical Data Warehouse.
Notes: The total amount of outstanding loans at the end of the period per country has been collected from 2008Q4 to 2020Q4, and the basis points changes have been calculated, taking 2008Q4 as the base quarter.