Investigating the impact of supervisory stress tests on bank performance: bank lending, credit risk, and diversification

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The Impact of Supervisory Stress Tests on Bank Performance: Bank Lending, Credit Risk, and Diversification

by

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Abstract

The thesis investigates the impact of supervisory stress tests on bank performance using three bank performance measures. The Global Financial Crisis exposed vulnerabilities within the banking system that resulted in insolvency issues for several financial institutions. In particular, there was a need for government intervention to support struggling banks during the crisis. Due to the crisis, new banking regulations via the Basel III accords have attempted to address vulnerabilities, improve regulations to foster market discipline, and strengthen the financial system. This thesis investigates one section of the Basel III accords that overhauled the stress testing regime.

The stress testing framework is a prudential risk management tool that banks and regulators apply to assess the effects of hypothetical shocks on the banks' balance sheets. Before the crisis, the banks utilised stress tests as an internal risk management tool. Yet, the newly reformed stress testing regime focuses on modifying the design and implementation of the stress testing regime. In effect, national regulators now conduct wide-scale stress tests for systemic banks, which provides regulators with valuable information concerning the bank's financial health or the banking system's resilience. From the results, the regulators have the power to undertake several decisions, such as ordering banks to improve their capital positions or, in some cases, control their dividend and share purchase policies.

Since the crisis, the reformed stress testing regime has received attention from several stakeholders, including regulators, banks, policy-makers, and academics. The effect of the disclosure policy and market reaction to the stress testing regime dominates the literature. However, I find that the impact of the supervisory stress tests on bank performance is limited. More recently, the literature addresses the effect of stress testing on bank lending and how the exercises instigate a reduction in bank lending. Importantly, the limited yet growing research focuses exclusively on the U.S. financial system.

In this thesis, I contribute to the literature by examining the effect of supervisory stress testing on three bank performance indicators. I expand on the limited literature by studying alternative financial jurisdictions such as the UK and EU. Regarding the three bank performance measures, I analyse the effect of stress testing on bank lending, credit risk, and diversification. The three empirical chapters produced in this thesis examine

these bank performance measures.

In the first empirical chapter, I examine the effect of the supervisory stress tests on bank lending in the UK banking system. The related literature finds that the stress testing regime for the U.S. financial system is causing the participating banks to reduce bank lending. I expand on the literature by assessing if the same observation occurs for banks participating in the UK stress testing regime that the Bank of England coordinates. Using a difference-in-difference methodology, the chapter's findings show that banks that fail the stress test reduce bank lending. Furthermore, the literature for the U.S. financial system documents that the effect of stress testing on bank lending is statistically significant for the earliest stress tests. Subsequently, the literature suggests that the influence of stress tests is diminishing over time. I address this phenomenon, and in contrast to the findings of the U.S. financial system, the effect of the stress testing regime continues to be statistically significant. In other words, the stress testing regime is not losing its effectiveness.

I examine the EU financial jurisdiction in the second empirical chapter and build on the first empirical chapter. Unlike the first chapter, I contribute to the literature by including two different methodologies to assess the effect of stress testing on bank lending. I include the difference-in-difference and stress test exposure methodology to capture the effect of stress testing on bank performance. For the difference-in-difference section, I find that the EBA stress testing exercises reduce corporate loans by the stress-tested banks. Regarding the stress test exposure methodology, I find that the stress-tested banks reduce consumer loans relative to the non-stress tested banks. The literature concerning the U.S. stress tests provides a brief reason why the stress-tested banks reduce lending. Primarily, to curb credit risk issues, the stress-tested banks reduced lending. Albeit, the growing literature does not empirically address this issue. Therefore, in this chapter, I contribute to the literature by examining the effect of stress testing on credit risk. Surprisingly, the results show that stress-tested banks face elevated credit risk instead of reducing credit risk. One feature of the EU financial jurisdiction is the large geographical location of the 27 member states. I exploit this feature and hypothesise that certain geographical locations may perform worse than alternative regions due to sovereign risk. In line with this difference, I examine stress-tested banks within the GIIPS region. The results yield that the stress-tested banks from this region reduce lending and face greater credit risk problems than stress-tested banks that are not part of the GIIPS region.

In the final chapter, I divert from the central theme of stress testing and bank lending by focusing on diversification. The chapter considers the role of diversification as a bank strategy to enhance profitability and financial stability during crisis periods for the U.S. financial system. Given the ongoing COVID-19 pandemic, I hypothesise that diversification can support bank performance. The results show that diversification can improve profitability and financial stability, as evident during the Global Financial Crisis and the COVID-19 pandemic. Notably, since the Global Financial Crisis can be characterised as a banking system-induced shock (endogenous shock), I find that the positive relationship between diversification and bank performance (profitability and financial stability) yields more robust results. The literature suggests that banks' diversification decisions can be effective if certain conditions are met. For example, to facilitate diversification, the literature identifies that a bank must have a more robust human capital structure to ensure diversification strategies are successful. In light of this, the empirical chapter assesses the impact of being stress-tested and diversified. Importantly, the COVID-19 pandemic is the first real crisis to stress a bank's balance sheet against a crisis. I find that stress-tested and diversified banks increase profitability and financial stability relative to diversified banks that are not part of the stress testing framework. This result could be due to the risk management culture in the stress-tested banks, as these groups of banks have faced greater regulatory pressures since the Global Financial Crisis.

Declaration

I hereby declare that the work produced in this thesis is original and solely my own. The thesis is completed as a partial requirement for the Doctor of Philosophy award of Loughborough University.

For the first empirical chapter, Dr Giovanni Calice (principal supervisor) and I have produced an academic paper. The paper has recently been accepted by the Journal of Banking Regulation and is forthcoming.

The title of the journal article: “The Effects of Supervisory Stress Testing on Bank Lending: Examining Large UK Banks.”

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What is now proved was once only imagined – William Blake

Abbreviations

BCBS	Basel Committee on Banking Supervision
BoE	Bank of England
CCAR	Comprehensive Capital Analysis and Review
CEBS	Committee of European Banking Supervisors
CET1	Common Equity Tier 1
EBA	European Banking Authority
ECB	European Central Bank
EU	European Union
FE	Fixed Effects
FED	Federal Reserve System
GFC	Global Financial Crisis
GMM	Generalised Method of Moments
IMF	International Monetary Fund
LLP	Loan Loss Provisions
LLR	Loan Loss Reserves
NSFR	Net Stable Funding Ratio
OLS	Ordinary Least Squares
SCAP	Supervisory Capital Assessment Program

Chapter 1

Introduction

1.1 Background

In the financial system, an essential function of a commercial bank is to act as an intermediary between savers and borrowers by facilitating the management of funds. In particular, banks provide credit to various customers; this includes but is not limited to households, corporations, and consumers. Supplying credit to the economy serves several purposes; for instance, credit enables businesses to grow and consumers to purchase real estate for residential or commercial purposes. Indeed, credit availability is a source of finance that can yield several benefits, such as economic growth and social development.

Disseminating credit to the economy is often associated with its risk, concerning debtors' ability to repay their loans in timely instalments agreed with the banks beforehand. To mitigate financial risk, banks have stringent risk management tools to monitor several dimensions of risk that may affect bank performance. These risks could potentially produce solvency issues for banks as a single institution or the banking system as a whole via contagion transmission channels.

The recent Global Financial Crisis (GFC) of 2008-2009 concerning the subprime mortgages triggered severe repercussions, leading to bank failure, as evidenced by the collapse of Lehman Brothers in the U.S. and Northern Rock in the UK (Goddard et al., 2009). Such large-scale bank failures require government intervention to support struggling banks at a time of widespread financial turbulence, as was apparent by the public bailout that provided a lifeline to The Lloyds Banking Group and The Royal Bank of Scotland[1].

[1] Barucci et al. (2019) outline the advantages of a bail-out programme. More specifically, the authors find that the EU financial system benefitted from the bail-out programme coordinated by the European Central Bank (ECB) during the Euro sovereign crisis, and the result of the program boosted the region's economic conditions. Similarly, government-owned banks tend to typically lend more to the real economy in times of a crisis, relative to private banks that restrict lending (Brei and Schclarek, 2015).

The intervention by the UK government and its peers led to further scrutiny on the banks' practices regarding their mismanagement of bank loans. In addition, the crisis shed light on the lack of resilience by banks to absorb financial shocks and remain afloat. As expected, additional scrutiny began to criticise the inadequate risk management measures that were in place before the financial crisis and if these prudent risk management tools were 'prudent enough' to anticipate a significant shock.

In response to the GFC, the Basel Committee enacted sweeping measures to repair the banking system. The Basel Committee on Banking Supervision (BCBS) (2011) established the Basel III Accords as a regulatory framework the banks must adopt to build individual resiliency, enhance market and consumer confidence, and ultimately prevent another financial crisis. The Basel III Accords first detail underlying issues within the banking industry, thus leading up to the events that instigated and amplified the GFC. More broadly, the Basel III Accords provide key guidelines that intend to restore the financial system and protect the real economy from future shocks and spillovers that may emanate from the banking system. In general, the Accords focus on restructuring the capital base of the banks via qualitative and quantitative adjustments. The Basel Committee has introduced a new leverage ratio to supplement the capital ratio that will serve as a buffer. The BCBS highlights that banks' unsustainable leverage before the crisis played a crucial role in increasing financial instability, thus leading to bank failure (Vazquez and Federico, 2015; Kalemli-Ozcan et al., 2012; Smith et al., 2017). In addition, one objective of the Basel III Accords is to develop a new liquidity framework that banks must adhere to, as insufficient levels of liquidity throughout the crisis often impede the recovery period (Chen et al., 2021; Gideon et al., 2012; Cornett et al., 2011).

Furthermore, the Accords have underscored the importance of a stable funding structure by implementing the Net Stable Funding Ratio (NSFR) to act as a long-term funding source. The implementation of the NSFR permits banks to utilise a stable funding structure to support their day-to-day activities if necessary. To support the regulatory framework set by the BCBS, a firm reliance on adequate risk management practices is essential. The Basel III Accords shed light on the severe weaknesses in the banks' risk management capabilities. The inability to effectively capture risk and assess its impact on the banks proved detrimental and contributed to the financial crisis. Through one scope, the shortcomings of the internal stress testing regime received the most attention.

The internal stress test assesses the banks' balance sheets to hypothetical shocks and the impact of the shock on a banks' performance. Yet, these internal stress testing practices failed to comprehend the impending crisis and underestimated the severity of the GFC. The BCBS (2009) detail several limitations in the banks' internal stress testing framework before the crisis. First, the BCBS (2009) address the disconnect between senior management and bank staff concerning the exercises. The absence or lack of involvement in the development, maintenance, and execution of the exercises by senior management, weakened the effectiveness of the exercises. Second, the BCBS (2009) notes that the methodology and structure of the internal stress tests were inadequate, as portfolios and financial instruments were often stressed in isolation (as opposed to in conjunction), extreme tail-risk scenarios were disregarded by senior staff they assumed they were unlikely. Furthermore, there was a large emphasis on historical data to build simulation models, which failed to account for extreme uncertainties.

Notwithstanding the complexity of feedback effects, the stress tests were not sufficiently designed to estimate the feedback effects, which in hindsight amplified the impact of the crisis (Viñals, 2012). In turn, the BCBS (2009) implemented guidelines for banks and supervisors to develop their stress testing capabilities by encouraging greater supervision by senior management at every stage of the exercise, which feeds into their decision-making. A broad range of scenarios must consider extreme tail-risk scenarios that are not driven by historical data but rather a forward-looking horizon. National regulators' enhanced supervision and cooperation with participating banks must be encouraged (Haldane, 2009).

In this context, the reformed stress testing framework driven by the Basel III Accords diverts from the previous internal stress testing regime by structurally modifying its approach in terms of its design and implementation. As an example, the Federal Reserve System (FED) (2009) conducted the first supervisory stress test during the GFC, named the Supervisory Capital Assessment Program (SCAP). The FED decided to disclose the test results for the SCAP to enhance bank transparency, market discipline, and public confidence. The decision to publicly announce the results received a mixed reaction from the market and banks, as confidential data or undesirable results may negatively affect banks. The International Monetary Fund (IMF) (2012) explain that the requirement for the reformed stress testing toolkit to share a banks' results against simulated stress publicly may prove contentious among banks. However, the availability of results is a step closer to greater transparency and may foster market discipline[2]. Given the shift to public

[2] See Sahin et al. (2020) that suggest the effect of disclosure on bank performance (stock market and CDS movement) may be

disclosure, there are advantages of disclosing outcomes, particularly during crises, as supervisory authorities gain information on the bank's exposure and the overall resilience of the banking system. At the same time, the disclosure can inform the market of a banks' performance and reassure investors of a banks' resilience during a time of financial turbulence (Schuermann, 2014).

In contrast, the disclosure of the exercises can produce costs for banks and markets. (Goldstein and Sapra, 2013) find that revealing confidential information on bank performance against an adverse scenario can expose vulnerabilities in particular banks, creating a divide between those considered stronger and those deemed weaker. Undesirable results for banks can reduce interbank lending, which may decline due to solvency issues that are instigated by public disclosure. Besides, Goldstein and Sapra (2013) explain that the market may rely on public disclosure of bank performance and ignore private information. This, in turn, may increase information asymmetry as banks can easily manipulate their balance sheet portfolios before a stress test to 'pass' to signal their resilience to the market.

For the European Union (EU), Alves et al. (2015) examine the impact of public disclosure for the first and second European Banking Authority's (EBA) stress tests. The paper finds that disclosing the outcome of the first stress test positively affects the stock market reaction and Credit Default Swap (CDS) spread. Predominantly, Alves et al. (2015) suggest that the first exercise's information proved valuable for investors and stakeholders, as the information enabled the market to judge a bank's solvency. On the other hand, failure of the stress test can produce an adverse stock market reaction for the banks.

In terms of the capital adequacy ratio, there may be attempts by senior bank managers to manipulate the ratio before the examination to assist the bank in passing the test, even though this may not accurately reflect the financial condition of the bank. Shahhosseini (2015) suggests that bank managers adjust their capital adequacy ratio by altering their balance sheets. Banks can reduce their loan charge-offs and increase their loan loss provisions (LLP), which boosts the capital adequacy ratio, thus making it easier for banks to meet the threshold. Attempts to manipulate the balance sheet can misinform regulators on the robustness of the banking sector. Nonetheless, Shahhosseini (2015) observes that the balance sheet manipulation occurred during the earlier supervisory stress tests. The attempts to manipulate the balance sheet in the subsequent tests have diminished due to the financial system becoming more resilient over time. In other words, there

dependent on the economic cycle.

has been a substantial change in risk culture and accumulation of capital since the GFC (Bernanke, 2013; Tarullo, 2014).

The background context above provides a brief overview of the effects of the reformed stress testing regime on bank performance since the Basel III Accords. Yet, there is limited research on the effect of supervisory stress testing on alternative bank performance measures.

In this thesis, I examine the impact of supervisory stress testing on alternative bank performance indicators. More specifically, I consider three bank performance indicators in this thesis. Specifically, the three indicators that I study are bank lending, credit risk, and diversification. To this end, the prime objective of the thesis is to critically analyse the impact of the stress testing framework on bank performance by studying alternative indicators and ascertaining if there are inadvertent effects of the exercises that may be perceived to be undesirable. Importantly, I contribute to the literature by examining if these inadvertent effects may challenge the spirit of the stress testing programme that has been reformed since the GFC. The thesis attempts to provide valuable policy recommendations to regulators and banks on the efficacy of the risk management tool.

1.2 Contribution of The Thesis

In terms of the thesis, I contribute to the literature by examining the effect of supervisory stress testing on bank performance. To support my contribution, I inspect three bank performance measures that serve as the main variables of interest.

The effect of supervisory stress testing on bank performance considers the three performance measures listed below:

- Bank lending
- Credit risk
- Diversification

The majority of the thesis focuses on the effect of supervisory stress testing on bank lending, which concerns the first and second empirical chapters. I elect to pursue this line of research due to the recent (yet nascent) literature that has attempted to understand the relationship between supervisory stress testing and bank lending. As explained in the previous section, credit availability is fundamental as it promotes economic and social growth. As discussed in the literature review section below, I find that a reduction in bank loans can impair economic growth, often amplifying and prolonging a financial crisis. During periods of financial difficulty, credit allocation can often impede the damage that a financial crisis causes and can 'speed up' the recovery process[3].

The first and second empirical chapters primarily inquire about the viability of the stress testing framework as a prudential tool principally used to manage financial stability. However, is there a visible reduction in credit due to the stress testing framework? Are bank regulators prepared to accept a trade-off between enhanced financial stability and/or a reduction in bank credit?

The recent yet limited literature focuses on the U.S. region, which finds that the supervisory stress tests have reduced bank loans, which may be an undesirable outcome. I am, therefore, motivated to produce this thesis to explore further the effect of stress testing on bank lending by predominantly enriching the emerging literature and focusing on similar financial jurisdictions. I, therefore, contribute to the literature by analysing two new financial jurisdictions, the UK and the EU. To my knowledge, these two financial jurisdictions have yet to be explored. The advantage of studying these financial jurisdictions is that they have in place their national stress testing regime[4].

1.2.1 Financial Jurisdictions

I find it essential to similarly review a developed economy such as the UK financial system to contribute to the literature. It is a dominant financial centre, given its interconnectedness in the global financial system. More specifically, one motive to examine the UK financial system is its relatively large size. In 2013, the UK banking system's assets equated to 450% of national GDP, one of the largest banking sectors relative to

[3] To reiterate the importance of bank lending and why this is essential, specifically during a crisis. I briefly overview a case study in section 1.4 that provides a basis for why bank credit is needed. The case study investigates the COVID-19 pandemic which is a recent contemporary and ongoing issue.

[4] Importantly, national stress testing frameworks are not identically similar and have their differences. The differences in the frameworks and their effect on bank performance is discussed in the literature review section.

similar developed economies. (Bush et al., 2014).

Furthermore, Bush et al. (2014) suggest that the exponential size of the industry can be a critical determinant that strains financial stability; thus, monitoring an environment with an extensive banking system is challenging for regulators. Moreover, there are several other benefits of studying the UK financial system, thus producing valuable policy implications for regulators. The U.S. financial industry is a central global hub concerning financial services, nationally and internationally. The prominence of the U.S. financial system received attention during the subprime mortgage crisis episode, where the collapse of the subprime mortgage market resulted in a national crisis. Given its interconnectedness across the globe, the impact of crisis spread via contagion (Goddard et al., 2009). Following the U.S. financial system's significance as a major financial hub, the UK (London) is designated as the second major financial hub due to its activity, human capital, leadership and robust framework (Hutton and Shalchi, 2021; Bruegel, 2021). As expected, the UK plays an integral role in the global financial system. Intuitively, if a banking crisis were to emerge from the UK, the impact of that crisis would be amplified and affect the smooth function of the global financial system.

Regulations for the UK banking system are coordinated by the Bank of England (BoE). Over time, regulations by the BoE have instigated structural changes, which has resulted in greater consolidation within the industry, greater complexity regarding the balance sheet portfolio mix, and a more concentrated industry where the largest four banks dominate (Mayer et al., 2021)[5]. The reforms, in essence, has empowered a few banks to become systemically large, and they are implicitly deemed as 'too big to fail' (Davies et al., 2010). Subsequently, if a banking crisis were to materialise, primarily via banks considered to be systemically important, governments may intervene by providing financial assistance using various funding sources (Fethi and Katircioglu, 2015). Nyasha and Odhiambo (2013) find that banking reforms targeted towards deregulation for banks and building societies (to enhance competition) have enabled the largest four banks in the UK to consolidate by merging with smaller banks and building societies. Naturally, mergers and acquisitions by the largest banks have increased their economies of scale and scope, thus increasing their influence as financial institutions on a global stage.

5 Mayer et al. (2021) suggest to tackle the problems of having a concentrated banking industry, 'challenger banks' can play a pivotal role in encouraging competition. Although, 'challenger banks' and their entry into the banking industry, and their effect on competition is still a work in progress.

I outline my contribution in the second empirical chapter by examining an alternate financial jurisdiction. The EU financial system is as relevant as the U.S. and UK financial systems. Likewise, the EU is viewed as a significant global financial centre for institutions, several governments, and the European continent due to its vast size regarding its total assets, which amounted to 42EUR trillion, as of 2013 (Langfield and Pagano, 2015).

In contrast to the U.S. and UK, the EU financial system is more complex and deeply interconnected due to a single currency among 27 member states. More specifically, the 27 member states from the EU adopt the Euro to trade among other member states. In particular, as the Euro is the legally accepted form of currency, the EU's monetary policy overrides and replaces any previous monetary policy regime from any member state (Scheller, 2004). In fact, the ECB is responsible for maintaining price stability (monetary policy) in 27 member states while considering independent fiscal policy by member states (Sondermann et al., 2019). Dermine (2002) sheds light on this issue and argues that if an internal shock in one member country occurs, that member country will initiate ad-hoc fiscal policy measures to tackle the financial shock. The EU can respond to that shock by utilising monetary policy to support the member's fiscal policy measures. Albeit, Dermine (2002) finds that there may be reluctance from the ECB to pursue monetary policy measures to help members who are experiencing a financial shock, as the monetary policy measures would affect all member states.

In times of a crisis, a financial region such as the EU can raise severe adverse issues for the region and global financial system given its large size and interconnectedness with markets across the globe via contagion links and vice versa (Betz et al., 2013; Roncoroni et al., 2021). Additionally, a bank failure of a large systemic bank within the region can trigger a financial crisis that would damage the EU region first and then spread and affect the global financial system (Black et al., 2013). As the EU financial system is considered a global financial hub, there is a high degree of exchange in services and cross-border lending with financial institutions (Committee on the Global Financial System, 2018). More recently, the EU banking system now engages with non-financial institutions that are recognised as the shadow banking industry, as Abad et al. (2022) find that the EU is highly exposed to the shadow banking system, which is predominantly based in the U.S. financial system. Furthermore, the asset exposure from the EU banks is more prevalent among the largest and complex banks that aim to diversify. Accordingly, Abad et al. (2022) conclude that exposure in alternate regions can lead to spillover effects across borders if a crisis emerges, thus raising systemic risk issues. Financial systems such as the UK and the U.S. also experience problems with systemic risk.

Regarding this issue, the EU financial system is no exception, as an interconnected environment coupled with the complex nature of the region also contributes to systemic risk. Gehrig and Iannino (2021) highlight the problem of systemic risk that arises in the EU financial system and find that although financial institutions attempt to control bank risk, as evident by the reduction in idiosyncratic risk, there is still a rise in systemic risk that looms in the background. Notably, Gehrig and Iannino (2021) document that the largest and most complex banks in the EU report a greater rise in systemic risk issues compared to the smaller banks.

Intuitively, a system as large as the EU financial sector has its share of systemically large complex banks considered 'too big to fail'. The Financial Stability Board (FSB) (2020) reports the problems of this phenomenon and clarifies why governments and regulators routinely monitor the safety of these systemically large institutions. Simply said, the failure of such large, interconnected banks that engage in cross-border lending can instigate systemic risk issues for the financial system and spillover into the real economy if a crisis emerges. The FSB (2020) finds that designating banks as 'too big to fail' can negatively impact moral hazard. Too big to fail banks recognise that irrespective of the risks they take, the governments will bail them out in times of a crisis due to their structural characteristics (Kaufmann, 2014).

The above paragraphs highlight the significance of the UK and EU financial systems, which mainly addresses how large the financial systems are, their interconnectedness, and the ability to produce systemic risk issues that cause concern for regulators.

I argue that contributing to the literature by examining these two financial jurisdictions is equally as significant as analysing the U.S. economy. In sum, this thesis analyses the effect of supervisory stress testing on bank performance for the UK, EU, and U.S.

1.3 Theoretical Contribution

In the previous section, I outlined the thesis's contribution by examining two new financial jurisdictions that, to my knowledge, are presently unexplored. I reiterate the essential implications of reviewing these two financial systems due to their interconnectedness, size, and influence on systemic risk. In this section, I now turn my attention to discussing the theoretical contributions of the thesis.

In essence, the thesis contributes to two separate banking theories embedded in the related literature. First, I contribute to the *Risk Management* and *Moral Hazard* Theory. The contribution to this specific theory is connected to the first and second empirical chapters, which examines the impact of supervisory stress tests on bank lending and credit risk.

The third empirical chapter diverts from the previous two empirical chapters by investigating the benefits of diversification during financial crises. In this context, I investigate whether participating in the U.S. stress tests programme and simultaneously holding a diversified banking portfolio affects bank performance. Therefore, the third chapter contributes to the *Portfolio Theory* that considers the composition of the banking portfolio.

In the subsections below, I discuss the two theories in detail and their relevance in the banking/finance literature.

1.3.1 Risk Management Hypothesis

Acharya et al. (2018) construct several hypotheses on how a stress-tested bank may behave and sum the hypotheses into two main theories that serve as the basis for the theoretical contribution for the thesis. The first hypothesis concerns the Risk Management Hypothesis, which states stress-tested banks will reduce their loan originations to curb credit risk issues. The opposing hypothesis is the Moral Hazard Hypothesis, which intuitively assumes that stress-tested banks will increase loan originations, giving rise to credit risk issues in the future. Motivated by Acharya et al. (2018), I briefly review the Risk Management Hypothesis and Moral Hazard Theory (Agency Theory).

As evidenced by the recent regulations that the BCBS (2011) imposed, there has been a renewed emphasis on building a robust risk management environment for banks to operate relative to the preceding risk management framework before the crisis (Adrian, 2018). Accordingly, Turgut (2018) identifies the role of regulations to enhance risk management practices. In theory, Turgut (2018) suggests that the purpose of imposing a stringent risk management framework is to ensure that banks do not incur financial losses, do not experience erosion in the value of their assets, or hinder bank performance. In particular, and in relation to the spirit of the thesis, a risk management framework is implemented to mitigate risk issues that may arise from bank activity. Similarly, risk management processes in stress-tested banks help mitigate risk, including credit risk that may originate from bank lending.

Regulations play a critical role in enhancing or evolving the risk management framework of a bank. However, the effectiveness of a more robust risk management framework can be strengthened by bank competition. A high degree of bank competition within an industry can produce stronger risk management practices, thus building a robust credit risk framework (Bülbül et al., 2019). Bank competition, in turn, may indirectly influence a stress-tested bank's risk management profile and ensure that adequate credit risk measures support lending by the banks.

The shift in risk management practices resulting from the crisis has brought attention to the stress testing regime's role in managing risk. Though the stress testing framework is under review in mitigating risk, the previous shortcomings of the risk management regime before the crisis are being repaired by the stress testing framework, as its function is vital to impede financial risk. (Härle et al., 2015).

The capital requirement component of the stress testing exercise must meet a certain capital threshold. The requirement is a binding condition and must follow Basel III capital regulations. The purpose of such capital requirements is to ensure that institutions as a single entity are robust and the banking system is not susceptible to widespread shocks that transform into contagion. Thakor (1996) implies that capital requirements (a feature of the stress tests) based on financial institutions' risk profile may produce negative externalities, such as reduced bank lending. Indeed, although the institutions' risk management is improving via capital regulations, there is a cost in reduced lending, which may distort the available credit to the real economy. John et al. (2000) argue that holding capital may not reduce bank risk. Alternate avenues of reducing risks, such as a managerial compensation arrangement between bank owners and managers, can help reduce risk-taking behaviour within a bank. Surprisingly, Palia and Porter (2007) find opposite results and imply that capital can reduce bank risk, and compensation arrangements amplify risk within firms.

Risk management aims to mitigate bank risks across several dimensions, including market, liquidity, and credit risk instances (Drehmann et al., 2006). According to Dowd (2008), the risk management framework may be viewed as a 'one size fits all' framework that assumes the risk management procedures are effective under all economic conditions. In light of the financial crisis, Dowd (2000) documents that the failure of the risk management practices was due to the constrained approach that ignored extreme risks and possible channels that lead to contagion. In addition, Cumming and Hirtle (2001) argue the weakness of the risk management process in financial institutions may be due to the approach as the supervision of risk should be consolidated rather than segmented into different areas. A consolidated system may allow firms to assess risk in a holistic approach.

1.3.2 Moral Hazard (Agency Theory)

The issues in the previous financial crisis captured the fragility in the banking system and the subsequent need for government intervention to rescue distressed banks. The crisis spurred an academic debate on the moral hazard issues that persist, especially regarding implicit guarantees from governments to provide a financial lifeline to firms (Boyd et al., 1998; Donnellan and Rutledge, 2016; Demsetz et al., 1997; Allen et al., 2015). The hazard of such implicit guarantees may incentivise banks to pursue risk-seeking investments that may debilitate bank performance in the long term and growth in the non-performing loans (Zhang et al., 2016; Hossain and Chowdhury, 2015; Döbeli and Vanini, 2004). Moreover, as the implicit government guarantee is in place to protect the financial system, Nier and Baumann (2006) argue that banks will reduce their capital buffers as the government guarantee acts as a safety net. As a result, the reduced capital produces negative externalities for firm risk.

Antzoulatos and Tsoumas (2014) posit that the likelihood of a government's decision to bail out a distressed bank is more applicable if the banks are categorised to be systemically significant. Presumably, stress-tested banks are systemically significant due to their size and presence in their national economies. It is intuitively applicable to appreciate that these sample of banks may enjoy the benefits of an implicit government guarantee if a crisis were to emerge. The moral hazard issues may transpire if stress-tested banks commit to providing loans to their customers, as they may implicitly expect a government bailout, given their financial reputation.

To alleviate such moral hazard issues, Duran and Lozano-Vivas (2015) find that a more robust capital composition of the banks (safer banks) is one aspect that may dissuade banks from exploiting moral hazard incentives. In other words, banks with adequate capital may engage less in risk-seeking activities due to their resilience in accumulating greater capital which, in turn, mitigates moral hazard problems. The analysis brings attention to the performance of stress-tested banks post-stress test, as banks that pass the test will have the capacity to lend and be discouraged from exploiting moral hazard benefits.

The implicit guarantee from governments to intervene in a financial crisis and bail out banks can be seen to be unfavourable. Yet, this may often be necessary, as Dow (2010) argues that the regulator's decision to intervene and provide financial assistance to banks can counterbalance the issue of moral hazard. In times of a crisis, if the regulator signals its support to the banking system via bailout guarantees, this may mitigate moral hazard concerns (Cordella and Yeyati, 2003). Seemingly, the guarantee of financial assistance may encourage banks to seek further risk. Although, Cordella and Yeyati (2003) show that the guarantee by the regulator may yield the opposite result. Suppose banks are given explicit guarantees in times of a crisis. In that case, the banks' charter value will increase, sending a strong signal to the market, thus influencing banks to reduce their risk-seeking behaviour. For stress-tested banks' lending behaviour, the regulator's guarantee to intervene may mitigate moral hazard issues and inhibit stress-tested banks from lending to risky borrowers.

In contrast, the stress testing regime also mitigates potential moral hazard behaviour irrespective of an implicit government guarantee in the background. García and Steele (2020) argue that introducing the supervisory stress test is primarily conducted to assess a bank's ability to withstand a simulated shock and its capital adequacy. Yet, the framework has prompted stress-tested banks to adjust their strategies. Briefly, the effect of the exercise incentivises stress-tested banks to reduce their share of risk-weighted assets relative to their total assets. Moreover, while the banks reduce their risk-weight assets, García and Steele (2020) confirm that banks' lending behaviour does not deteriorate. More precisely, stress-tested banks reduce their risk-weighted asset composition and focus on loan originations as this is perceived to be less risky. The market and regulators view the decision made by the stress-tested banks to reduce risk-weighted assets and increase lending as a safe option, which, therefore, reduces the risk profile of the banks and helps lower the banks' funding cost. García and Steele (2020) find that such decisions made by the bank to reduce its risk profile helps attenuate any moral hazard implications. On the other hand, Berndt and Gupta (2009) suggest that an increase in loan originations may indicate a rise in moral hazard issues as banks may sell loans of less quality to the secondary market, which increases risk.

In the context of moral hazard, the matter of the principal and agent is discussed, as the principal and agent may have different financial incentives. Dow (2000) argues that within the theme of theory, bank traders may undertake risky investments to boost their revenue, thus benefiting the agent at the cost of the principal. On the other hand, in some cases, the clear distinction between an agent (trader) acting in their interest and the principal (management) encouraging risky behaviour is unclear. Dow (2000) states that the function of bank management is equally as crucial in reducing moral hazard behaviour. In line with the thesis, bank management behaviour in stress-tested banks' lending decisions is similarly crucial. Providing loans to safe and risky customers is a decision that managers can select via stricter monitoring or lending standards. Overall, the leadership and control by managers at the stress-tested banks can condense moral hazard issues.

1.3.3 Portfolio Theory

In the third empirical chapter, I depart from the previous chapters by examining an alternate bank performance indicator. I address the issue of bank diversification and its influence on bank profitability and financial stability during a financial crisis. Regarding the theoretical contribution of the respective chapter, I turn my attention towards portfolio theory. In essence, the portfolio theory states that a bank's balance sheet must hold uncorrelated assets to support a bank's performance. More specifically, the feature of owning a diverse range of assets can generate more revenue, and/or reduce idiosyncratic risk. Indeed, the choice to diversify is linked to the Risk Management Hypothesis, which can therefore help alleviate any moral hazard concerns.

The primary attribute of the portfolio theory is to reduce bank risk by acquiring and holding a diverse variety of assets. In essence, the theory proposes to maintain financial risk, banks should not hold their 'eggs in one basket'. In fact, Acharya et al. (2006) assess the function of diversifying into other avenues and find that diversification can often amplify financial risk and reduce profitability. In the context of Italian banks, Acharya et al. (2006) find evidence to suggest that the expansion of credit by Italian banks to different sectors and industries can lead to greater financial instability due to the costs of diversifying their loan portfolio. In general, as the Italian banks elect to expand their lending across different locations and sectors, there is a reduction in the effectiveness of bank monitoring due to factors such as experience or greater competition. The theory recommends a diversified balance sheet to act as an adequate buffer to stem financial risk; there are arguments against the decision to diversify. Acharya et al. (2006) explain that selecting a diverse portfolio can produce an unintended effect.

1.4 Coronavirus Case Study and Bank Lending Implications

We are currently observing the COVID-19 pandemic that has rapidly spread across the globe, causing public hysteria, a rise in the infection rate, and an exponential increase in fatalities. In the context of the UK, I find that the crisis has a detrimental impact on public life and has shaped government policy to introduce lockdown measures that aim to stem the spread of the virus. As a consequence, non-essential businesses had to remain temporarily closed[6]. Closing businesses has inevitably meant that there has been a sharply negative effect on economic activity.

While the government has been a central factor in combating the virus by creating measures to help preserve public health and the economy. The banking system has stepped up to provide critical financial services to businesses, as there has been a disruption of cash flow for businesses. To help financially support the firms that need access to cash for various reasons, demand for small business loans from banks has rapidly risen. In one case, the number of registered applications made by businesses affected by the pandemic reached 100,000 applications in its first day (Hotten and Mustoe, 2020), thus signalling the rise in demand for loans to counteract the disruption businesses and households are currently experiencing. At the same time, banks are under immense pressure to review these applications. Besides, branch closures and infection rates have exacerbated reviewing the applications. Furthermore, as the number of loan applications and acceptance rate increases, a rise in credit risk is expected.

Amid the creation of banking loan schemes, there was a slight frustration by the current governor of the BoE. He emphasised banks' crucial role in providing credit to the economy and encouraged banks to lend (Elliott, 2020). In a joint letter addressing the financial institutions, the Chancellor, BoE Governor, and Interim Chief Executive of the Financial Conduct Authority underscore the necessary steps banks must take to protect the economy and ensure banks are actively participating in the lending schemes. The letter stresses why credit allocation across the economy, especially to businesses, is fundamental in mitigating the effects of the coronavirus pandemic. The letter also issues new guidelines and solutions to reduce the burden or workload UK banks would face in the absence of the COVID-19 pandemic. Specifically, the 2020 stress test that was scheduled to take place is now scrapped; this decision to not implement the stress test was to reduce

[6] The section considers all relevant information on the coronavirus pandemic up to and including June 2020.

the operational burden from banks, thus easing the pressure. Additionally, the countercyclical capital buffer is set to 0%. The reduction in the capital buffer alleviates banks' capital restrictions, which means they have more capital to transform into cash for lending purposes (Sunak et al., 2020)[7].

To briefly summarise the case study, the effect of the pandemic is felt throughout the globe. Still, concerning the UK government's decision to support businesses during national lockdowns, the need to provide lending to businesses is essential to limit damage to the economy. The joint letter to the UK banks by the Treasury, BoE, and Financial Conduct Authority encourages banks to lend and have made exceptions for banks. Hence, they are readily available to provide loans to the economy. Failure to do so will result in firm and business closures, which may irreversibly damage the economy in the long term, and further amplify the effect of the pandemic on the economy.

The role of credit during the COVID-19 pandemic has received renewed attention and emphasises the importance of credit to an economy. Intuitively, for the first and second empirical chapter, I investigate if the stress testing regime affects credit allocation and if these exercises may disrupt credit flow to the economy.

The proceeding three sections briefly discuss the empirical chapters and provide an overview of their respective findings. Detailed analysis and discussion are included in the separate chapters.

1.5 The Effect of Supervisory Stress Testing on Bank Lending: An Analysis of the UK Banking System

The supervisory stress test's objective is to evaluate how resilient individual banks and banking systems are to an adverse shock. In effect, the exercise is employed to address the vulnerabilities that banks may face in a shock, and most importantly, their capital adequacy if a crisis were to materialise. However, one strand of the literature suggests that the stress tests reduce bank lending to the economy. Considering the reduction in loans to the economy is essential, as the decrease in loans can lead to undesirable consequences for the real economy.

[7] The joint letter can be found on the BoE's website. https://www.bankofengland.co.uk/letter/2020/letter-from-the-chancellor-governor-and-fca-to-th

The chapter documents that the limited research on the relationship currently examines the U.S. banking system. I contribute to the discussion by analysing the specific effect of the UK banking system. A feature of the chapter that distinguishes itself from the current literature (discussed below), is that I include two stress testing timelines from two supervisory authorities. First, I analyse the effect of the BoE's stress testing exercises on UK bank lending. I then proceed to examine the stress testing exercises administered by the EBA for robustness checks.

The chapter's results coincide with the findings shown for the U.S. banking system to some extent, where banks who fail the stress tests reduce lending, thus providing evidence to suggest that heterogeneities among the stress-tested banks exist, which may affect bank lending to the economy. Furthermore, the literature questions the effectiveness of each stress test, which argues that the earliest stress tests significantly influenced bank lending relative to the most current exercises. Though, I report that stress tests applied to the UK banking system do not exhibit a decline in the effectiveness of the stress tests throughout the period.

In line with the theoretical contribution, I find supporting evidence that posits that banks that fail the stress test reduce loans which coincide with the risk management hypothesis. Failed banks reduce loans to mitigate credit risk problems. From a regulator's perspective, the decision to reduce loans by failed banks may cause concern and affect the availability of credit for the real economy. Instead, as banks mitigate credit risk, this ultimately improves financial stability, a principal objective for regulators.

1.6 The Effect of The EBA's Stress Testing Framework on Bank Lending and Credit Risk: Examining The EU Banking System

In the second empirical chapter, I begin to investigate the effects of stress testing and bank lending, similar to the first empirical chapter. The core objective is to assess the effects of stress testing on bank lending. Importantly, the recent literature hypothesises that stress-tested banks reduce lending to mitigate credit risk issues. Nonetheless, the hypothesis's shortcoming that suggests banks modify their lending approach to reduce credit risk issues is not empirically addressed, to my knowledge.

I examine a new financial jurisdiction to complement the literature in terms of the contribution. In sum, I analyse the bank lending decisions and credit risk profile of stress-tested banks in the EU. The EU banks that

I consider must undergo bi-annual stress tests that the EBA supervises. One unique feature of the chapter is that I differentiate between the first empirical chapter and the literature review by including two different methodologies that account for the effect of stress testing by employing a difference-in-difference estimator and constructing the ‘stress test exposure’ variable. In regards to the difference-in-difference estimator, the results confirm that stress-tested banks have reduced corporate bank lending relative to non-stress tested banks. Moreover, I find that the stress-tested banks face elevated pressures of credit risk compared to non-stress tested banks.

In the second step, I account for the differences within stress-tested banks using the ‘stress test exposure’ variable methodology. Highly-exposed banks against the stress test will reduce consumer loans compared to banks that perform better against the adverse stress test.

Finally, the literature and results from the first empirical chapter find that failing a stress test significantly affects bank lending decisions. However, the findings state that other determinants such as stress-tested banks’ geographical location can impact bank lending decisions and credit risk profile. Specifically, stress-tested banks from the GIIPS region reduce bank lending more than banks from non-GIIPS countries and simultaneously display heightened signs of elevated credit risk. To my knowledge, this is a significant contribution that has not yet been considered and may provide incentives for future research.

Briefly, for the theoretical contribution, stress-tested banks reduce lending to certain loan types such as corporate and consumers loans as these are associated with greater risk. The reduction in these loan types is in line with the risk-management hypothesis. The results find that stress-tested banks from GIIPS experience greater credit risk and lower lending activity relative to their peers. The issue at hand may affect moral hazard problems that regulators must consider.

1.7 Bank Diversification, Profitability, and Financial Stability: Comparisons Between The GFC and COVID-19 Pandemic

In the final empirical chapter, I diverge from the central theme of the thesis and focus on a contemporary issue that is currently ongoing. The impact of the COVID-19 pandemic has not only debilitated public life. Still, it has shed light on the financial industry’s ability to withstand a shock and deliver on its function to lend to the economy. I hypothesise that bank diversification strategies can support bank performance during a crisis and alleviate any potential financial stability concerns. The chapter finds supporting evidence that diversification improves bank profitability and enhances financial stability for a sample of U.S. banks, especially during the early stages of the COVID-19 pandemic and the GFC. Indeed, the results suggest that the relationship between diversification and financial stability is stronger during the GFC period than the ongoing COVID-19 pandemic. The earlier crisis was defined as an endogenous shock determined within the financial system, whereas the COVID-19 pandemic is an exogenous health shock.

To relate to the thesis, I also investigate the inclusion of the stress testing regime and its benefits in promoting a prudent risk management framework. Essentially, since the GFC, no real crisis as strong as the COVID-19 pandemic has emerged. The current setting allows the empirical chapter to statistically consider the subset of banks participating in the U.S. stress tests. In other words, I construct an interaction variable and analyse if stress-tested and diversified banks yield a comparative advantage. Intuitively, a stress-tested and diversified bank is to some extent more resilient than its counterparts as the stress-testing regime ensures banks hold adequate capital. In addition, the banks elect to diversify the balance sheet, which enables banks to shift risk (one motivation to diversify). In sum, stress-tested and diversified banks are more financially stable and profitable than their counterparts. The results postulate that the stress testing framework tool as a macroprudential tool is effective and plays a significant role in the regulator's toolkit, even during times of financial crisis.

In relation to the theoretical contribution, the results align with the portfolio theory, which states that holding uncorrelated assets in the balance sheet can shift risk, and enhance revenue streams for the banks. Albeit the literature recommends a certain threshold of diversification that is optimal. In fact, I find that a diversified portfolio during a financial crisis is vital to uphold financial stability for the banks and help alleviate moral hazard issues in terms of government guarantees for struggling banks.

1.8 Thesis Structure

The following section reviews the stress testing, bank lending, and diversification literature. In regards to the first empirical chapter, I focus on the effects of stress testing on bank lending for the UK banking system. In the second empirical chapter, I examine the impact of stress testing on bank lending for the EU. In addition, I analyse the effects of stress testing on credit risk within the EU. The final empirical chapter considers the impact of diversification on bank profitability and financial stability. As a contribution, the final chapter explores the interaction between stress-tested and diversified banks and how this affects bank performance. Next, I provide policy recommendations that emerge from the results of the empirical chapters. Lastly, I conclude the findings of the thesis.

Chapter 2

Literature Review

2.1 Literature Review Outline

The first subchapter reviews the supervisory stress testing literature, which predominantly focuses on the implementation and impact of the exercises due to the GFC. In general, the subchapter studies the effects of stress testing on bank lending, which motivates the direction of the thesis. Importantly, I observe that the relationship between stress testing and bank lending is limited and solely concentrates on the U.S banking system.

To enhance the thesis structure, I progress to examine alternate papers that discuss the effect of stress testing, especially on bank performance and market reaction, as this incentivises the methodological approach. Similarly, the literature enables us to recognise the criticisms of the exercise as a risk management tool and the influence of the framework in other jurisdictions.

One advantage of studying the stress testing literature is that the related papers explicitly distinguish between stress-tested banks by frequently allocating these banks into groups due to certain characteristics. The characteristics may entail if they have passed or failed the exercise and also evaluate the weaker or stronger banks with respect to their post-capital level. Grouping stress-tested banks are common among the literature as it identifies heterogeneity. The literature suggests that there are differential effects among heterogeneous banks. Therefore, analysing heterogenous stress-tested banks motivates the econometric identification strategy for the thesis.

The second subchapter addresses the literature review on bank lending and the determinants that affect decision-making for bank lending. Noticeably, I appreciate that a vast literature discusses bank lending in great detail and covers many aspects. Though for this subchapter, I choose one key area. Namely, I focus on bank lending behaviour during financial crises and how crises may affect or sway bank lending policy. The reader might ask, why consider the bank lending literature review that predominantly references financial crises, and why overlook various other factors? Recall that a stress test is defined as examining the banks' stability when experiencing an adverse shock that has the characteristics of a financial crisis. Therefore, a stress test is akin to a hypothetical financial crisis. The subchapter briefly overviews alternative factors that influence bank lending policy, for instance, the monetary policy regime.

The final subchapter diverges from the main theme and examines the diversification literature. In sum, the review critically analyses if bank diversification can either benefit or harm bank performance. Indeed, the benefit of reviewing the literature provides insight into the variables and methodologies that are employed. Seemingly, the literature review may deviate from the main theme (stress testing and bank lending). Yet, I find that the literature review provides evidence that suggests diversification can be adequate if other underlying factors are considered, such as the influence of human capital efficiency.

Detailed analysis is provided in the respective subchapter and drives the identification strategy.

2.2 Stress Testing and Bank Lending

Since the post-financial crisis, small business lending by U.S. banks has remained stagnant and has not risen relative to commercial and industrial lending. Cortés et al. (2019) observe this relationship and find that the U.S. stress testing exercises have triggered stress-tested banks to cut back on small business lending. Their paper highlights that the stress-tested banks reduce lending and exit from markets or counties where they do not have a physical bank presence. Notably, the reduction in small business lending is prevalent towards riskier borrowers. Furthermore, the stress-tested banks raise the interest rates on loans for small businesses in markets with a physical bank presence. The reduction in lending may have severe consequences for the local economy, such as a fall in local investment or local output (Doerr, 2019). Cortés et al. (2019) question if the exercises alter aggregate lending. In general, the authors find when stress-tested banks reduce lending, smaller banks (non-stress tested) replace these banks and become primary lenders. The paper advocates that the shift in lending from stress-tested to non-stress tested banks may be beneficial. Specifically, the non-stress tested banks have stronger relationships based on the soft information acquired on the borrowers' characteristics. Also, the shift in lending from non-stress tested banks helps maintain financial stability and promotes competition.

Calem et al. (2019) document the effect of prudential measures since the GFC and find that the regulations may be distorting bank lending for the U.S. banking system. One prudential measure they discuss is the impact of stress testing on bank lending. Calem et al. (2019) find that stress testing has reduced jumbo mortgage lending, which is statistically strong for the 2011 CCAR (Comprehensive Capital Analysis and Review). The authors find subsequent stress testing frameworks did not significantly affect bank lending, as banks improved their capital ratios. The paper analyses the effect of the 2011 CCAR stress test and find that the effect is significant for the three quarters immediately after the stress test. Calem et al. (2019) show differential effects of stress testing on jumbo mortgage lending, which depends on the capital position of the banks that participate in the stress test. The paper finds that banks with lower ex-ante capital originate fewer jumbo mortgages than highly capitalised banks before entering the stress test. Similar to Cortés et al. (2019), the results show that when the stress-tested banks reduce jumbo mortgages, non-stress tested banks substitute the gap and increase their jumbo mortgage loans.

Like the aforementioned papers above, Acharya et al. (2018) document the impact of the stress tests on bank lending. The authors use a difference-in-difference approach that examines a sample of U.S. banks that participate in the U.S. stress tests and those that do not. Importantly, Acharya et al. (2018) find a change in the behaviour of the stress-tested banks, as their primary objective has been to reduce credit risk. To minimise credit risk, stress-tested banks increase loan spreads for their corporate borrowers (via syndicated lending) and cut back on lending for several loan types such as commercial real estate and credit card loans. The authors elaborate on why these loan types experience a fall in available credit and state these loan types are associated with greater credit risk. In addition, Acharya et al. (2018) assess the interpretation behind the findings and conclude there are differences amongst the stress-tested banks. Banks deemed financially stronger (measured as above the median with their capital ratios) reduce loans more than banks with lower capital levels. Likewise, Acharya et al. (2018) confirm that failing the stress test is not a determinant that influences bank lending. In addition, the exercises may be losing their effectiveness in the long term, as the statistically significant results are visible in the earliest stress testing periods relative to the latest periods (Calem et al., 2019).

In a related paper, Bassett and Berrospide (2018) examine the relationship between stress testing and bank lending for the U.S. banking system. In contrast, Bassett and Berrospide (2018) approach the topic by constructing the effect of a stress test by employing an alternative methodology. The paper assesses the difference between the banks' internal stress test post-capital ratio and the supervisors' internal stress test post-capital ratio and defines this as the 'capital gap'. Importantly, they identify that the change in the capital gap reflects the effect of the stress test. The paper finds that as the capital gap increases, bank lending increases. The evidence provided by the paper counteracts the literature which currently examines the U.S. banking system that documents that stress tests are reducing bank lending (Acharya et al., 2019; Calem et al., 2019; Cortés et al., 2019). On the contrary, it is not surprising, as the effect of the stress test is specified differently. Bassett and Berrospide (2018) document that it is vital to inspect the stress testing scenarios for each test. The test may inform banks that there is a possible shock to a certain loan type, indicating that risk could emerge in the future. The simulated shock of the loan type in the stress testing scenario may convince banks to reduce loans for specific markets, which could be viewed as an indirect effect.

Connolly (2017) documents the effect of stress testing on firms that borrow from participating banks. The author argues that regarding the same firm (borrower), the stress test has caused an increase in bank lending as compared to the lending levels in the pre-stress testing period. Said differently, the introduction of the 2009 SCAP stress test has meant that participating banks have increased their lending volumes to the same firm. Furthermore, as expected, there are differences amongst the stress-tested banks. Well-capitalised banks increase lending more than banks with weak post-capital positions (falling below the capital threshold of the test). Firms with strong relationships with banks pre-stress tests do not face any difficulties borrowing from the same bank post-stress tests. The established links with the bank benefit the firm, and banks will continue to lend, thus allowing firms to continue investing. One limitation of the paper is that Connolly (2017) entirely focuses on the first U.S. stress test (SCAP 2009), which may bias the paper's findings and misinterpret the long-term effects of the stress testing exercises on bank lending. Future research should consider the effects of successive stress tests and if the banks continue to lend to the firms with established links.

Cortés et al. (2019) analyse the small business market and provide evidence to suggest there is a contraction in lending that the stress tests have spurred. Chen et al. (2017) similarly examine the lending behaviour of large U.S. banks for the small business market and suggest there is a substantial decline in small business lending activity. Notably, Chen et al. (2017) do not exclusively examine the behaviour of stress-tested banks in the U.S. Nevertheless, the authors suggest that the contraction in small business lending can be attributed to the new banking regulations such as Basel III and the supervisory stress tests as a forward-looking exercise. Furthermore, Chen et al. (2017) explore the knock-on effects for small businesses. More precisely, when large banks reduce lending, smaller banks and non-bank financial firms fill the gap and lend to small businesses (Cortés et al., 2019). However, small businesses are negatively affected by the loan conditions, as smaller banks charge a higher interest rate on their loans. Hence, while small businesses can still access loans by switching to alternative sources, the loans they receive are attached with a financial burden (unfavourable loan terms). This, in turn, affects wage growth and unemployment levels in the region where the small businesses are based. Strikingly, the authors find a time lag transition for small businesses that borrow from smaller banks, which Cortés et al. (2019) do not examine.

Supervisory authorities such as the EBA or the FED are instrumental in the success of the stress testing exercises. Concerning the stress tests, supervisors design the scenarios and banks can either fail or pass, conditional on the banks meeting the quantitative or qualitative requirements. Shapiro and Zeng (2019) build a theoretical model that proposes that regulators who administer the stress test can indirectly affect bank lending due to their decisions. Importantly, the authors develop assumptions around the regulator's behaviour concerning stress tests. The regulators are signalling their reputation to the banks via the stress test. The paper suggests that the signal they send to banks concerning their reputation is a dichotomous choice between being defined as strict or lenient. Suppose the regulatory bodies desire to appear strict. In that case, they will fail banks, which determines the choices made by the participating banks, this would primarily lead to a reduction in bank lending, and the banks would invest in alternative assets. If regulators wish to appear lenient, they will pass the stress-tested bank (irrespective of a weak capital position), which suggests that banks will continue lending in the next period. In summary, Shapiro and Zeng (2019) highlight the role that regulators can have on bank lending and how their reputation (solely controlled by their decision making) can influence bank lending. Furthermore, the decision of a regulator to either fail or pass banks is associated with a trade-off between growth in bank lending or financial stability.

In the context of the U.S. banking system, Liu et al. (2019) explore how the Fed's monetary policy impacts bank lending behaviour. The authors first assess how a reduction in monetary policy affects bank lending behaviour and find evidence to show that U.S. banks increase their share of commercial and industrial loans to foreign countries, more specifically the emerging countries. However, the authors further analyse the differences amongst the banks and concentrate on banks that are included in the Fed's stress testing programme. The paper focuses on the post-stress test capital ratio of the banks. It differentiates the lending behaviour between banks with a large capital buffer and those holding a small capital buffer. The banks that marginally pass the set threshold for each respective bank (identified by the small buffer) lend less to emerging countries than banks with larger capital buffers that lend more due to their stronger performance against the stress test. Importantly, the authors explain that the loosening of the monetary policy predominately stimulates the change in bank lending. Although this does not advocate that all banks will behave the same, certain banks must abide by macro-prudential restrictions and practices such as stress tests that may impact their lending intentions. Implementing programmes such as stress testing may indirectly hinder the intended effect of the monetary policy objective from increasing lending.

2.2.1 Criticisms of Stress Testing

In the case of criticism of the stress testing regime, Cornett et al. (2018) investigate the effects of the exercise and find that stress-tested banks in the U.S. manipulate their balance sheets, specifically their capital ratios. The paper observes that the stress-tested banks increase their capital ratios relative to non-stress tested banks, which often occurs before the start of the stress test. Furthermore, to support their objective of passing the stress test, the stress-tested banks will change their dividend policy by reducing how much dividends they pay to their shareholders relative to non-stress tested banks. Hence, the reduction in dividends further enhances banks' capital ratios. Likewise, the results find that stress-tested banks engage more in political lobbying compared to non-stress tested banks. The analysis suggests that banks may engage in strategic tactics to pass the stress test, but this may bias the actual risk profile of the bank. As the balance sheet is modified to boost the capital ratio, the regulators may not accurately estimate the real effects of an adverse shock on the bank.

Post stress test, the regulator publishes the results of the individual banks within the programme and provides analysis on the ability of the whole banking system to absorb a shock. The disclosure of the results ensures market discipline and provides the market with information on the banks' performance if a potential adverse shock occurs. However, the disclosure of results can create a damaging effect on the banks in question. Goncharenko et al. (2018) address the effect of the disclosure policy on the stress-tested banks' performance and explain that the disclosure of results can negatively impact the bank. Furthermore, the negative impact is more pronounced for the systemically important institutions identified as the largest and most complex banks. Goncharenko et al. (2018) identify that the effect of disclosing the results can hamper bank performance. Nevertheless, they do not address how the disclosure policy may affect banks that pass or fail the stress test. In addition, Goncharenko et al. (2018) base their findings on examining two stress-tested frameworks (2011 and 2014 EBA stress test). The strength of the results may have been enhanced by including alternative stress testing frameworks to see if the results hold for the later stress testing exercises.

In line with the paper cited above, the disclosure policy can have a limited effect on ensuring market discipline. Lazzari et al. (2017) find that the comprehensive assessment of the banks undertaken in 2014 for EU banks had little effect in signalling the health of the banks and the banking system as a whole. The comprehensive assessment was similarly linked to the stress test in the EU financial system in 2014. Still, it explains that concerning the disclosure of the comprehensive assessment of the banks, the disclosure of the results does not play a major role in improving bank transparency. More specifically, Lazzari et al. (2017) show that the information emerging from the comprehensive assessment finds it challenging to differentiate between stronger and weaker banks.

The stress tests that concern the EU and the BoE's frameworks use consolidated data of the banks' balance sheet and primarily assess the effects of a hypothetical shock on the banking group as one unit. Cerutti and Schmieder (2014) find that using the consolidated data of a bank's balance sheet can be disadvantageous as it does not truly represent the effects of adverse stress on the individual banking group. Most importantly, they advocate for the stress test to be applied to the banking group's parent and subsidiaries. In other words, the stress tests should use unconsolidated banks' balance sheets instead of consolidated data. Cerutti and Schmieder (2014) highlight that during a period of a financial shock, subsidiary banks may be restricted or ring-fenced by the supervisory authority that controls the subsidiary banks' jurisdiction. In effect, the supervisor can restrict funds transfer between the parent bank and subsidiaries during a crisis. Therefore, the research finds that using an unconsolidated approach that captures the effect on bank subsidiaries can reflect the true effect of an adverse shock on the parent bank and its subsidiaries. Subsequently, stressing the parent bank and each subsidiary offers granular information on the performance of the financial institutions.

The result of each subsidiary will produce different post-capital ratios, which informs the banks and the supervisors on more realistic outcomes.

One critique of the stress tests accurately reflects the risk to banks under an adverse shock. Taleb et al. (2012) study the stress tests and find that the exercise may mislead or distort the stress test outcomes, thus undermining the actual performance of the banks. The authors argue that the limitation of the current stress tests is the inadequate number of scenarios that financial regulators often use to assess an adverse risk. The authors explain that the baseline and one adverse scenario are common features of stress tests but cannot accurately portray the impact on a bank, as more scenarios are required to reflect potential downturns. Furthermore, Taleb et al. (2012) theoretically present a model that captures various effects of extreme tail-risk events and propose variations in tail-risk events, thus leading to several possible estimates.

The stress testing results can often be undermined by the design of the macroeconomic scenario. The macroeconomic scenario is designed to represent the effects of a plausible adverse shock on the bank. However, Hesse et al. (2014) document that the limitation of the macroeconomic scenario is often related to its inability to accurately include the possible spillover effects that may occur if a real crisis were to emerge. Hesse et al. (2014) develop a model to test the effect of spillovers that arise from a selective number of European countries on banks' solvency and liquidity position[8]. The paper first explains that spillovers were a persisting effect during the GFC of 2008-2009 due to the volatility in sovereign spreads. While combining the effects of the macroeconomic scenario and the potential spillover effects, the paper's results show that the stress on the banks is larger, as expected. Hesse et al. (2014) document that the spillover effect will significantly affect the banks' solvency and liquidity position. To account for the effects of spillovers is an important step to represent a more comprehensive outlook of the banks' outcome due to an adverse shock.

In a recent paper, Nguyen et al. (2020) assess how stress testing has affected bank behaviour concerning the evolution of liquidity on the banks' balance sheets (on and off). The paper benefits from using quarterly data, which examines the start of the stress test and periods that succeed the initial stress test exercise. Briefly, Nguyen et al. (2020) document that due to the U.S. stress tests, banks have reduced their liquidities, with the primary reason being to mitigate risk. Besides, the results show that while the banks reduce liquidity for the

[8] The countries that are defined as the peripheral countries are the GIIPS (Greece, Italy, Ireland, Portugal and Spain).

assets side of the balance sheet, the liquidity for the liabilities side increases. In contrast, the stress-tested banks look to increase the deposits from customers to enhance their funding structure. The paper is the first to consider how stress tests affect liquidity creation by banks. Although, the analysis falls short of comprehensively analysing the effects of stress testing on bank liquidity. The empirical results fail to identify if failing the stress test affects liquidity creation. The analysis neither identifies if banks with a larger capital gap (greater reduction in the capital) show significant results. Also, the effect of being a G-Sib bank may have shown interesting results.

2.2.2 Stress Testing and Market Reaction

The disclosure of stress tests in different periods can also reveal information on stress testing. The notion that disclosure of stress testing is similar across different periods is not evident. Georgescu et al. (2017) examine the 2014 and 2016 EBA stress test and argue that the disclosure of results for each exercise will not yield similar outcomes for the participating banks' CDS returns and stock prices. Furthermore, the paper studies the stress testing period by investigating different events for the exercise and find that it is essential to capture all components of the stress test, such as the release of the methodology, the announcement of the stress test and the results. For example, Georgescu et al. (2017) find that different disclosure events such as an announcement can affect banks' CDS and stock prices; therefore, future research needs to consider various components during the duration of the stress testing exercise. A criticism of the paper is that alternate stress testing frameworks can lead to different results. For instance, the paper highlights that the 2014 stress test included a CET1 capital pass/fail threshold that banks must meet. The paper should have included the effects of the stress test before the 2014 stress test, as there were pass/fail thresholds, and controlling for these similar stress tests may have served as additional robustness checks to verify the findings by the paper.

An important distinction between the stress testing exercises conducted across different jurisdictions is that the stress test results on banks' stock prices will not provide a similar outcome. Georgescu et al. (2017) investigate the effects of stress testing in Europe and find differences in two EU stress tests because of the structure of the respective framework. However, Candelon and Sy (2015) further explore this dynamic and show that the stress testing exercises for the U.S. and EU banking system led to different outcomes concerning each year the stress test occurs. Importantly, Candelon and Sy (2015) find that it would be difficult to compare the stress testing exercises within jurisdictions and between different jurisdictions, as the framework of the stress tests is constantly changing. Therefore, the stress tests are not comparable. The paper documents that the U.S stress tests were more effective in positively affecting the banks' stock price than the EU stress tests because of the effective approach adopted by the U.S. in constructing its stress testing framework. Although, for the U.S., the effect of the stress tests is diminishing over time and is not significantly affecting banks' returns. The main limitation addressed by the paper is that the stress tests focus heavily on the scenarios and capital ratios. The paper advises a greater emphasis on the structure of the stress test, such as the number of banks, the assumption of the balance sheet's evolution, and reassurance by the governments to provide financial assistance if a crisis were to materialise.

Petrella and Resti (2013) further dissect the effects of the stress test exercise on the market reaction by analysing a more detailed event study. The authors postulate that the 2011 EBA stress test provides greater disaggregated data relative to the 2010 exercise for the participating banks. Disaggregated data permits the authors to explore how different variables may affect the banks' performance as measured by the stock price. Petrella and Resti (2013) take advantage of the disaggregated data study and test this against the abnormal returns of the banks and imply. The authors advocate disaggregated data as it shows that the markets can react to different metrics rather than solely focusing on the primary solvency metric, which is often the Tier 1, Total Capital, and CET1 ratios. The critique of the previous stress tests results from the limited data points.

Neretina et al. (2015) explore how the U.S. stress tests affect the markets' reaction to several events surrounding the stress testing exercises. Neretina et al. (2015) contribute to the literature by examining how the exercise affects market risk and idiosyncratic risk. Accordingly, the stress tests from 2009-2014 have led to a decrease in risk for the market and the banks. The paper diverges from the current literature by examining different events concerning the exercise, such as the announcement and results. Neretina et al. (2015) contribute to the event study methodology by controlling for the supervisory authority's intervention related to the stress test. Specifically, the paper states that the Chairman of the Federal Reserve (Bernake) provided clarifications regarding the stress test framework that occurred in 2009. This clarification altered the stock market reaction, which affected the banks' stock. On the other hand, the clarification by Bernake did not influence the CDS spreads. The paper highlights the importance of considering different event windows and how this may significantly affect the markets' reaction. Furthermore, the paper finds that the results across the stress testing periods are not similar, which generally show that the stress testing exercises in providing information are diminishing and are most predominant for the earliest stress tests (Acharya et al., 2018).

In a similar vein, Morgan et al. (2014) document that different events during the stress testing exercise in 2009 can produce several effects. Morgan et al. (2014) first examine the differences between stress-tested banks and non-stress tested banks and find differences in the reaction from the markets regarding banks' stock prices. More importantly, the effect of each event (announcement, clarification, methodology, and results) can have different effects. Furthermore, the differences between banks with a capital gap and those that do not experience a capital gap are evident. As expected, banks that pass the stress test enjoy positive returns relative to banks that have failed the stress test. Also, as explained by the paper, it is crucial to examine further banks that fail and assess how the market reacts to banks with larger capital gaps than banks with smaller gaps. Morgan et al. (2014) document that banks with larger capital gaps experience more negative returns than banks with smaller gaps. One limitation of the paper is related to the number of exercises. The paper fails to account for the other stress testing years and fails to assess if the 2009 SCAP stress test findings align with the effects of the succeeding stress tests.

In a related paper, Borges et al. (2019) explore the effects of 2010, 2011, and 2014 stress tests for the EU. The authors find differential effects concerning the events across the three exercises regarding the announcements, methodology, and results. Surprisingly, the paper finds that the methodology of the stress tests is an influential factor in providing information to the markets, compared to the announcement and results. Borges et al. (2019) highlight the differences between the three stress testing exercises and find that the market reacts differently because of the structure of each stress test. Neretina et al. (2015) show positive and statistically significant results for the earliest stress test regarding the 2009 SCAP test. Strikingly, Borges et al. (2019) find that the earliest stress test did not contribute to a positive increase in stock market returns for the banks. Specifically, the limitations presented by the methodology for the 2010 stress test failed to reassure the market of the stress being stringent enough to reflect possible adverse shocks. The paper, therefore, explains that the limitations of presenting a restricted methodology can significantly affect the reaction of the market. Furthermore, the importance of segregating banks into passed and failed banks are important to analyse as advocated by the authors, who show that for 2014 results, the risk associated with failing the stress test is inherently higher than banks that pass the stress test. Yet again, the analysis of banks failing the stress test leads to a negative stock market reaction, thus indicating the disclosure of results that provide disaggregated data can provide greater information to the markets.

2.3 Bank Lending and Financial Crisis

In times of a financial crisis, the economic downturn in one country can alter a shift in lending practices for another country. The subprime mortgage crisis that first crystallised in the U.S. affected many economies worldwide. Puri et al. (2011) examine this event and develop their research by examining how the U.S financial crisis affected German Saving banks. The paper states a fall in bank lending to customers because of the German Savings banks' exposure to the U.S. banking system prior to the financial crisis. Puri et al. (2017) find that banks more affected by the U.S. crisis reduced consumer and mortgage loans relative to the German Saving banks less exposed to the U.S. financial crisis. Additionally, the paper documents that among the more exposed banks to the U.S. banking sector. Smaller and less liquid banks were far more likely to reduce bank lending to consumers and prospective borrowers seeking mortgages. Furthermore, due to the credit risk often observed with mortgages, the reduction in mortgage lending was more prominent than the reduction in consumer lending to customers. Consequently, Puri et al. (2011) provide evidence to show that during a crisis, bank lending behaviour may affect different loan types because of its credit risk.

Cubillas and Suárez (2018) also document that there has been a negative consequence of reduced bank lending due to the financial crisis. In regards to an unintended effect, the authors find that although certain banks will become insolvent. Due to mergers or government bailout guarantees, surviving banks will gain a greater market share. Cubillas and Suárez (2018) study the effects of an increase in bank market share and how this affects bank lending. The paper finds that banks that gain a greater market share will increase bank lending (post-financial crisis). There are several reasons behind this transition. First, as some banks become insolvent, customers with prior relations with the insolvent banks will look to other funding sources. Second, banks with greater market share have greater access to different funding sources, and due to their size, the funding will be less costly.

The lending standards of a bank is often conditional on the risk profile of the bank and/or the prevailing economic conditions of where the bank operates. Van der Veer and Hoeberichts (2016) evaluate the impact of bank lending standards in the Netherlands and how this drives bank lending decisions. As anticipated, the paper finds that as banks adopt stricter bank lending standards, which generally suggests it is more difficult to access loans, bank lending originations decrease by banks to businesses. The result does not come as a surprise. Still, the authors highlight that the strategy by banks to either make lending standards stricter or easier is often dependent on prevailing economic conditions. Van der Veer and Hoeberichts (2016) show in their paper that before the financial crisis, lending standards were more flexible, which in turn led to an increase in loan originations. Although, once the financial crisis emerged, the lending standards became increasingly stricter, which meant that banks reduced loan origination. In sum, the paper suggests that the lending standards can be influenced by different elements, like a financial crisis, for example.

Banks' geographical location and relationships with customers can affect bank lending behaviour. Barboni and Rossi (2019) study the behaviour of local banks and show that during the onset of the financial crisis, local banks provided more lending to customers (with previously established relationships before the crisis) than non-local banks. The authors posit that smaller, more local banks benefit from establishing closer relations with customers because smaller banks may have specialised knowledge in a certain industry or are more informed regarding the local economy than larger non-local banks. Before the financial crisis, there was no visible differential lending pattern between smaller local and larger banks. Presumably, as the financial crisis crystallised, the larger banks became disadvantaged as they did not possess accurate information on the financial stability of firms or customers, so they withheld lending. Subsequently, local banks have richer (soft) information because of their close links with customers, meaning they will continue to lend to customers they had previously established links before the crisis. Following the main results, Barboni and Rossi (2019) state that their study's limitation considers two time periods, one year before and one year after the financial crisis. Using such a limited timescale may inadvertently draw the wrong conclusions about the lending behaviour of local banks. While the local banks continue to lend, the effect is only visible for the year immediately following the financial crisis. The paper fails to capture the evolution of lending by local or larger banks for the long term.

D'Aurizio et al. (2015) address the same phenomena of bank lending to firms across Italy but are solely interested in how bank lending behaviour changes for firms. The research first postulates that there are differences among firms that may incentivise banks to lend to them or cut back on lending. The paper divides the firms into two groups based on their ownership structure: family-based firms and non-family-based firms. The empirical analysis suggests that after the onset of the financial crisis in Italy, banks have been originating more loans to family firms relative to non-family firms. An important question that arises from this finding is why banks are more willing to lend this specific type of firm relative to the alternative group? The answer lies in using soft or private information that has risen since the financial crisis.

Loans are essential for firms for several reasons, including new investment opportunities or simply supporting their daily operations. During the subprime mortgage crisis of 2008 - 2009, many firms could not access funds from banks because banks were adopting policies to reduce credit risk, maintain strong capital positions, and remain adequately liquid. Casey and O'Toole (2014) examine how a sample of firms across 11 Euro Area countries behave when they cannot access credit by banks. The paper suggests that the banks reject a subset of the firms' loan applications. For another class of approved loan applications, firms themselves will reject the loan conditions due to the perceived cost (such as a high-interest rate). The paper finds that while the financial crisis has inhibited banks' reduction in lending, firms cannot rely on bank lending to fund investment opportunities or their daily business activities, which means that firms must seek alternative finance sources. Casey and O'Toole (2014) show that these firms primarily substitute bank loans for trade credit, defined as a 'buy now, pay later' scheme with their established suppliers. Interestingly, the authors find that while government loans and schemes are available for firms, the probability of a firm applying for this type of finance decreases. Yet again, a repeated theme regarding bank lending is influenced by a financial crisis, which first inhibits a banks' lending capability, thus having knock-on effects for firms that cannot access funds. The reduction in credit availability could directly cause a fall in investment by firms, which can amplify a financial crisis and prolong economic recovery.

Coleman and Feler (2015) study the Brazilian banking sector and how bank loan originations have shifted due to the GFC. The authors explain that the role of government-controlled banks was an important factor that supported the economy from the financial crisis. The paper seeks to answer if a higher share of government-controlled banks lends more loans than alternative banks such as private banks in different regions across Brazil during the financial crisis. Coleman and Feler (2015) find that in areas with a prominent presence of government-controlled banks, these banks will lend more loans than regions with a smaller presence of government-controlled banks. The paper finds that because of an increase in loan originations by government-controlled banks in these regions, there were positive benefits, such as increased economic productivity and higher wage growth. Notwithstanding the purpose of government-controlled banks, the authors address one caveat that can distort the seemingly positive effects. Coleman and Feler (2015) suggest that government-controlled banks' lending decisions are influenced by political interference. Government-controlled banks will lend to regions where the ruling party has a visible or social presence. This, in turn, may cause adverse selection issues.

2.3.1 Bank Lending and Monetary Policy

Salachas et al. (2017) address the effect of monetary policy on bank lending behaviour. Initially, monetary policy is separated into two strands. The first strand concerns the conventional monetary policy, which targets the base rate. The second strand is related to unconventional monetary policy based on the quantitative easing programme. Salachas et al. (2017) find that different monetary policy programmes are beneficial for bank lending behaviour. The success of the monetary policy regime is often conditional on the current health of the financial environment. Before the financial crisis of 2008, conventional monetary policy was effective in influencing bank lending. However, this becomes ineffective after a crisis as a result of the prevailing circumstances, such as a fall in interbank lending due to heightened credit risk among banks. The effect of quantitative easing was instrumental in increasing bank lending, and this was necessary after the financial crisis. A limitation of the paper fails to acknowledge the changes in different loan categories. For example, monetary policy might have been less effective for mortgage lending, especially as the financial crisis of 2008 was categorised as a subprime mortgage crisis.

Avdjiev and Hale (2019) examine the influence of U.S. monetary policy on bank lending behaviour and primarily focus on how monetary policy affects global bank lending by financial institutions that reside in advanced economies. The focal result of the paper finds that during strong economic times (as labelled by a boom period concerning the business cycle), a rise in interest rates will lead to banks from advanced economies originating loans to other advanced economies and developing economies. Importantly, the strong backdrop regarding the economic environment, banks seek to lend out loans as they are confident with the economy's health and that banks will generate higher interest on loans because of the change in monetary policy. On the other hand, bank lending behaviour can change, mainly depending on the economic condition. If the economy is experiencing a downswing, then an increase in the U.S. base rate encourages banks to restrict lending to developing economies and distribute their loan originations to other advanced economies. Avdjiev and Hale (2019) argue that banks and other financial institutions looking to curb their credit risk would prefer to extend low-risk loans during a crisis. Intuitively this can also be recognised as a flight to quality.

Borio and Gambacorta (2017) investigate the lending behaviour of large banks from 10 advanced economies. Since the financial crisis, banks across the globe have experienced fluctuations in their lending behaviour against the background of an environment characterised by low-interest rates. Borio and Gambacorta (2017) show that adjusting interest rates does not stimulate economic growth as desired by regulatory bodies and central banks. Suppose a country is experiencing a downturn in economic conditions (expressed by the low-interest-rate environment). In that case, a further cut in the short-term interest rate will not produce the desired results of encouraging more lending. The paper finds that the further reductions in the short-term interest will reduce bank lending because the banks will generate less revenue due to erosion of the net interest income. Banks prefer to allocate their capital or cash to different projects or opportunities because the lending channel is somewhat impaired or does not provide a satisfactory return for their investments. One criticism of the paper is that the results of the largest banks from the most advanced economies are empirically addressed. This, in turn, ignores the lending behaviour of smaller banks and banks located in emerging countries. It would have been interesting to see if alternative banks replace the largest banks as the main lenders when the largest banks cut back on lending (Cortés et al., 2019).

Most of the papers cited and discussed in this subchapter emphasise the impact of external shocks such as monetary policy or how bank variables adjust lending strategy for banks. However, one strand of the literature researches the effect of individual traits of bank managers such as CEOs. Take, for example, Ho et al. (2016), who state that financial exuberance by bank CEOs is a fundamental determinant that is overlooked but relevant to bank lending behaviour or the level of bank leverage that the institutions hold. Primarily, Ho et al. (2016) conclude that among banks, CEOs that are overconfident and risk-seeking can damage bank performance relative to bank CEOs that are more prudent or more risk-averse. The paper finds that overconfident bank CEOs engage in more lending before a crisis, often associated with higher risk. Post-financial crisis, the banks that include overly-confident CEOs experienced more damage to their banks in several ways. The first notable way is because of the lax lending standards before the crisis; the banks will experience a greater rise in the number of non-performing loans; this is also due to the greater risk profile of the bank that was determined by the overconfident bank CEOs. The second result is the evident increase in the probability of default or the solvency issues that emerge due to the lending standards.

2.4 Bank Diversification

Laeven and Levine (2007) examine the impact of diversification on the market value of financial conglomerates, defined as large banks in their paper. However, the paper employs the Tobin q (market value) dependent variable in their econometric testing. To some extent, it may provide information on how diversification can influence bank profitability, and more generally, how diversification affects bank behaviour. Using a sample of 43 countries, the paper's empirical results show a negative correlation between diversification and market value. The decision to diversify in alternative activities reduces the market value of the banks, thus exhibiting a diversification discount. The authors postulate that the reduction in the market valuation of the bank may be caused by agency problems that arise among senior bank managers and outsider shareholders. In essence, the authors propose that manage their market value, banks should be encouraged to specialise in activities that they possess expertise, and not venture into unchartered territories.

In a similar vein to Laeven and Levine (2007), Elsas et al. (2010) gauge the impact of diversification on bank value as defined by the market value. In contrast to the findings of Laeven and Levine (2007), Elsas et al. (2010) document that diversification as a banking strategy can benefit bank value. However, the paper implies that an indirect effect drives the relationship. First, the authors report that while the relationship between bank diversification and market value yields an insignificant result, diversification can induce greater profitability, leading to a shift in market value. An advantage of the paper is the number of robustness checks made to ensure that the relationship holds. The paper includes the effect of diversification on profitability and market value during the subprime crisis period. The impact of diversification remained positive during the crisis, and at the time of the financial turbulence, diversification helped maintain bank value. Overall, the paper points towards a diversification premium.

Khan et al. (2020) similarly assess the link between diversification and bank performance. The paper highlights the role of diversification, bank efficiency and bank value. With respect to bank diversification, Khan et al. (2020) inspect a sample of U.S. banks and find that banks can enjoy higher market value by choosing to diversify (defined by asset and revenue diversification measures). Furthermore, concerning if diversification improves bank efficiency, the results of the paper report mixed results that suggest that diversification can improve or attenuate bank efficiency. The limitation of the paper is that the intended function of diversification as a risk-reducing or profit maximising strategy is not analysed for the subprime crisis period. Generally, for the U.S. banking system, the paper finds a consistent finding that there is a diversification premium compared to a diversification discount that is often reported.

Sanya and Wolfe (2011) also find evidence to show that a greater reliance on non-interest income (diversified) for a long period can lead to greater volatility for banks and should be deterred as a strategic move for banks. Albeit, Sanya and Wolfe (2011) support the choice for banks to diversify as their empirical results report that diversification can improve financial stability and boost profitability levels. Importantly, the paper studies a set of banks that are located in emerging economies compared to the main body of the literature that mainly investigates the effect of diversification for developed countries. Thus, diversification benefits are accessible to banks across different regions and can incentivise banks from emerging economies to diversify.

In a theoretical model designed by Wagner (2010), the author examines the role of bank diversification and its implications for financial stability. Wager (2010) argues that the diversification of a bank's portfolio is not optimal and can only be desirable when the intensity of diversification is low. Diversification benefits the banking system; this includes the reduced risk concerning bank assets and the opportunity to tap into new markets to generate alternate revenue lines. Yet, Wagner (2010) explains that diversification should be monitored, as the degree of diversification is crucial to understand. In sum, the paper states that diversification in a bank's portfolio is primarily undertaken to reduce idiosyncratic/individual risk for the financial institution. When multiple banks follow the same approach of choosing to diversify (mainly reducing idiosyncratic risk), their respective bank portfolios become highly correlated as the banking system begins to hold similar assets. Due to holding similar assets across the banks' balance sheets, the banking system is susceptible to a systemic crisis if one bank fails. Subsequently, this can significantly damage the financial system and produce negative externalities. Indeed, the author investigates the effect of diversification on financial stability. However, the paper is limited as it does not explore the role of diversification during a financial crisis (an objective of the third empirical chapter).

Financial companies' mergers and acquisitions are formed to maximise revenues and/or minimise costs. DeLong (2001) addresses the effects of merger announcements for the banking system in the U.S, where the paper posits that the choice for banks to merge can be completed in two ways. First, the banks can either specialise (focus) in their respective operations and/or local geographical proximity. The second decision is to either diversify into new non-traditional banking operations such as underwriting services and/or expand their operations in different geographical locations (across different states), thus extending their presence and offering services to potential customers. In relation to the initial stock market reaction to a merger, DeLong (2001) shows that banks that announce mergers that focus (specialise) on the same activity and continue to focus in the same local geography enjoy higher abnormal returns, as evidenced by the empirical results. In contrast, the paper states that banks that diversify into new activities and other geographical locations do not benefit from the positive reaction from the stock market. Yet, DeLong (2001) explains that the long-term effects of diversifying cannot be predicted. The change in abnormal returns only measures the merger's announcement and not the impact over a long period.

Diversification of a banks' portfolio can help shield firms and economies from a crisis. According to Doerr and Schaz (2021), during financial crises spanning from 1999-2015, the decision to opt for a diverse loan portfolio can enable banks to continue lending to firms that are located in regions that have experienced an economic shock. By exploiting the syndicated loan market data, Doerr and Schaz (2021) explain that due to a diversified loan portfolio, banks are in a stronger position to continue lending to firms in contrast to banks that concentrate on a specialised loan portfolio. As nonfinancial firms have access to finance that is available from diversified banks during an economic downturn, this, in turn, allows firms to channel their energies into further investments, thus increasing employment levels. Moreover, the authors discuss how bank type can often distort the effect. Principally, domestically located and diversified banks lend more to firms than foreign banks that reduce bank lending.

2.4.1 Bank Diversification and Regional Studies

Bank diversification and its potential benefits and costs are predominantly analysed in the context of the U.S. banking system. Baele et al. (2007) add to the discussion of bank diversification and its ramifications on bank performance by examining the European banking sector. The barriers to engaging in diversification activities are less restrictive relative to the U.S. banking system bound by prudential regulations. The authors report that bank diversification improves the bank's value as demonstrated by the stock market reaction, in which the paper employs a modified version of the Tobin Q. In contrast, bank diversification can improve bank value (consequently profits); there are certain compromises that the banks must make. Baele et al. (2007) document a mixed reaction concerning the bank's financial stability. Diversification negatively affects the systematic risk of the banking sector, although the individual risk of each bank is positively correlated by diversifying (Wagner, 2010). Notably, there is a specific threshold concerning diversifying that banks must ensure they do not go above, as too much diversification can hinder individual bank risk.

For the Austrian banking system, Rossi et al. (2009) examine a sample of large banks spanning from 1997-2003 and suggest that diversification can lead to greater profit efficiency, reduced bank risk, and permit banks to retain less capital. Concerning the reduced financial risk for the banks, the authors postulate that diversification of the loan portfolio allows the banks to condense their loan loss, provisioning for probable bad/nonperforming loans. Consequently, the reduction in loan loss provisions can help facilitate a less risky loan portfolio which ultimately reduces bank risk for the institution as a whole. Notably, Rossi et al. (2009) propose that diversification can help alleviate concerns regarding the tightening of the interest rate margin that the Austrian banking sector experienced during 1997-2003. A shortcoming of the paper is that the period leading up to the subprime financial crisis was not included. Interesting results concerning the behaviour of diversified banks in Austria around the financial crisis may have enriched the analysis on diversification.

In a study examining the influence of diversification from a sample of banks belonging to the GCC (Gulf Cooperation Council) region, there is evidence to imply that bank diversification negatively affects financial stability even though national policy in the region actively encourages diversification. Abuzayed et al. (2018) find that policies that push for bank diversification, such as an increased reliance on non-interest generating activities, do not support financial stability (the intended goal of bank diversification). Interestingly, the authors document that there are heterogeneities among the banks that may support diversification activities, as the ownership and business model of the bank is of relevance. Islamic banks fare better than traditional banks (dealing with interest). More generally, Islamic banks that engage in diversification are more financially stable, as shown by the positive relationship in the paper. While the decision to diversify is to help reduce bank risk, Abuzayed et al. (2018) explain that other banking and macroeconomic characteristics are viewed to be more important determinants to support financial stability. A drawback of the paper is that the impact of diversification on financial stability is not empirically analysed for the GFC period. In addition, it would be of interest to evaluate if Islamic banks that diversified remained financially stable relative to their peers during the crisis.

Moudud-Ul-Huq et al. (2018) depart from the literature on bank diversification that mainly examines developed economies (the U.S. and Europe) and focus on a sample of banks that emerge from the peripheral region of Southeast Asia. In the context of Indonesia, Thailand, Vietnam, Malaysia, and the Philippines, the authors explain that this region is of significant interest to investigate, as an influx of deregulation in the last decade has transformed the banking system, allowing banks to seek new business opportunities that are non-traditional. Moudud-Ul-Huq et al. (2018) report that bank diversification in the region positively correlates with bank performance (defined by profitability and bank risk). Nonetheless, the authors highlight that certain diversification strategies are crucial and may be more beneficial. First, the paper suggests that income diversification is a more appropriate strategy to adopt relative to asset diversification, which primarily focuses on non-interest-bearing assets (other earning assets that exclude loans). A limitation of the paper is that the sample period is 2011-2015, which excludes the effect of the GFC. The paper's results may have been strengthened by assessing the effect of diversification during the financial crisis for the Southeast Asia region.

In a study examining a sample of Japanese Cooperative banks, Harimaya and Ozaki (2021) contribute to the diversification literature by inspecting how diversification affects bank efficiency as an indicator of bank performance. As the Cooperative banks (defined as Shinkin banks in Japan) are restricted in nature on their operating activities such as developing certain customer relations and bound by geographical boundaries, the authors note that these samples of banks are an interesting subset of banks in Japan to scrutinise. In summary, Harimaya and Ozaki (2021) show that diversification, as viewed through two dimensions (loan and income), positively affects bank efficiency and improves bank performance. Moreover, the paper contributes to the literature by focusing on small banks. Importantly, the results show that diversification strategies can also support small banks relative to large banks routinely examined in the bank diversification literature.

2.4.2 Bank Diversification and Underlying Factors

Underlying factors may drive the decision to diversify for banks. Deng et al. (2013) document that institutional shareholders such as hedge funds or financial institutions play a pivotal part in influencing a bank's decision to diversify. These institutions that hold a significant proportion of shares in the banks can influence a bank's diversification strategies and improve bank performance which also benefits the shareholders. Essentially, the authors find evidence showing a positive relationship between bank diversification and financial stability, which is driven by the shareholders' involvement. Deng et al. (2013) state that the effectiveness of diversification is improved by stronger monitoring and discipline by the presence of these institutions that hold a large proportion of shares. In addition, the paper proposes that these institutions can monitor a bank's risk management practices and help foster discipline. With this in mind, the authors imply that institutions and their respective monitoring can act as a proxy to reduce or even replace stringent regulations that limit bank activity. In contrast to the literature, Deng et al. (2013) study the relationship between the involvement of an institution and their decision to diversify during the GFC and report a stronger positive relationship that intensifies during the crisis period.

The efficacy of diversification can be diluted if banks are deemed to be inefficient concerning their operational activity and/or labour structure. Adesina (2021) investigates diversification activity across 43 African countries and reports that the decision to diversify leads to negative implications, such as financial stability and reduced profitability. However, Adesina (2021) advises that underlying bank characteristics such as human capital can effectively facilitate diversification and improve bank performance. Banks that are efficient in terms of human capital and choose to diversify will observe greater financial stability, profitability, and cost efficiency relative to banks with poor human capital levels that also diversify. The rationale behind this is that banks with stronger and more efficient human capital will have the expertise, experience, and ability to support banks in times of diversifying. Importantly, the relationship between diversification and bank performance should not be addressed in isolation, as important factors can underscore the effectiveness of diversification and bank performance.

Doan et al. (2018) examine the relationship between diversification and bank efficiency. Though, the paper contributes to the literature by assessing how different bank ownership types influence the intended objectives of diversification. The baseline results of the paper report that income diversification positively impacts bank efficiency across 83 countries over 10 years, including a mix of developed and peripheral nations. Nonetheless, when incorporating an explanatory variable that measures the non-interest income share in their econometric model, Doan et al. (2018) report opposing results. They find that the increase in non-interest income share can lead to greater volatility in earnings for the bank, thus inevitably hampering bank efficiency. Ultimately, the results find that bank ownership type can support the role of diversification and its effect on bank efficiency. For instance, after the GFC, foreign banks that are deemed to be more diversified can improve bank efficiency relative to government-controlled banks. Indeed, the authors propose that the relationship between diversification and bank efficiency is not as simple as it seems, and underlying determinants such as the ownership type of the bank can be imperative factors that can distort or enhance the relationship.

Chapter 3

The Effects of Supervisory Stress Testing on Bank Lending: An Analysis of The UK Banking System

3.1 Introduction

Since the GFC, the inception of supervisory stress tests has been at the cornerstone of new prudential measures. A supervisory stress testing exercise is applied by regulatory authorities to assess the resiliency of individual banks and the banking system as a whole to withstand a potential adverse shock. The desired outcome of the stress testing exercises is to provide information to banks, regulatory authorities, and market participants on the ability of a bank to survive an adverse shock by judging its capital position. The results and methodology of stress tests are also publicly disclosed to provide greater transparency of the banks in question and ensure market discipline is maintained.

Although the primary role of the stress testing exercise is to provide information to relevant stakeholders, there has been debate on its effectiveness and the limitations that stem from the exercise (Acharya et al., 2018; Cortés et al., 2019). Little attention has been given to the effects of stress testing on bank lending behaviour. I observe that the limited literature on the effects of stress testing on bank lending focuses on the U.S. banking system (Acharya et al., 2018; Cortés et al., 2019; Calem et al., 2019).

The chapter's contribution to the literature examines the effects of stress testing on bank lending for the UK banking system. Firstly, the motivation to explore the effects of stress testing on bank lending is related to one of the constraints made by the BoE's stress testing methodology:

"Bank staff analysis also took into account the extent to which banks could take certain 'strategic' management actions to cushion the impact of the stress scenario on their balance sheets . . . . . . A core objective of capital

regulation from a macroprudential perspective is to ensure that the banking system is sufficiently capitalised to be able to maintain the supply of bank lending in the face of adverse shocks. The FPC agreed a general principle that management actions proposed by banks to reduce the size of their loan books would not be accepted, unless these were driven by changes in credit demand" (BoE, 2014:5)

Secondly, several papers imply that a reduction in bank lending leads to a negative impact on economic activity due to a fall in investment by firms which may exacerbate the effects of a financial crash or recession if a crisis were to materialise (Fraisse et al., 2017; Abuka et al., 2019).

To support the contribution, I build on the work of Acharya et al. (2018), by using a difference-in-difference approach that tests two groups (stressed banks and non-stressed banks) in two different periods (pre-stress testing and post-stress testing). For the main empirical results, the chapter incorporates the effect of the BoE's stress testing exercises. For robustness checks, the chapter includes the effect of the EBA's stress testing exercises. The inclusion of two different stress testing timelines by the BoE and EBA are included to provide a comprehensive outlook on the resiliency of the UK banking system and are used in conjunction to provide detailed information (EBA, 2014). Furthermore, the two supervisory stress test frameworks include a different sample of stress-tested banks and begin supervisory stress testing in different periods.

The results show that the effect of the stress testing exercises on bank lending is not statistically significant for the majority of the loan types. However, when controlling for banks that fail or pass the stress test, the statistically significant results indicate that failed banks will reduce lending; this supports the Risk Management Hypothesis discussed in the above chapter. In comparison, the literature on the effects of stress testing and bank lending has been examined relatively recently. The emerging literature suggests that banks reduce lending to manage credit risk (Acharya et al., 2018).

I find that the literature questions the effectiveness of the supervisory stress testing exercises, as the literature states that stress testing exercises were most effective in reducing bank lending during the earliest period (Calem et al., 2019). In contrast, the chapter's findings show that the impact of failing the stress test will still lead to a reduction in bank lending irrespective of the earliest stress testing years and the latest stress testing periods.

For policy implications, I find that the stress testing exercises fulfil the primary role of ensuring financial stability by analysing banks' capital adequacy to an adverse shock. In addition, the banks that fail and reduce lending may be seemingly beneficial as they mitigate credit risk, which improves financial stability, thus contributing to the objectives of the stress tests.

The following section will overview the first empirical chapter's main research questions and objectives. I then proceed to discuss the data and methodology, in which I detail the econometric model that is similar to related papers. The empirical results outline the baseline findings and assess the BoE's stress testing framework on bank lending. The robustness tests section addresses the EBA's stress testing framework. In turn, I develop policy recommendations drawn from the empirical results. The final section concludes the chapter.

3.2 Research Questions and Objectives

As explained in the previous subsection and discussed in the literature review, providing credit to the economy is essential in supporting economic activity and can often mitigate a financial crisis. I appreciate that the extensive bank lending literature considers various determinants that affect bank lending decisions. I, however, diverge from this and focus on a new determinant that the Basel III regulations have developed. More specifically, I observe that an emerging strand of the literature reports that the stress testing exercises are causing a reduction in bank lending.

The stress testing exercises are implemented to test a banks' balance sheet against plausible hypothetical shocks. The analysis of banks' performance under these tests can provide policymakers with information on the health of the individual bank and the banking system as a whole. The core purpose is to ensure that the banks are financially stable and are resilient enough to withstand an economic shock and simultaneously lend.

Against this backdrop, I develop the main research question of the empirical chapter below.

- Do supervisory stress tests affect bank lending?

The research question is the principal theme of this empirical chapter, but as the literature review chapter shows, numerous elements must be considered when attempting to answer this question. Consequently, considering the effects of stress testing on bank lending is not straightforward. I am motivated to break down the main research question into narrower research objectives that follow the literature review.

I complete this by further dissecting the question and focusing on different aspects of the literature. The findings in the recent literature drive the following research questions and objectives discussed below.

- Does failing the stress test means banks reduce lending relative to banks that pass the stress test?

Stress-tested banks are tested against a capital threshold that they must pass. Failure to meet this capital threshold will result in banks failing the stress test, which may enable regulators to intervene and order banks to reconsider their capital distributions. Banks can fail for several reasons, whether that be qualitative or quantitative. Although, banks that fail or perform poorly often reduce bank lending relative to their counterparts who pass the stress test. The current literature largely incentivises this research question. Therefore, it is important to consider the role of failing the stress test, as this may exhibit significant results and could impact lending decisions.

In addition, the literature suggests that the stress testing exercise may be losing its effectiveness throughout time.

- Are the stress testing exercises losing their effectiveness concerning bank lending? In other words, were stress tests effective for the earliest years?

The recent literature finds that the stress testing exercises may be losing their effectiveness over time. For example, Neretina et al. (2015) document that the earliest stress tests effectively produced a strong market reaction. In particular, Neretina et al. (2015) state that during the 2009 SCAP, Bernanke's intervention and clarification of the stress testing exercise in 2009 produced a strong market reaction. Although, Neretina et al. (2015) report that the effectiveness of stress testing in the U.S. is beginning to diminish. To my knowledge, the effectiveness of the UK administered stress testing framework has yet to be explored. I contribute to this strand of the literature to study the dynamic impact of the stress testing exercise on bank lending following Acharya et al. (2018).

3.3 Data

The chapter employs publicly available data from Orbis Bank Focus (formerly known as BankScope) for the bank-specific variables. In addition, to complement missing data, the chapter benefits from the banks' annual reports that are available online. The macro-economic variables originate from the Office for National Statistics and the BoE. Consequently, the IFRS (International Financial Reporting Standards) accounting standards were first implemented in 2005 for the UK financial system. Therefore, the sample is from 2005-2018 (Zeghal et al., 2015; Stenka et al., 2008).

In selecting the sample of the banks tested in this empirical chapter, I must refer to the banks the BoE considers for their stress testing framework and simultaneously include a control group similar to stress-tested banks to ensure that pool of banks is as comparable as possible. The stress-tested banks' participation is regarded as an exogenous decision due to their vast size and potential contributions to system risk. That is, their participation in the programme is not randomly selected but rather necessary due to their significance to the domestic and global economy. The BoE considers 7 banks in their framework, and their structure (ownership type) includes bank holding companies (BHC), building societies, commercial banks, and cooperative banks.

Accordingly, when choosing the sample of the banks for the respective chapter, I ensure that I include banks with an ownership type belonging to the four structures mentioned previously. In the first step, when I utilise the Orbis Bank Focus database, I include banks that belong to these four ownership types represented in the database. Said differently, one criterion for all banks in my sample should be designated as a bank holding company (BHC), building society, commercial bank, or a cooperative bank.

The literature examining the behaviour between stress-tested and non-stress tested banks employs a certain threshold to ensure that a similar pool of banks is reviewed. Small and large banks have major differences, such as being subjected to various regulatory guidelines, dissimilar geographical reach, and many other factors as the bank size disparity may yield differing analysis. More precisely, I follow the literature and select banks above the 10 BN GBP threshold, which controls for similar banks that are large in scale (Cornett et al., 2018).

Moreover, I removed subsidiary banks from the sample if their parent bank is a part of the list because I included banks representing the highest consolidation level (Committee of European Banking Supervisors, 2010). The chapter includes the current bank controlling for mergers and acquisitions (Bahaj and Mallherbe, 2017).

Following the selection criterion above that considers the literature, the regulatory approach, data availability via Orbis Bank Focus and the annual reports. The total number of banks in the sample includes 19 banks, where 7 banks are part of the stress-tested framework that the BoE coordinates.

The remaining 12 banks serve as a control group. In particular, as mentioned above, the 12 control banks follow a similar approach to the stress-tested banks' selection criteria. The 12 banks are either a bank holding company (BHC), building society, commercial bank or cooperative bank. Moreover, I ensure that the control groups are represented at the highest consolidation. More specifically, I ensured that any subsidiary of the 12 banks was not included in the sample as this would result in 'double counting'. In addition, for the control group to be included in the sample, they must be currently active. The total sample of banks may seem relatively small compared to much larger financial jurisdictions such as the USA or EU. However, the 7 largest banks in the UK represent nearly 80% of lending to the UK economy. Therefore, the inclusion of the 7 banks plus the following 12 largest banks in the sample reflect a strong sample of banks that provide credit to the UK economy.

The data is deflated using a GDP deflator, and the reference year is 2005. For the dependent variables, which are the types of loan growth, I remove outliers and drop observations above 300% (Sanfilippo-Azofra et al., 2018). All variables are also winsorised at the 1st and 99th percentile and include robust standard errors. The variables are defined in table 3.1, including the summary statistics. Tables 3.2 and 3.3 show t tests for the stress-tested banks for the BoE and EBA specifications, respectively. The correlation matrix for the first primary dependent variable is shown in table 3.4. I do not report correlation matrices for the remaining five dependent variables for brevity. Although, there are no concerns regarding multicollinearity issues.

Table 3.1: Summary Statistics

Variable	Description	Observations	Mean	Std. Deviation	Min	Max
Panel A: All 19 banks for the complete sample (2005-2018)						
	Dependent Variables					
Total loans change	For the Total loans change, I use the percentage change between the current and previous years.	211	5.28	22.91	-33.07	120.94
Net loans to customers change	For the Net loans to customers change, I use the percentage change between the current and previous years.	211	6.63	24.76	-43.38	135.75
Net loans to banks change	For the Net loans to banks change, I use the percentage change between the current and previous years.	200	1.39	42.10	-77.36	157.54
Mortgage loans change	For the Mortgage loans change, I use the percentage change between the current and previous years.	188	8.57	25.27	-14.13	165.02
Consumer loans change	For the Consumer loans change, I use the percentage change between the current and previous years.	162	0.88	35.49	-94.83	165.52
Corporate loans change	For the Corporate loans change, I use the percentage change between the current and previous years.	173	5.02	39.53	-85.30	254.84
	Independent Variables					
Size	The natural log of total assets.	229	11.17	1.84	8.54	14.40
Profitability (ROA)	The return on assets, which is profit over total assets for each year.	229	0.25	0.67	-2.21	2.06
Profitability (ROE)	The return on Equity, which is profit over equity for each year.	229	4.32	11.68	-43.95	27.10
Credit Risk (NPL)	The non-performing loan ratio is used to measure credit risk. The variable is calculated by impaired loans divided by total gross loans.	204	2.53	2.22	0.13	10.35
Credit Risk (LLP)	Loan Loss Provisions divided by Total Loans.	208	0.53	0.59	0.00	2.68
Efficiency (CtoA)	To calculate bank efficiency, the operating expenses is divided by total assets.	229	1.56	1.03	0.32	5.19
Efficiency (CtoI)	Another proxy used to calculate bank efficiency is the operating expenses divided by operating income.	226	69.26	38.86	30.19	262.06
Capital (CET1)	The CET1 ratio is applied by CET1 capital over Risk Weighted Assets.	210	13.42	5.75	4.73	33.22
Capital (Tier 1 Leverage)	Calculated by Tier 1 capital divided by on and off-balance sheet assets.	223	4.49	1.44	1.76	10.20
Capital (Tier 1)	Tier 1 capital over Risk Weighted Assets.	213	15.01	6.61	7.02	41.91
Capital (Total Capital)	The Total capital ratio is calculated by Total capital over Risk-Weighted Assets.	229	18.39	6.61	10.70	44.20
Economic conditions (Real GDP Growth)	For the economic conditions or the macro-economic conditions, the real GDP growth rate is used.	229	1.52	1.71	-4.19	3.10
Economic conditions (Unemployment)	The unemployment rate for the UK.	229	5.99	1.41	3.95	8.04
Economic conditions (Bank Rate)	The official Bank rate (base rate) set by the BoE's Monetary Policy Committee.	229	1.39	1.72	0.25	5.50
	Stress testing terms					
Stressed Bank BoE	Dummy variable designated as 1 for the 7 UK stress-tested banks (treatment group) and 0 for the 12 remaining banks (control group).	230	0.43	0.50	0	1
Stressed Bank EBA	Dummy variable designated as 1 for the 4 UK stress-tested banks (treatment group) and 0 for the 15 remaining banks (control group).	230	0.24	0.43	0	1
Post Stress Period BoE	Time dummy variable designated as 1 for 2014-2018 (post-stress test) and 0 for 2005-2013 (pre-stress test).	230	0.41	0.49	0	1

Post Stress Period EBA	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2005-2009 (pre-stress test).	230	0.70	0.46	0	1
Failed Bank BoE	Dummy variable designated as 1 for banks that failed the stress test at least once and 0 for banks that have never failed. The variable is analogous to the alternative failed stress test variable by Acharya et al. (2018).	230	0.24	0.43	0	1
Panel B: Stress-tested banks (treatment banks) before the treatment period (2005-2013)						
	Dependent Variables					
Total loans change	For the Total loans change, I use the percentage change between the current and previous years.	56	7.05	24.16	-21.25	120.94
Net loans to customers change	For the Net loans to customers change, I use the percentage change between the current and previous years.	56	7.21	24.31	-24.92	135.75
Net loans to banks change	For the Net loans to banks change, I use the percentage change between the current and previous years.	54	6.29	41.24	-60.58	157.54
Mortgage loans change	For the Mortgage loans change, I use the percentage change between the current and previous years.	55	7.25	23.74	-7.80	165.02
Consumer loans change	For the Consumer loans change, I use the percentage change between the current and previous years.	55	2.55	22.83	-27.95	100.89
Corporate loans change	For the Corporate loans change, I use the percentage change between the current and previous years.	52	15.81	42.97	-21.03	254.84
	Independent Variables					
Size	The natural log of total assets.	62	13.14	0.89	11.63	14.40
Profitability (ROA)	The return on assets, which is profit over total assets for each year.	62	0.38	0.41	-1.43	1.06
Profitability (ROE)	The return on Equity, which is profit over equity for each year.	62	8.42	9.69	-42.70	26.73
Credit Risk (NPL)	The non-performing loan ratio is used to measure credit risk. The variable is calculated by impaired loans divided by total gross loans.	55	2.89	2.75	0.25	10.35
Credit Risk (LLP)	Loan Loss Provisions divided by Total Loans.	62	0.68	0.56	0.05	2.30
Efficiency (CtoA)	To calculate bank efficiency, the operating expenses is divided by total assets.	62	1.27	0.43	0.52	1.97
Efficiency (CtoI)	Another proxy used to calculate bank efficiency is the operating expenses divided by operating income.	62	56.42	19.94	30.19	169.15
Capital (CET1)	The CET1 ratio is applied by CET1 capital over Risk Weighted Assets.	58	9.38	2.91	4.73	16.24
Capital (Tier 1 Leverage)	Calculated by Tier 1 capital divided by on and off-balance sheet assets.	61	3.52	0.97	1.76	6.51
Capital (Tier 1)	Tier 1 capital over Risk Weighted Assets.	62	11.39	3.23	7.02	18.38
Capital (Total Capital)	The Total capital ratio is calculated by Total capital over Risk-Weighted Assets.	62	15.19	3.37	10.70	22.90
Economic conditions (Real GDP Growth)	For the economic conditions or the macro-economic conditions, the real GDP growth rate is used.	62	1.10	2.13	-4.19	3.10
Economic conditions (Unemployment)	The unemployment rate for the UK.	62	6.28	1.47	3.95	8.04
Economic conditions (Bank Rate)	The official Bank rate (base rate) set by the BoE's Monetary Policy Committee.	62	2.22	2.07	0.50	5.50
	Stress testing terms					
Stressed Bank BoE	Dummy variable designated as 1 for the 7 UK stress-tested banks (treatment group) and 0 for the 12 remaining banks (control group).	63	1	0	1	1

Stressed Bank EBA	Dummy variable designated as 1 for the 4 UK stress-tested banks (treatment group) and 0 for the 15 remaining banks (control group).	63	0.57	0.50	0	1
Post Stress Period BoE	Time dummy variable designated as 1 for 2014-2018 (post-stress test) and 0 for 2005-2013 (pre-stress test).	63	0	0	0	0
Post Stress Period EBA	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2005-2009 (pre-stress test).	63	0.44	0.50	0	1
Failed Bank BoE	Dummy variable designated as 1 for banks that failed the stress test at least once and 0 for banks that have never failed. The variable is analogous to the alternative failed stress test variable by Acharya et al. (2018).	63	0.57	0.50	0	1
Panel C: Stress-tested banks (treatment banks) after the treatment period (2014-2018)						
	Dependent Variables					
Total loans change	For the Total loans change, I use the percentage change between the current and previous years.	35	-1.78	7.08	-20.16	19.00
Net loans to customers change	For the Net loans to customers change, I use the percentage change between the current and previous years.	35	-1.58	6.61	-15.62	15.60
Net loans to banks change	For the Net loans to banks change, I use the percentage change between the current and previous years.	35	-1.53	34.78	-75.96	116.16
Mortgage loans change	For the Mortgage loans change, I use the percentage change between the current and previous years.	34	1.16	5.79	-8.99	17.44
Consumer loans change	For the Consumer loans change, I use the percentage change between the current and previous years.	33	0.65	9.62	-16.51	35.53
Corporate loans change	For the Corporate loans change, I use the percentage change between the current and previous years.	34	-3.46	10.36	-35.92	17.09
	Independent Variables					
Size	The natural log of total assets.	35	13.17	0.74	11.97	14.26
Profitability (ROA)	The return on assets, which is profit over total assets for each year.	35	0.18	0.34	-0.82	0.67
Profitability (ROE)	The return on Equity, which is profit over equity for each year.	35	3.09	5.53	-14.32	9.35
Credit Risk (NPL)	The non-performing loan ratio is used to measure credit risk. The variable is calculated by impaired loans divided by total gross loans.	35	2.59	1.65	0.55	7.58
Credit Risk (LLP)	Loan Loss Provisions divided by Total Loans.	33	0.37	0.36	0.03	1.56
Efficiency (CtoA)	To calculate bank efficiency, the operating expenses is divided by total assets.	35	1.38	0.39	0.74	2.03
Efficiency (CtoI)	Another proxy used to calculate bank efficiency is the operating expenses divided by operating income.	35	65.97	21.82	30.99	128.63
Capital (CET1)	The CET1 ratio is applied by CET1 capital over Risk Weighted Assets.	35	13.22	3.44	9.13	25.43
Capital (Tier 1 Leverage)	Calculated by Tier 1 capital divided by on and off-balance sheet assets.	35	4.05	0.76	2.94	5.75
Capital (Tier 1)	Tier 1 capital over Risk Weighted Assets.	35	15.43	3.70	10.58	28.38
Capital (Total Capital)	The Total capital ratio is calculated by Total capital over Risk-Weighted Assets.	35	19.79	4.35	13.70	36.10
Economic conditions (Real GDP Growth)	For the economic conditions or the macro-economic conditions, the real GDP growth rate is used.	35	2.19	0.43	1.79	2.95
Economic conditions (Unemployment)	The unemployment rate for the UK.	35	5.62	1.14	4.34	7.53
Economic conditions (Bank Rate)	The official Bank rate (base rate) set by the BoE's Monetary Policy Committee.	35	0.45	0.10	0.25	0.50

	Stress testing terms					
Stressed Bank BoE	Dummy variable designated as 1 for the 7 UK stress-tested banks (treatment group) and 0 for the 12 remaining banks (control group).	35	1	0	1	1
Stressed Bank EBA	Dummy variable designated as 1 for the 4 UK stress-tested banks (treatment group) and 0 for the 15 remaining banks (control group).	35	0.57	0.50	0	1
Post Stress Period BoE	Time dummy variable designated as 1 for 2014-2018 (post-stress test) and 0 for 2005-2013 (pre-stress test).	35	1	0	1	1
Post Stress Period EBA	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2005-2009 (pre-stress test).	35	1	0	1	1
Failed Bank BoE	Dummy variable designated as 1 for banks that failed the stress test at least once and 0 for banks that have never failed. The variable is analogous to the alternative failed stress test variable by Acharya et al. (2018).	35	0.57	0.50	0	1
Panel D: Non-stress tested banks (control banks) before the treatment period (2005-2013)						
	Dependent Variables					
Total loans change	For the Total loans change, I use the percentage change between the current and previous years.	62	4.91	22.81	-33.07	120.94
Net loans to customers change	For the Net loans to customers change, I use the percentage change between the current and previous years.	62	5.57	24.00	-43.38	135.75
Net loans to banks change	For the Net loans to banks change, I use the percentage change between the current and previous years.	59	0.01	48.92	-77.36	157.54
Mortgage loans change	For the Mortgage loans change, I use the percentage change between the current and previous years.	46	7.98	26.73	-14.13	165.02
Consumer loans change	For the Consumer loans change, I use the percentage change between the current and previous years.	37	1.27	52.82	-94.83	165.52
Corporate loans change	For the Corporate loans change, I use the percentage change between the current and previous years.	44	-4.15	29.08	-85.30	86.59
	Independent Variables					
Size	The natural log of total assets.	73	9.71	0.60	8.56	12.09
Profitability (ROA)	The return on assets, which is profit over total assets for each year.	73	0.28	0.79	-2.21	2.06
Profitability (ROE)	The return on Equity, which is profit over equity for each year.	73	4.22	12.48	-43.95	27.10
Credit Risk (NPL)	The non-performing loan ratio is used to measure credit risk. The variable is calculated by impaired loans divided by total gross loans.	58	2.69	1.86	0.22	10.35
Credit Risk (LLP)	Loan Loss Provisions divided by Total Loans.	68	0.62	0.75	0.00	2.68
Efficiency (CtoA)	To calculate bank efficiency, the operating expenses is divided by total assets.	73	1.67	1.28	0.32	5.19
Efficiency (CtoI)	Another proxy used to calculate bank efficiency is the operating expenses divided by operating income.	71	66.73	27.78	30.67	174.17
Capital (CET1)	The CET1 ratio is applied by CET1 capital over Risk Weighted Assets.	61	13.73	6.26	6.52	32.91
Capital (Tier 1 Leverage)	Calculated by Tier 1 capital divided by on and off-balance sheet assets.	68	4.66	1.16	2.19	9.25
Capital (Tier 1)	Tier 1 capital over Risk Weighted Assets.	59	15.19	7.51	7.02	35.59
Capital (Total Capital)	The Total capital ratio is calculated by Total capital over Risk-Weighted Assets.	73	17.75	6.78	10.70	42.90
Economic conditions (Real GDP Growth)	For the economic conditions or the macro-economic conditions, the real GDP growth rate is used.	73	1.03	2.06	-4.19	3.10

Economic conditions (Unemployment)	The unemployment rate for the UK.	73	6.29	1.55	3.95	8.04
Economic conditions (Bank Rate)	The official Bank rate (base rate) set by the BoE's Monetary Policy Committee.	73	1.88	1.94	0.50	5.50
	Stress testing terms					
Stressed Bank BoE	Dummy variable designated as 1 for the 7 UK stress-tested banks (treatment group) and 0 for the 12 remaining banks (control group).	73	0	0	0	0
Stressed Bank EBA	Dummy variable designated as 1 for the 4 UK stress-tested banks (treatment group) and 0 for the 15 remaining banks (control group).	73	0	0	0	0
Post Stress Period BoE	Time dummy variable designated as 1 for 2014-2018 (post-stress test) and 0 for 2005-2013 (pre-stress test).	73	0	0	0	0
Post Stress Period EBA	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2005-2009 (pre-stress test).	73	0.52	0.50	0	1
Failed Bank BoE	Dummy variable designated as 1 for banks that failed the stress test at least once and 0 for banks that have never failed. The variable is analogous to the alternative failed stress test variable by Acharya et al. (2018).	73	0	0	0	0
Panel E: Non-stress tested banks (control banks) after the treatment period (2014-2018)						
	Dependent Variables					
Total loans change	For the Total loans change, I use the percentage change between the current and previous years.	58	8.23	27.24	-33.07	120.94
Net loans to customers change	For the Net loans to customers change, I use the percentage change between the current and previous years.	58	12.16	31.19	-43.38	135.75
Net loans to banks change	For the Net loans to banks change, I use the percentage change between the current and previous years.	52	-0.16	39.81	-77.36	130.52
Mortgage loans change	For the Mortgage loans change, I use the percentage change between the current and previous years.	53	15.20	31.45	-14.13	160.22
Consumer loans change	For the Consumer loans change, I use the percentage change between the current and previous years.	37	-1.80	44.37	-94.83	156.07
Corporate loans change	For the Corporate loans change, I use the percentage change between the current and previous years.	43	8.06	53.91	-85.30	254.84
	Independent Variables					
Size	The natural log of total assets.	59	9.74	0.56	8.54	10.51
Profitability (ROA)	The return on assets, which is profit over total assets for each year.	59	0.11	0.85	-2.21	1.69
Profitability (ROE)	The return on Equity, which is profit over equity for each year.	59	0.87	13.99	-43.95	14.16
Credit Risk (NPL)	The non-performing loan ratio is used to measure credit risk. The variable is calculated by impaired loans divided by total gross loans.	56	1.97	2.23	0.13	10.35
Credit Risk (LLP)	Loan Loss Provisions divided by Total Loans.	45	0.28	0.34	0.00	1.57
Efficiency (CtoA)	To calculate bank efficiency, the operating expenses is divided by total assets.	59	1.86	1.28	0.35	5.19
Efficiency (CtoI)	Another proxy used to calculate bank efficiency is the operating expenses divided by operating income.	58	88.05	61.24	30.57	262.06
Capital (CET1)	The CET1 ratio is applied by CET1 capital over Risk Weighted Assets.	56	17.40	5.75	7.16	33.22
Capital (Tier 1 Leverage)	Calculated by Tier 1 capital divided by on and off-balance sheet assets.	59	5.55	1.68	2.28	10.20
Capital (Tier 1)	Tier 1 capital over Risk Weighted Assets.	57	18.50	7.77	7.18	41.91

Capital (Total Capital)	The Total capital ratio is calculated by Total capital over Risk-Weighted Assets.	59	21.72	8.24	10.70	44.20
Economic conditions (Real GDP Growth)	For the economic conditions or the macro-economic conditions, the real GDP growth rate is used.	59	2.17	0.44	1.40	2.95
Economic conditions (Unemployment)	The unemployment rate for the UK.	59	5.55	1.13	3.95	7.53
Economic conditions (Bank Rate)	The official Bank rate (base rate) set by the BoE's Monetary Policy Committee.	59	0.45	0.11	0.25	0.75
	Stress testing terms					
Stressed Bank BoE	Dummy variable designated as 1 for the 7 UK stress-tested banks (treatment group) and 0 for the 12 remaining banks (control group).	59	0	0	0	0
Post Stress Period BoE	Time dummy variable designated as 1 for 2014-2018 (post-stress test) and 0 for 2005-2013 (pre-stress test).	59	1	0	1	1
Post Stress Period EBA	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2005-2009 (pre-stress test).	59	1	0	1	1
Failed Bank BoE	Dummy variable designated as 1 for banks that failed the stress test at least once and 0 for banks that have never failed. The variable is analogous to the alternative failed stress test variable by Acharya et al. (2018).	59	0	0	0	0

Table 3.2: t-test between stress-tested banks and non-stress tested banks based on the BoE's stress testing frameworks

The table reports the t-test between two different groups. The difference in means between the stress-tested banks and non-stress tested banks (with respect to the BoE's stress tests framework) is analysed for each loan type. All 19 banks are used within the sample for the t-test. The full sample is observed (2005-2018). The sample is then broken down into two parts. Pre-stress test and post-stress test. There are 7 stress-tested banks and 12 non-stress tested banks.

	Full Sample			**2005-2013**			**2014-2018**		
	Stress-Tested Banks	Non-stress Tested Banks	Difference	Stress-Tested Banks	Non-stress Tested Banks	Difference	Stress-Tested Banks	Non-stress Tested Banks	Difference
Total Loans Growth	3.65	6.51	-2.86	7.05	4.91	2.14	-1.78	8.22	-10**
Net Loans to Customers Growth	3.83	8.75	-4.92	7.21	5.58	1.63	-1.58	12.16	-13.74**
Net Loans to Banks Growth	3.22	-0.07	3.29	6.29	0.01	6.28	-1.53	-0.16	-1.37
Mortgage Loans Growth	4.93	11.85	-6.92*	7.25	7.98	-0.73	1.16	15.2	-14.04**
Consumer Loans Growth	1.84	-0.26	2.1	2.55	1.27	1.28	0.65	-1.8	2.45
Corporate Loans Growth	8.19	1.89	6.3	15.81	-4.15	19.96**	-3.46	8.06	-11.52
CET1 Ratio	11.03	15.37	-4.34***	9.03	12.72	-3.69***	14.4	18.16	-3.76***

Table 3.3: t-test between stress-tested banks and non-stress tested banks based on the EBA's stress testing frameworks

The table reports the t-test between two different groups. The difference in means between the stress-tested banks and non-stress tested banks (with respect to the EBA's stress tests framework) is analysed for each loan type. All 19 banks are used within the sample for the t-test. The full sample is observed (2005-2018). The sample is then broken down into two parts. Pre-stress test and post-stress test. There are 4 stress-tested banks and 15 non-stress tested banks.

	Full Sample			**2005-2013**			**2014-2018**		
	Stress-Tested Banks	Non-stress Tested Banks	Difference	Stress-Tested Banks	Non-stress Tested Banks	Difference	Stress-Tested Banks	Non-stress Tested Banks	Difference
Total Loans Growth	2.01	6.35	-4.34	5.68	6.02	-0.34	-3.85	6.74	-10.59*
Net Loans to Customers Growth	2.55	7.96	-5.41	6.41	6.32	0.09	-3.62	9.90	-13.52**
Net Loans to Banks Growth	-2.04	2.60	-4.64	0.75	3.91	-3.16	-6.51	1.02	-7.54
Mortgage Loans Growth	5.40	9.75	-4.34	8.78	7.03	1.75	-0.29	12.51	-12.79*
Consumer Loans Growth	-1.90	2.12	-4.02	-1.87	4.12	-5.99	-1.96	-0.19	-1.77
Corporate Loans Growth	3.70	5.56	-1.86	7.38	6.32	1.05	-2.31	4.70	-7.01
CET1 Ratio	10.37	14.49	-4.12***	8.67	11.78	-3.11***	13.27	17.69	-4.42***

Table 3.4: Correlation Matrix (Total Loans Change)

The table reports the correlation matrix of the variables used for the methodology. The dependent variable is Total Loans Change. The explanatory variables are the following: the size of the bank proxied by the natural log of total assets, the profitability variable is measured by the return on total assets (ROA). The credit risk measure is the non-performing loan ratio, which is divided by the non-performing loans over gross loans. The bank's efficiency is defined by the total cost of the bank divided by the banks' total assets. The CET1 capital ratio defines the capital variable. The macro variables are the GDP growth rate and the Bank rate for the UK. All values are rounded to two decimal points. Table 3.1 defines and presents the summary statistics for all the variables.

	Total Loans Change	*Size*	*Profitability*	*Credit Risk*	*Efficiency*	*Capital*	*Economic conditions (GDP Growth)*	*Economic conditions (Bank Rate)*
Total Loans Change	1.00							
Size	-0.12	1.00						
Profitability	0.31	0.02	1.00					
Credit Risk	-0.23	0.20	-0.39	1.00				
Efficiency	0.07	-0.16	0.16	0.08	1.00			
Capital	-0.01	-0.38	0.07	-0.25	-0.03	1.00		
Economic conditions (GDP Growth)	0.05	-0.05	0.02	-0.11	0.13	0.11	1.00	
Economic conditions (Bank Rate)	0.35	0.06	0.20	-0.27	-0.06	-0.45	0.15	1.00

The share of total lending for the UK economy is shown for each bank reported in table A1 in the appendix section. The largest banks in the sample are included as part of the stress testing framework by the BoE and the EBA. The top 7 banks provide 80% of the UK real economy lending. Their dominance in the UK banking industry is the primary reason these banks participate in the stress testing exercises (BoE, 2015). Tables A2 to A4 are univariate tests for the sample of the banks. Table A2 reports the differences between banks that fail or pass the stress test. Table A3 reports that non-stress tested banks have higher CET1 and Tier 1 leverage ratios than stress-tested banks. Generally, banks with lower CET1 levels have higher loan levels, as seen with the corporate loan growth (table A3). Table A4 reports the differences between Globally Systemically Important Banks and Non-Globally Systemically Important Banks[9].

The chapter incorporates variables controlling for loan demand and loan supply presently employed in the bank lending literature. I control the bank's size by including the natural logarithm of total assets. The size of the bank can influence if banks lend or not, and the current literature states that to a certain extent, an increase in size leads to a reduction in lending due to smaller banks having more information about their local firms relative to larger banks (Naceur et al., 2018; Cortés et al., 2018). Although size can lead

[9] To designate if a bank is a Globally Systemically Important Bank or not, I refer to the Financially Stability Board (2018).

to positive effects, certain banks are labelled as ‘too big to fail’, meaning the banks will increase lending as they increase in size (Brei et al., 2013). The profitability variable is defined as return on assets. It is expected that there is a positive relationship between bank profitability and bank lending (Kim and Sohn, 2017; Acharya et al., 2018; Cortés et al., 2018). The chapter includes the non-performing loans ratio to proxy for credit risk. A reduction in bank lending often follows an increase in credit risk (Roulet, 2018; Kim and Sohn, 2017; Acharya et al., 2018; Cortés et al., 2018). The efficiency variable is used to measure how efficient a bank is, and it is assumed that more efficient banks will increase lending (Acharya et al., 2018; Howcroft et al., 2014). The CET1 capital ratio is used to represent the capital variable. The variable is included as one of the capital ratios often used as a threshold by the BoE and EBA for their stress testing framework (EBA, 2014). Moreover, the capital ratio has ambiguous impacts on bank lending. Capital can increase or decrease lending for certain financial systems (Naceur et al., 2018). Banks with sufficient capital levels will increase lending relative to those with low capital levels (Carlson et al., 2013).

The economic condition variable is the main macro-economic variable that is tested, and to proxy this, I use real GDP growth. As the country’s GDP growth rises, the lending rate will also rise (Brei et al., 2013). The effect of the official bank rate set by the BoE is included in the econometric regressions.

3.4 Methodology

For the methodology, I apply a difference-in-difference approach to analyse the effects between two groups in two different periods. In regards to the results, I use panel data, including the fixed effects model.

The difference-in-difference approach is commonly used to test the effect of a specific treatment or policy intervention on an agent of interest and assess if the impact of the treatment or policy intervention significantly affects the agent. Assume that new regulations will affect an agent, for example, a bank. The policy intervention may require banks over a certain size threshold to hold greater capital due to their size, which supports financial resilience (the main objective of the treatment). In order to examine if the treatment is effective, certain assumptions must be met to ensure that the framework that assesses the treatment on the treatment group has produced the desired outcome.

First, the assumption of the difference-in-difference approach would require testing two groups. The banks subjected to the treatment and a pool of control banks that are similar to the treated banks but are not subjected to the treatment. Ultimately the control banks are excluded as the size of the banks falls below the threshold. Moreover, the assumption of similar groups would be a prerequisite before the analysis. The statistician can reassure that the difference in future outcomes would not be due to other possible factors rather than the treatment (ceteris paribus).

Second, the initial period of the treatment is relevant when utilising the difference-in-difference approach. The difference-in-difference approach would consider the difference in financial resilience between banks before the treatment period for several years. In the next step, the difference-in-difference approach would proceed to consider the difference in financial resilience between banks after the treatment period of several years. To ensure the difference-in-difference approach produces two data points that consider the financial resilience of both banks, before and after treatment, the number of years that are examined should be similar for both periods, which often depends on the number of years available. In other words, one assumption for the approach would be to develop a data point with the same number of years.

In the thesis, I follow these assumptions by ensuring that both groups of banks are similar as possible by predominately ensuring that these banks are large with respect to their size (total assets). Intuitively, the one factor that I analyse, which separates both banks, is the stress testing framework. The treatment banks in the thesis are subject to the stress tests, and the control banks are not subject to the stress test, which helps meet the assumption of confirming two similar groups are addressed. Although this chapter considers the BoE and EBA frameworks, the treatment periods differ, as the BoE started its stress testing framework in 2014, and the EBA initiated their framework in 2010. In line with the pre-treatment and post-treatment period. I ensure that both these periods are as similar as possible, subject to data availability at the time of writing. Therefore, the assumption is that there are enough years to serve as the pre-treatment and post-treatment periods.

Regarding the parallel assumption for the difference-in-difference approach, figures A1 to A8 illustrate the difference in lending levels between the banks since the implementation of the treatment. For the BoE, the treatment period occurred in 2014, and for the EBA, the treatment period occurred in 2010. In several figures, I find a disparity in the change in bank lending since the treatment period, which implies that the assumptions of parallel trends are met. This incentivises the chapter to consider the effect of stress testing on bank lending and permits using the difference-in-difference approach. Furthermore, the figures also illustrate the change in lending between banks that fail the stress test and those that pass the stress test, which suggests that failing the stress testing exercise during the treatment period resulted in a change in bank lending.

I address the effects of the BoE's stress test exercises for the main specification. The rationale behind this is that the BoE includes more banks than the EBA. Most importantly, the BoE's stress testing framework explicitly fails banks across its exercises. With this in mind, I can account for the effects of failing the stress test with the BoE's stress testing timeline, which I cannot do with respect to the EBA's stress testing timeline, as the authority does not fail UK banks during its earliest stress testing exercises. For this reason, the effects of the EBA's stress testing exercises on UK bank lending serves as additional robustness checks.

Subsequently, the BoE coordinated the stress testing exercises with the EBA in 2009 but began its national stress testing framework in 2014. As the BoE started its national stress testing exercise in 2014, I consider that 2014 is defined as the start of the treatment period. The chapter selects 7 banks as the treatment banks and 12 alternative banks as the control banks. For the main specification, the 7 banks that are included in the BoE stress test to date are HSBC Holdings plc, Barclays plc, Lloyds Banking Group plc, The Royal Bank of Scotland Group plc, Standard Chartered plc, Santander UK plc, and Nationwide Building Society.

Concerning the robustness checks which assess the effect of the EBA's stress testing exercises, 4 banks are a part of the treatment banks and 15 banks are placed in the control group. Furthermore, the start of the EBA's treatment period is 2010[10] . The 4 banks included in the EBA's stress tests are HSBC Holdings plc, Barclays plc, Lloyds Banking Group plc, and The Royal Bank of Scotland Group plc.

The primary variable of interest for the empirical results is the difference-in-difference interaction applied to examine the effect of stress testing. To implement the difference-in-difference approach, I use the two dummy variables representing the treatment group and treatment period. For example, the 'Stress Test Bank BoE' variable interacts with the 'Post Period BoE' to produce the difference-in-difference result.

The primary econometric model for the BoE's stress testing exercise is shown in equation (3.1). The

[10] The EBA first applied an EU-wide stress test in 2009. I choose 2010 as the treatment period as the inclusion of the 4 UK banks are stated and the results of the stress test of each bank within the exercise are publicly disclosed. That being said, I undertake further robustness tests where the treatment period starts from 2009.

$\beta 3$ coefficient is the variable of interest that captures the difference-in-difference interaction. All other explanatory variables are lagged by one time period (to correct for endogeneity), and the 'Loan Type Growth' dependent variable is substituted with the different loan types. The EBA's stress testing exercise is shown in equation (3.2).

$$\begin{aligned} Loan\ Type\ Growth_{i,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,t-1} + \beta_2 Macro\ Variables_{t-1} \\ & + \beta_3 Stress\ Tested\ Bank\ BoE_i * Post\ Stress\ Period\ BoE_t \\ & + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\ & + \varepsilon_{i,t} \end{aligned} \tag{3.1}$$

$$\begin{aligned} Loan\ Type\ Growth_{i,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,t-1} + \beta_2 Macro\ Variables_{t-1} \\ & + \beta_3 Stress\ Tested\ Bank\ EBA_i * Post\ Stress\ Period\ EBA_t \\ & + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\ & + \varepsilon_{i,t} \end{aligned} \tag{3.2}$$

The BoE fails a few participating banks during the stress tests. Subsequently, I control for the effects of failing and assess if failure of the stress test reduces loan growth. Equation (3.3) captures the effect with the $\beta 4$ coefficient, which I refer to as the difference-in-difference-in-difference (triple difference) (Acharya et al., 2018).

$$\begin{aligned} Loan\ Type\ Growth_{i,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,t-1} + \beta_2 Macro\ Variables_{t-1} \\ & + \beta_3 Stress\ Tested\ Bank\ BoE_i * Post\ Stress\ Period\ BoE_t \\ & + \beta_4 Stress\ Tested\ Bank\ BoE_i * Post\ Stress\ Period\ BoE_t \\ & * Failed\ Bank\ BoE_{i,t-1} + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\ & + \varepsilon_{i,t} \end{aligned} \tag{3.3}$$

3.5 Empirical Results

In the empirical results, I test the effect of stress testing on bank lending for several loan types available from Orbis Bank Focus. To capture the impact of stress testing on bank lending, I employ the difference-in-difference approach, which assesses the effect of a treatment (policy) on a nominated treatment group. In the case of the chapter, I test the stress testing framework's treatment or policy on a sample of banks that must undergo stress tests due to their significance to the domestic and global financial system. In each table, I include the main difference-in-difference interaction, which represents the effect of stress testing. The difference-in-difference interaction consists of a time dummy variable (treatment period) and a bank dummy variable (treatment group). In particular, the interaction is defined as the treatment, referred to as the Average Treatment Effect. In other words, the average effect of the stress testing programme on bank lending.

The second interaction that I consider is the triple difference, which assesses the effect of failing the stress test, and how this may impact bank lending. Intuitively, the second interaction could also be observed as the Average Treatment Effect of failing the stress test. Examining the Average Treatment Effect of the main coefficients is necessary, as this contributes to the literature review and provides regulators with policy recommendations on the effect of the treatment (stress tests). Subsequently, the information allows regulators to assess if the intended effect of the treatment aligns with the intended objective(s) of the stress testing framework.

In relation to the dependent variables, the loan types are expressed as growth rates. An increase or decrease of the explanatory variables included in the models will either increase or decrease the change in the dependent variables by percentage points. Importantly, the effect of the difference-in-difference interaction would either increase or decrease the dependent variables in percentage points. More specifically, the difference-in-difference interaction would assess the difference between the treatment and control bank since the implementation of the treatment, which is the objective of the thesis.

Tables 3.5-3.10 report the specification of the BoE's test by using the difference-in-difference interaction. Models (1)-(5) include the effects of the stress test by including three difference-in-difference interactions. In line with the primary double interaction (Stressed Bank BoE * Post Stress Period BoE), I find that the results of the stress test exhibit mostly insignificant results for all loan types. Except for the change in consumer and corporate loans (table 3.9 and 3.10), they are positive and negative, respectively.

Regarding consumer loans, for the majority of the models, I find that stress-tested banks will increase consumer loans by approximately 21 p.p. relative to the control banks since the treatment that was implemented in 2014. To some extent, the literature on the effect of stress testing and bank lending remains relatively limited, as the topic is currently emerging. Therefore, possible economic motivations behind the results are, at this point, unclear. Although consumer loans are inherently risky due to the loan type that deals with consumer credit, it is counterintuitive to find that the stress testing exercises are leading to a rise in consumer credit relative to the banks that are not participants in the stress tests. The result is unexpected, as it should show that the UK stress-tested banks would be seeking to reduce consumer loans to ensure that they mitigate credit risk. However, table 3.9 highlights that UK stress-tested banks are increasing consumer credit.

In table 3.10, the stress testing exercise (double interaction) reduces corporate loans by approximately 26 p.p. compared to the non-stress tested banks since the treatment period. The negative relationship is expected, as the literature indicates that banks are reducing loans to improve credit risk. Given that corporate loans can be riskier, stress-tested banks may seek to curb the origination of corporate loans. For the remaining models in the table, the effect of stress testing on corporate loans loses statistical significance.

The empirical results align with the findings of Acharya et al. (2018) and deviate in other ways. For example, Acharya et al. (2018) report statistically significant results when analysing the impact of the stress testing exercise. Although for most of the variables, I do not see this to be the case.

The empirical results become statistically significant when I control for the triple difference interaction, otherwise known as the effect of failing the stress test. If a bank fails the stress test, there is a reduction in lending for several loan types. Acharya et al. (2018) suggest two different hypotheses to explain the behaviour of the banks. The authors explain that their findings support the Risk Management Hypothesis, where banks will reduce lending after a stress test. The second is the Moral Hazard Hypothesis, where banks increase lending after a stress test. The chapter's empirical approach is similar to Acharya et al. (2018). I, therefore, support the Risk Management Hypothesis and show that banks that fail the stress test will reduce lending to ensure they can manage credit risk.

Regarding total loan lending, model (2) in table 3.5 shows that the effect of failing the stress testing reduces total lending by approximately 8 p.p. That is, the banks that fail the stress test will reduce total loans relative to the non-stress tested banks and the banks that passed since the start of the treatment period in 2014. The result is expected, as the literature review section highlights that the effect of failing a stress test can have severe ramifications for the banks, such as an adverse market reaction or the possibility of regulatory intervention. In addition, the result highlights that capturing the failure of a stress-tested bank is influential and can affect bank lending. Models (3) and (4) of the table include the two difference-in-difference interactions that are analysed in the previous two models. However, the models are modified by excluding macroeconomic variables and time dummy variables to assess if the results hold, respectively. The results still exhibit the negative relationship between failing a stress test and reducing total lending. The triple difference interaction includes one dummy variable and two-time dummy variables. However, I develop another variation to create a double interaction, which assesses the lending behaviour of banks that have failed the stress test. The double interaction is shown in model (5) and replaces the triple difference interaction. In fact, I find that the triple difference interaction in models (2), (3), and (4) are identical to the double interaction shown in model (5). Therefore, in the succeeding tables, I do not discuss the results of model (5) and primarily discuss the triple difference interaction, which is identical to the double interaction.

Additionally, I find that banks that fail the stress test will reduce net loans to customers relative to non-stress tested banks and those that pass the stress test. Notably, the net loans to customers are highly similar to the total loans dependent variable, as net loans to customers plus net loans to banks equals total lending (author's calculations). As a result, the table findings are predictable and highly similar to the findings of the total loans variable. Consequently, table 3.6 documents that failing the stress test (triple interaction) will reduce net loans to customers by approximately 10 p.p. relative to non-stress tested banks and those that pass the stress tests during the treatment period. Models (2), (3), and (4), which report the triple difference interaction, show similar significant results. The identical double interaction in model (5) also implies that banks that fail the stress test will reduce lending. As discussed in the literature review section, the result is anticipated as there are repercussions of failing a stress test.

The final lending type that exhibits a reduction in lending is mortgage loans. The impact of failing the stress test is statistically significant, as shown by the triple interaction in models (2), (3), and (4). The results find that failing the stress test will reduce mortgage loans by approximately 10 p.p. relative to non-stress tested banks and those that pass the stress test. Mortgage loans may be inherently risky, as banks have recently experienced the subprime mortgage crisis and may be more inclined to reduce mortgages, especially if the banks are performing worse than their counterparts. Subsequently, failing the stress test may incentivise banks to reduce this specific loan type due to its risky characteristic and either increase lending for alternative credit types or seek to improve their capital structure. In line with three models that show statistically significant results, the double interaction in model (5) also yields identical to the triple difference interaction.

Furthermore, I consider the dynamic effects of stress testing each year since the start of the BoE's stress tests in 2014. The empirical analysis assesses if the effect of stress testing on bank lending diminishes over time, as the literature suggests that the earliest periods were more effective in reducing bank lending (Calem et al., 2019).

For the baseline difference-in-difference interaction shown in table 3.11, model (1), for each dependent variable, I find that most of the findings are statistically insignificant, except for the net loans to customers during 2015. The result indicates that stress-tested banks reduced lending in 2015 by approximately 13 p.p. relative to the non-stress tested banks. However, I include the triple difference interaction in model (2), and the statistical significance for net loans to customers in 2015 disappears.

Table 3.12 shows that the consumer loan growth is similar to the results shown in the main difference-in-difference interaction. In particular, I find that the stress-tested banks increased consumer loans by approximately 24 p.p. in 2014 and 26 p.p. in 2017 relative to non-stress tested banks. As explained above, the results for the consumer loans may seem counterintuitive due to the risky nature of the consumer loan type. The stress-tested banks should perhaps reduce consumer loans to mitigate credit risk and help contribute to individual financial stability, a vital objective of the stress testing framework. Moreover, in model (2), I include the dynamic effect of the triple interaction and find that the double interaction remains significant, as seen in model (1). Specifically, stress-tested banks increased consumer loans in 2014 and 2017 by approximately 29 and 21 p.p., respectively. Given that the stress testing exercises began in 2014, the earliest stress tests may be deemed more effective in influencing bank lending, as suggested by the literature. For consumer loans, I find that the stress testing exercise may not be losing its effectiveness for this specific loan type as I find significant results for the earliest stress test (2014) and one of the latest stress tests (2017).

Concerning corporate loans, I find that for model (1), in 2015, the stress-tested banks reduced lending by approximately 26 p.p. relative to non-stress tested banks. This result is expected, given that corporate loans are associated with greater risk. Furthermore, given that the literature suggests that the earliest exercises were more effective in affecting bank lending, it is expected to find a statistically significant result. In model (2), the results also show that corporate lending by the stress-tested banks decreased in 2015. The result is larger than the coefficient in model (1), which exhibits approximately a 32 p.p. decrease in corporate loans relative to non-stressed test banks. To some extent, it could be said that the effect of stress testing may be losing its effectiveness over time, as there are no statistically significant results for the latest years.

I focus on tables 3.11 and 3.12 and the triple difference interaction, which now examines the dynamic impact of the exercises. The results yield statistically significant results for the total loans dependent variable, where I find a reduction in lending by the failed banks relative to the non-stress tested banks and passed banks by approximately 7 p.p., 11 p.p., and 15 p.p., in 2014, 2015, and 2018, respectively. Noticeably, the results confirm that the stress testing exercises are not losing their effectiveness over time as the results indicate that the exercises were influential in the earliest and the latest periods[11].

Next, I assess the dynamic triple difference interaction of the net loans to customers and, unsurprisingly, find similar results. Given that the dependent variable is highly correlated to total loans, the results are predicted to be alike. The results show that banks that fail the stress test will reduce net loans to customers relative to non-stress tested banks and passed banks by 8 p.p., 11 p.p., and 18 p.p. in 2014, 2015, and 2018, respectively. Yet again, the results provide evidence to suggest that stress testing as a macroprudential tool is not losing its effectiveness, as the latest years exhibit statistically significant results.

In relation to net loans to banks, I find that for 2015, the banks that failed the stress test reduced bank loans by approximately 47 p.p. relative to the non-stress tested banks and those that passed the stress test. Moreover, the result suggests that the earliest stress tests may have been more effective, as the latest year does not show any statistically significant relationship. As the literature on stress testing on bank lending is relatively emerging, the rationale behind the failed stress-tested banks' decision to reduce bank lending remains ambiguous. However, as bank loans are reasonably safe relative to consumer and corporate loans, the failed stress-tested banks would expect to increase their share of bank loans, which would follow a 'flight to quality' strategy.

[11] The result of the latest years may be due to other factors which exclude the stress testing programme. The section below explains other factors that may drive the result as opposed to the stress testing programme.

Lastly, the dynamic analysis of the mortgage loans shows evidence of a loan reduction by the failed stress-tested banks relative to the alternative groups. Said differently, failed stress-tested banks reduce mortgage loans relative to non-stress tested banks and those that pass the stress test in 2015, 2017, and 2018 by approximately 8 p.p., 10 p.p., and 14 p.p., respectively. The result is expected as the banks have faced a financial crisis that was characterised as a subprime mortgage crisis, and failure of the stress test may persuade banks to reduce this loan type, which can be purported as inherently risky. In the case of the effectiveness of stress testing over time, the results indicate that for the effect of stress testing on mortgage loans, the exercise's effectiveness is not diminishing over time as hypothesised for the U.S. financial system. That is, for the UK banking system, the stress testing framework remains relevant and presently affects the decisions made for the origination of mortgage loans.

In the previous tables (table 3.5-3.8), I include a double interaction which is presented in model (5). The double interaction is similar to the triple interaction, which examines the effect of failing the stress test, which is present in models (2), (3), and (4). As the double interaction equals the triple interaction, I do not include or discuss the dynamic effect of the double interaction in tables 3.11 and 3.12, as the result would be identical to the dynamic triple difference interaction.

In sum, no discernible patterns emerge from the dynamic results, and the effect of stress testing on bank lending has shown to be similar throughout the period. This is in contrast to the findings of the U.S. financial system, which document that the effect of stress testing on bank lending was most effective during the earlier periods.

In line with the literature, Cortés et al. (2019) find that banks will reduce lending to small businesses. Due to data availability, I cannot control the loan size concerning corporate or consumer lending and the type of business banks specifically lend to. However, the most related loan type is corporate lending, reported in tables 3.10 and 3.12. The effect of stress testing on corporate loans is statistically significant throughout these two tables. Given the results, Cortés et al. (2019) explain that stress-tested banks will cut banks on lending if they do not have information on the geographical location of their branch. This allows smaller banks with more detailed information to replace these stress-tested banks and increase lending. I do not report the lending rates of the smaller banks (control banks) within the empirical model or if they replace the stress-tested banks. Although table 3.2 reports a t-test between stress-tested banks and non-stress tested banks.

Interestingly, the results show that during and after the stress testing period, non-stress tested banks increase lending for total loans, net loans to customers and mortgage loans which are statistically significant. The analysis reported in table 3.2 suggests that stress-tested banks will reduce lending, as seen in Cortés et al. (2019). The stress-tested banks will be replaced by non-stress tested banks, indicating that aggregated lending is not reduced (Mésonnier and Monks, 2015).

The third paper that relates to the chapter's findings is by Calem et al. (2019), who dedicate their attention to the effects of stress testing on the jumbo mortgage market. In contrast, the results do not report the size of the mortgages due to the granularity of data. Albeit, I report the effect of the change in mortgage loan growth by the stress testing exercises. The results reported in table 3.8 demonstrate how stress testing affects mortgage loan growth. Firstly, I report that statistically significant results show an effect of stress testing on mortgage lending, but this is seen for banks that fail the stress test. Calem et al. (2019) additionally explain that they analyse the effect of stress testing on the jumbo mortgage market for the earlier FED stress test (2011 Comprehensive Capital Analysis and Review). To assess if the relationship holds, I analyse the effect of the earlier stress tests and find there are statistically significant results and banks that fail will reduce lending. Furthermore, the impact of failing in the earliest stress test period is no different to failing in the most recent years.

Shapiro and Zeng (2019) posit possible bank lending behaviour shifts from their theoretical model. They find that banks that fail the stress test will reduce bank lending, and those that pass the stress test will increase lending. Though their model is based on the regulatory authority's decision, I find evidence from the results that banks that fail will reduce lending, and those who will pass will increase lending. The chapter's results show that banks that fail will reduce loan types such as net loans to customers and mortgage loans. Therefore, to improve on Shapiro and Zeng's (2019) theoretical model, the authors should consider banks' lending behaviour concerning the type of loans. Most importantly, Shaprio and Zeng (2019) focus on the feedback effect of a bank failing the stress test. Still, the results do not consider the feedback effect of one bank failing the stress test and how this may affect the lending decisions made by other banks participating in the stress test.

The current literature that addresses the effects of stress testing on bank lending for the U.S banking system provides evidence that bank lending is reduced post-stress test. Bassett and Berrospide (2018) document that the effect of stress testing on bank lending is positively correlated. The differences in the results compared to the related papers are due to the construction of the stress testing variable. This chapter uses a difference-in-difference approach, but Bassett and Berrospide (2018) assess the effect of stress testing by calculating the capital levels between the internal banks' stress testing exercise and the supervisory authority's stress test. Due to data availability, I cannot calculate the capital gap as a bank's internal stress test results is not publicly disclosed. I relate to Bassett and Berrospide's (2018) finding by showing that the effect of stress testing on bank lending is positive, conditional on the bank passing the stress test.

The empirical results reported in tables 3.5-3.10 also control banking and macroeconomic variables. A common theme that is repeated in the results is that size negatively affects bank lending. The results show that an increase in size decreases total lending and net loans to customers. The rationale behind this result is that an increase in bank size allows smaller banks to lend relative to larger banks. Smaller banks build closer relationships with customers enabling them to lend and establish closer connections with their customers (Naceur et al., 2018). The increase in profitability for banks leads to an increase in total lending net loans to banks, which was expected (Kim and Sohn, 2017). The efficiency variable shows mixed results. An increase in the efficiency ratio means higher costs will decrease lending for net loans to customers and increase lending to banks. For brevity, I do not report the results of the explanatory variables for the remainder of the chapter.

3.5.1 Economic Motivation

The results show that failing the stress test can reduce lending, but is there any rational explanation for this? The first point that may have caused a reduction in lending is tighter regulations after the financial crisis. Recent regulations after the crisis have been implemented to reduce systemic risk and enhance the resilience of banks to any future adverse shocks. In saying this, the supervisory stress testing exercises are a part of the regulations that may have led to a reduction in lending. Furthermore, tighter regulations may impact larger banks relative to smaller banks. Morris-Levenson et al. (2017) find that the tighter regulations are causing a reduction in lending post-GFC, which is more prominent for mortgage lending. The tighter regulation that reduces lending by the largest banks does not mean that mortgage lending is being reduced because smaller, less regulated banks will replace the larger banks and fill the gap by providing lending.

In addition, tighter regulation for the stress-tested banks is a continuous process. From this, I see that if banks fail the stress test, the Prudential Regulation Authority or the Financial Policy Committee will evaluate if further action is needed to preserve financial stability. The Prudential Regulatory Authority especially requires banks to create capital plans if they fail the stress test. The requirement or additional scrutiny by supervisory authorities can be seen as supplementary regulations, which means banks may reduce lending (BoE, 2014).

A similar finding on why banks reduce lending is reported by Chen et al. (2017), who document that the largest banks in America, namely the largest four banks, are actively reducing bank loans to the small business market. Their finding aligns with Morris-Levenson et al. (2017) and suggest that bank lending behaviour has been affected by the GFC. Chen et al. (2017) find that the reduction in lending was instigated by the financial crisis, where the largest banks reduced lending for reasons that may seem unclear. First, the authors explain that further regulation such as supervisory stress tests or growth in regulatory capital buffers has influenced the largest banks to cut lending. Following this, the choice to reduce lending for small businesses was triggered by the credit losses that the largest banks experienced during the financial crisis for small business lending. Due to the losses experienced by the banks during the crisis, the authors considered that banks are cautious in entering the small business market as they may perceive the market to be riskier. As shown in the previous findings (Cortés et al., 2019), an underlying substitution effect occurs when large banks reduce lending for specific markets. Chen et al. (2017) find that smaller banks and finance companies replace the largest banks and provide lending to small businesses when the largest banks reduce lending. However, the authors differentiate their findings and explain when the largest banks reduce lending; there is a time lag for small banks to enter the market. Worded differently, small banks and finance companies do not immediately replace the largest banks. Another suggestion the paper makes is that the largest banks reduce lending due to competition, as they suggest that they would not receive financial advantages against their competitors.

The composition and strength of the balance sheet is another subsequent factor that may explain the results. Kapan and Minou (2018) show that the balance sheet composition is important to analyse and may explain that the strength of the balance sheet can drive the effects on bank lending. The paper suggests that the effects are based on the financial crisis, and to remain resilient against a shock, the banks must have strong balance sheets that allow them to provide bank loans. The authors explain that the strength of the balance sheet can be assessed by the quantity and quality of capital that the banks hold. Following the results, I can see how capital can influence banks' lending behaviour. To categorise if banks pass or fail the stress test, banks are assessed against regulatory capital thresholds that they must meet, and supervisors need to evaluate if a real adverse shock were to present itself. Would the banks have sufficient capital? The failure of the banks in the BoE's model specification was due to banks falling below the set threshold in each respective stress testing exercise. Therefore, the fall in the capital is due to the banks' balance sheet being assessed against a stringent stress test, thus producing negative externalities for bank credit.

Irrespective of the stress testing exercises, there is analysis suggesting that certain regulators' policies can indirectly influence bank lending after the GFC. For example, regarding the U.S. federal reserve, Chakraborty et al. (2020) find that the regulator undertook assets purchases from banks such as Mortgage-backed securities (MBS) and treasury assets for quantitative easing. However, the authors document that the MBS purchases made by the Federal Reserve led to an increase in mortgage lending by banks. Chakraborty et al. (2020) explain that as mortgage lending increases due to the MBS purchases, commercial lending to firms has been reduced. The results show that the composition of lending has changed due to this policy. Additionally, the impact on the real economy is addressed by the paper. It shows that the decision of the banks to reduce commercial lending has led to a contraction in investment by firms, which adversely affects economic activity. At the same time, the paper does not analyse the effect of stress testing on lending. I can see those actions by the regulators such as the FED can influence bank behaviour, where lending can increase for a certain market and decline in other markets.

As discussed above, the stress testing literature finds that the earliest exercises were most effective in influencing bank lending relative to the latest exercises. Nevertheless, the results of the empirical chapter contradict the assumptions made in the literature, as the evidence for the UK banking system confirm that the latest stress testing exercises influenced bank lending behaviour. It is of interest to propose that other alternative factors or events may have occurred in the UK or the global financial system during this period which may have affected bank lending behaviour relative to the stress testing regime.

In line with this assumption, a possible factor that may have influenced the latest result could be due to regulations. The UK financial system experienced a change in regulations during this period which targeted the operational function of the UK banking system. The ring-fencing legislation implemented in 2018 is perhaps one factor that may drive the significant result for the latest years, which is reported in tables 3.11 and 3.12, as opposed to the stress testing regime.

Since the crisis, one of the UK government's aims was to ensure the financial system is resilient and well-equipped to absorb losses. Notably, the UK government has pressed for new regulations to avoid similar events, such as the episode seen in the GFC. In this regard, the ring-fencing legislation has been established to divide the different entities within the large banks. Large banks (Bank Holding Companies) that engage in various forms of business can also be attributed to having a more extensive global reach and are considered more globally 'interconnected', thus increasing systemic risk. In order to manage individual and systemic risk within the banking system, the ring-fencing legislation creates a divide within the bank by segregating activities that are considered the 'retail banking division' and those that concern the 'investment arm' of the banking group.

Accordingly, Britton et al. (2016) suggest that the benefit of ring-fencing certain bank activities can help reduce the burden of a financial shock on the banking group as a whole and minimise the risk to the retail banking activities which engage in vital services for the public. Intuitively, by separating the 'retail arm' of the group, the notion is that a possible shock would have less of an effect relative to not being ring-fenced. In times of a recession, the retail arm will continue to operate and allow customers to access lending facilities and deposit their funds. In a speech, Proudman (2018) outlined that the ring-fencing measures can also help mitigate the chance of government bail-outs. Proudman (2018) also concludes that if ring-fencing measures had been introduced before the crisis, the effect of the crisis would be less intense and may have averted the need for capital injections by the UK government. The legislation set by the UK government will apply the ring-fencing measure to large banks that hold £25 Billion in retail deposits (Britton et al., 2016). In response to the announcement of the £25 Billion threshold, Jones (2022) documents that the banks that are subject to the ring-fencing measures are now burdened with the costs of adjusting their banking activity. Specifically, Jones (2022) explains that banks are choosing to hold extra capital to help support their transition into two separate entities. Accumulating additional capital to cushion against possible shocks can cause knock-on-effects for the economy, such as a reduction in lending or investment as the bank capital is now tied to the ring-fencing measures.

Presumably, due to the large sample size used in this respective empirical chapter, most banks will be obligated to adjust their operational activities to ring-fence the retail division of their business from the investment arm of the banking group. The likely effects of ring-fencing may disrupt the banking group, and to a slight extent, there could be a possible change in the lending behaviour of the largest banks, which may drive the results for the latest years as shown in tables 3.11 and 3.12.

In a recent paper, Chavaz and Elliot (2021) examine the application of the ring-fencing legislation for the UK banking system in 2018 and find evidence to confirm that there has been a change in lending practices. First, Chavaz and Elliot (2021) explain that due to the ring-fencing measures, there is a structural divide within the bank into two separate entities, retail banking and investment banking entities. The paper argues that the investment banking entity cannot access the deposits from the bank's retail entity due to the ring-fencing measures, which would have been possible previously. This, in effect, has inhibited funding for the investment banking division, ultimately shifting the banking group's activities to focus more on the bank's retail arm. Consequently, Chavaz and Elliot (2021) imply that retail banking has shifted its lending activity toward the mortgage and consumer loans market (Cullen, 2018). In turn, as there is a greater presence of the largest banks in these respective loan markets, smaller banks are now facing elevated competitive pressures from the largest banks (Morris et al., 2021; Morris, 2022). In order to remain relevant competitors in the market, the smaller banks may engage in riskier lending to compete for customers in the mortgage market, which can be seen as an undesirable effect.

In a government report, the HM Treasury (2022) provide an independent analysis of the ring-fencing measures and outlines the regime's influence since its application. From the report, the HM Treasury finds that while the measures are established in order to create a distinction between vital services that, by definition, are offered by the retail bank that deals with customers and the investment banking or international banking division that focuses on the market. Albeit, there is criticism to suggest that the retail division may be viewed as the higher priority relative to the investment and international banking division. The HM Treasury (2022) conclude that while the retail division offers vital services, the investment bank divisions that are not ring-fenced, also offer vital services that support the smooth functioning of the economy, such as providing lending to other financial institutions. In sum, the ring-fencing measures may isolate the retail banking component of the banking group as they are assumed to offer vital services. The report suggests that the weakness of the measures may overlook the significance of the other divisions within the group that can equally provide essential services that can boost economic activity and competition on a global scale.

In contrast to Chavaz and Elliot (2021), who document a shift in the mortgage market due to the ring-fencing measures, the HM Treasury (2022) report finds opposing results. The report outlines that mortgage lending has not markedly changed, and the ring-fencing measures have not played an influential role in adjusting the market share of the larger banks that are obligated to ring-fence their retail activities from their investment and international activities.

Furthermore, concerning the level of corporate and small business lending, the HM Treasury (2022) show no evidence to indicate that introduction of the ring-fence legislation has materially adjusted the activity in corporate and business lending. Said differently, there is no evidence to suggest that the measures have either markedly increased or decreased the loan activities for the respective loan types. The report's findings infer that the activity in these markets has remained relatively similar to the periods preceding the implementation of the ring-fencing measures.

In essence, the ring-fencing legislation may contribute to the differing lending patterns within the UK economy during 2018 and perhaps explain the result of the dynamic analysis of the latest stress testing years. Albeit, the HM Treasury (2022) report suggests that there is no substantial evidence to imply that the measures have significantly impacted the lending behaviour of the largest banks in the economy.

I attempt to ascertain if the results of the latest years are driven by other factors rather than the stress testing exercises. Notably, the HM Treasury (2022) conjecture that the effect of the ring-fencing measures may be offset or ambiguous due to the number of structural reforms and events that occurred in the backdrop while the ring-fencing measures were being implemented. The report lists other plausible reforms or circumstances that may have impacted the UK banking system. For instance, the report states that the exit of the UK from the EU may have contributed to the banking sector changes and distorted the real impact of ring-fencing measures. In addition, the recent global pandemic, COVID-19, may have influenced the activity in the banking industry.

Given that the sample of the empirical chapter does not include the period of the COVID-19 pandemic, it is self-explanatory to assume that the effect of the COVID-19 pandemic does not affect the latest years of the results reported in tables 3.11 and 3.12. Therefore, I address the possible effects of Brexit on UK bank lending and attempt to address if Brexit affects bank lending for the 2018 period relative to the stress testing exercises that are tested for this respective chapter. That is, did Brexit affect the lending behaviour of the UK economy during the end of the empirical chapter's sample period?

The impact of the Brexit vote to leave the EU had an impact on the syndicated loan market for the UK financial system. Berg et al. (2021) argue that the effect of the Brexit vote negatively impacted the syndicated loan market. Importantly, the authors emphasise that the reduction of loans in the syndicated market was not associated with banks' supply of loans to the economy but rather the demand for syndicated loans by UK businesses (Bloom et al., 2019). The paper suggests that businesses were hesitant to access the syndicated loan market due to the economic conditions, such as a projected reduction in economic growth due to the vote and future uncertainty. In contrast, Berg et al. (2021) note that there is no discernible effect on corporate loan lending as clarified by the BoE, which suggests that the impact of Brexit on alternative loan types is mixed. The paper's findings suggest that the effect of leaving the EU may have played an essential role in banks' lending behaviour. During this period, the significant step in structurally changing the landscape of financial services by leaving the EU is one factor that could explain the results for the latest years reported in tables 3.11 and 3.12, relative to the stress testing exercise that the thesis examines.

In a recent article, Noonan (2022) details how the asymmetry in regulations (post-Brexit) may influence bank lending behaviour. More specifically, Noonan (2022) explains that the EU financial system is diverging in how it adopts the globally accepted Basel III regulations, as the EU system is utilising strategies that enable the EU banks to hold less capital against a loan they originate. Additionally, the EU banks can extend loans to corporations that do not have a credit rating. Regarding competition, the article postulates that the EU financial system would be more attractive for corporations and firms in the UK, as these firms can access loans from EU banks that are less costly and available to firms with no credit rating. In other words, the UK financial system would be at a disadvantage if its counterpart followed a more lenient version of the Basel III accords and could offer more attractive loans. The regulatory reforms since the Brexit vote are constantly evolving, and due to the complexities of the financial systems across the UK and EU, the regulations since the crisis may affect the lending activity of UK banks due to competitive pressures. Competition among financial institutions coupled with everchanging regulatory reforms may explain the result of the dynamic analysis relative to the stress testing exercise that the empirical chapter assumes.

Table 3.5: The Effects of The BoE's Stress Tests on Total Loans Lending

The table reports the effects of the BoE's stress tests on bank lending. The dependent variable is total loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Post Stress Period BoE is a time dummy variable designated as 1 for 2014-2018 and 0 for 2005-2013. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Total Loans Change %				
	(1)	(2)	(3)	(4)	(5)
Size	-17.54**	-18.15**	-18.15**	-16.50**	-18.15**
	(7.81)	(7.48)	(7.48)	(6.17)	(7.48)
Profitability	2.46*	2.05*	2.05*	2.24	2.05*
	(1.22)	(1.15)	(1.15)	(1.43)	(1.15)
Credit risk	1.61	1.49	1.49	0.99	1.49
	(1.74)	(1.66)	(1.66)	(1.22)	(1.66)
Efficiency	-5.53	-5.28	-5.28	-3.67	-5.28
	(4.97)	(4.91)	(4.91)	(4.42)	(4.91)
Capital	-0.25	-0.31	-0.31	0.03	-0.31
	(0.54)	(0.54)	(0.54)	(0.36)	(0.54)
Economic conditions (GDP Growth)	15.98	11.86		-0.28	11.86
	(59.13)	(57.68)		(0.65)	(57.68)
Economic conditions (Bank Rate)	-3.48	-2.23		3.98**	-2.23
	(17.42)	(17.02)		(1.83)	(17.02)
Stressed Bank BoE * Post Stress Period BoE	-1.05	3.26	3.26	5.25	3.26
	(5.84)	(6.35)	(6.35)	(4.30)	(6.35)
Stressed Bank BoE * Post Stress Period BoE * Failed Bank BoE		-7.98**	-7.98**	-8.35**	
		(3.48)	(3.48)	(3.05)	
Failed Bank BoE * Post Stress Period BoE					-7.98**
					(3.48)
Constant	180.74	195.60	222.28**	187.46**	195.60
	(151.75)	(144.77)	(85.82)	(71.71)	(144.77)
Observations	184	184	184	184	184
R-Squared	0.29	0.30	0.30	0.26	0.30
Number of Banks	19	19	19	19	19
Bank fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	-	YES
Mean VIF	1.57	1.75	1.61	1.75	1.75
Sargen-Hansen Test (p-value)	18.063	18.158	28.092	18.158	18.158
	(0.0208)	(0.0334)	(0.0002)	(0.0334)	(0.0334)
Model Used	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.6: The Effects of The BoE's Stress Tests on Net Loans to Customers Lending

The table reports the effects of the BoE's stress tests on bank lending. The dependent variable is net loans to customers growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Post Stress Period BoE is a time dummy variable designated as 1 for 2014-2018 and 0 for 2005-2013. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Net Loans to Customers Change %				
	(1)	(2)	(3)	(4)	(5)
Size	-22.74***	-23.47***	-23.47***	-21.73***	-23.47***
	(7.82)	(7.30)	(7.30)	(6.21)	(7.30)
Profitability	-0.60	-1.10	-1.10	-0.60	-1.10
	(3.24)	(3.25)	(3.25)	(3.66)	(3.25)
Credit risk	1.73	1.59	1.59	0.94	1.59
	(1.77)	(1.66)	(1.66)	(1.30)	(1.66)
Efficiency	-11.11*	-10.81*	-10.81*	-8.09	-10.81*
	(6.27)	(6.13)	(6.13)	(5.32)	(6.13)
Capital	-0.21	-0.28	-0.28	0.19	-0.28
	(0.54)	(0.52)	(0.52)	(0.25)	(0.52)
Economic conditions (GDP Growth)	51.77	46.82		-0.43	46.82
	(53.76)	(51.29)		(0.66)	(51.29)
Economic conditions (Bank Rate)	-16.23	-14.73		3.80**	-14.73
	(15.22)	(14.53)		(1.67)	(14.53)
Stressed Bank BoE * Post Stress Period BoE	-6.14	-0.95	-0.95	5.09	-0.95
	(4.55)	(4.86)	(4.86)	(4.10)	(4.86)
Stressed Bank BoE * Post Stress Period BoE * Failed Bank BoE		-9.60***	-9.60***	-10.08***	
		(3.18)	(3.18)	(2.69)	
Failed Bank BoE * Post Stress Period BoE					-9.60***
					(3.18)
Constant	191.31	209.18	287.87***	253.31***	209.18
	(160.18)	(148.39)	(86.93)	(74.08)	(148.39)
Observations	184	184	184	184	184
R-Squared	0.29	0.30	0.30	0.25	0.30
Number of Banks	19	19	19	19	19
Bank fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	-	YES
Mean VIF	1.56	1.74	1.60	1.74	1.74
Sargen-Hansen Test (p-value)	20.366	22.730	21.191	22.730	22.730
	(0.0090)	(0.0068)	(0.0035)	(0.0068)	(0.0068)
Model Used	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.7: The Effects of The BoE's Stress Tests on Net Loans to Banks Lending

The table reports the effects of the BoE's stress tests on bank lending. The dependent variable is net loans to banks growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Post Stress Period BoE is a time dummy variable designated as 1 for 2014-2018 and 0 for 2005-2013. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Net Loans to Banks Change %				
	(1)	(2)	(3)	(4)	(5)
Size	8.62	8.06	8.06	6.69	8.06
	(16.63)	(16.68)	(16.68)	(17.49)	(16.68)
Profitability	10.38**	10.06*	10.06*	9.01	10.06*
	(4.88)	(5.07)	(5.07)	(6.31)	(5.07)
Credit risk	-0.39	-0.52	-0.52	0.57	-0.52
	(1.85)	(1.76)	(1.76)	(1.93)	(1.76)
Efficiency	34.51**	34.83**	34.83**	28.61*	34.83**
	(14.98)	(15.08)	(15.08)	(15.82)	(15.08)
Capital	0.33	0.28	0.28	-0.73	0.28
	(1.20)	(1.20)	(1.20)	(1.11)	(1.20)
Economic conditions (GDP Growth)	-395.79	-399.82		4.30**	-399.82
	(268.64)	(266.04)		(2.01)	(266.04)
Economic conditions (Bank Rate)	135.30	136.45		4.56	136.45
	(82.71)	(81.99)		(3.73)	(81.99)
Stressed Bank BoE * Post Stress Period BoE	13.37	17.45	17.45	3.26	17.45
	(11.41)	(14.65)	(14.65)	(9.90)	(14.65)
Stressed Bank BoE * Post Stress Period BoE * Failed Bank BoE		-7.40	-7.40	-6.85	
		(12.23)	(12.23)	(11.15)	
Failed Bank BoE * Post Stress Period BoE					-7.40
					(12.23)
Constant	491.39	505.41	-118.45	-120.13	505.41
	(576.18)	(569.69)	(201.77)	(216.85)	(569.69)
Observations	173	173	173	173	173
R-Squared	0.26	0.26	0.26	0.16	0.26
Number of Banks	18	18	18	18	18
Bank fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	-	YES
Mean VIF	1.52	1.70	1.59	1.70	1.70
Sargen-Hansen Test (p-value)	29.086 (0.0003)	33.118 (0.0001)	37.472 (0.0000)	33.118 (0.0001)	33.118 (0.0001
Model Used	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.8: The Effects of The BoE's Stress Tests on Mortgage Loans Lending

The table reports the effects of the BoE's stress tests on bank lending. The dependent variable is mortgage loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Post Stress Period BoE is a time dummy variable designated as 1 for 2014-2018 and 0 for 2005-2013. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Mortgage Loans Change %				
	(1)	(2)	(3)	(4)	(5)
Size	-16.50	-17.32	-17.32	-15.99	-17.32
	(12.14)	(12.01)	(12.01)	(11.24)	(12.01)
Profitability	1.96	1.22	1.22	0.35	1.22
	(2.84)	(2.76)	(2.76)	(1.83)	(2.76)
Credit risk	1.84	1.66	1.66	1.70	1.66
	(2.38)	(2.24)	(2.24)	(1.49)	(2.24)
Efficiency	1.49	1.72	1.72	1.44	1.72
	(10.52)	(10.47)	(10.47)	(8.71)	(10.47)
Capital	-0.14	-0.22	-0.22	-0.29	-0.22
	(0.72)	(0.74)	(0.74)	(0.55)	(0.74)
Economic conditions (GDP Growth)	-6.11	-8.54		-1.52*	-8.54
	(53.79)	(53.26)		(0.82)	(53.26)
Economic conditions (Bank Rate)	1.94	2.68		2.04	2.68
	(14.90)	(14.82)		(1.24)	(14.82)
Stressed Bank BoE * Post Stress Period BoE	1.18	6.46	6.46	6.23	6.46
	(9.36)	(9.50)	(9.50)	(4.61)	(9.50)
Stressed Bank BoE * Post Stress Period BoE * Failed Bank BoE		-10.18*	-10.18*	-10.99**	
		(5.21)	(5.21)	(4.84)	
Failed Bank BoE * Post Stress Period BoE					-10.18*
					(5.21)
Constant	197.70	212.83	198.42	187.32	212.83
	(217.92)	(216.03)	(138.93)	(131.87)	(216.03)
Observations	172	172	172	172	172
R-Squared	0.16	0.17	0.17	0.14	0.17
Number of Banks	18	18	18	18	18
Bank fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	-	YES
Mean VIF	1.57	1.74	1.62	1.74	1.74
Sargen-Hansen Test (p-value)	31.218	39.861	12.067	39.861	39.861
	(0.0001)	(0.0000)	(0.0984)	(0.0000)	(0.0000)
Model Used	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.9: The Effects of The BoE's Stress Tests on Consumer Loans Lending

The table reports the effects of the BoE's stress tests on bank lending. The dependent variable is consumer loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Post Stress Period BoE is a time dummy variable designated as 1 for 2014-2018 and 0 for 2005-2013. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Consumer Loans Change %				
	(1)	(2)	(3)	(4)	(5)
Size	-7.68	-8.00	-8.00	-1.71	-8.00
	(11.59)	(11.49)	(11.49)	(14.89)	(11.49)
Profitability	-0.54	-0.82	-0.82	-2.00	-0.82
	(2.14)	(1.98)	(1.98)	(1.69)	(1.98)
Credit risk	0.55	0.48	0.48	0.86	0.48
	(1.16)	(1.17)	(1.17)	(0.90)	(1.17)
Efficiency	-3.01	-2.88	-2.88	-6.27	-2.88
	(7.51)	(7.55)	(7.55)	(5.90)	(7.55)
Capital	0.65	0.60	0.60	0.23	0.60
	(0.98)	(0.98)	(0.98)	(0.57)	(0.98)
Economic conditions (GDP Growth)	-97.34	-101.92		-2.19	-101.92
	(141.23)	(141.32)		(1.27)	(141.32)
Economic conditions (Bank Rate)	28.95	30.30		5.41*	30.30
	(44.39)	(44.61)		(2.57)	(44.61)
Stressed Bank BoE * Post Stress Period BoE	18.90	20.93*	20.93*	12.16**	20.93*
	(11.26)	(10.95)	(10.95)	(4.86)	(10.95)
Stressed Bank BoE * Post Stress Period BoE * Failed Bank BoE		-3.83	-3.83	-5.35	
		(6.96)	(6.96)	(6.01)	
Failed Bank BoE * Post Stress Period BoE					-3.83
					(6.96)
Constant	233.42	245.87	66.66	17.04	245.87
	(294.50)	(294.14)	(145.62)	(183.38)	(294.14)
Observations	145	145	145	145	145
R-Squared	0.16	0.16	0.16	0.06	0.16
Number of Banks	16	16	16	16	16
Bank fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	-	YES
Mean VIF	1.60	1.78	1.62	1.78	1.78
Sargen-Hansen Test (p-value)	33.673	54.823	69.343	54.823	54.823
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Model Used	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.10: The Effects of The BoE's Stress Tests on Corporate Loans Lending

The table reports the effects of the BoE's stress tests on bank lending. The dependent variable is corporate loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Post Stress Period BoE is a time dummy variable designated as 1 for 2014-2018 and 0 for 2005-2013. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Corporate Loans Change %				
	(1)	(2)	(3)	(4)	(5)
Size	-16.84	-16.38	-16.38	-18.37	-16.38
	(13.69)	(13.96)	(13.96)	(12.84)	(13.96)
Profitability	-17.08	-16.68	-16.68	-14.81	-16.68
	(12.51)	(12.36)	(12.36)	(13.30)	(12.36)
Credit risk	1.84	1.97	1.97	0.49	1.97
	(1.79)	(2.08)	(2.08)	(1.66)	(2.08)
Efficiency	8.43	8.15	8.15	16.70	8.15
	(12.92)	(13.45)	(13.45)	(16.47)	(13.45)
Capital	-0.53	-0.48	-0.48	0.62	-0.48
	(1.10)	(1.10)	(1.10)	(0.77)	(1.10)
Economic conditions (GDP Growth)	-190.52	-189.77		-1.14	-189.77
	(117.23)	(118.81)		(1.29)	(118.81)
Economic conditions (Bank Rate)	61.62*	61.30		8.91*	61.30
	(35.14)	(35.49)		(4.68)	(35.49)
Stressed Bank BoE * Post Stress Period BoE	-26.33*	-30.56	-30.56	-16.67	-30.56
	(13.18)	(21.52)	(21.52)	(17.83)	(21.52)
Stressed Bank BoE * Post Stress Period BoE * Failed Bank BoE		7.86	7.86	7.48	
		(20.13)	(20.13)	(19.99)	
Failed Bank BoE * Post Stress Period BoE					7.86
					(20.13)
Constant	520.09*	512.60	200.89	179.30	512.60
	(293.83)	(298.81)	(159.10)	(159.84)	(298.81)
Observations	154	154	154	154	154
R-Squared	0.29	0.29	0.29	0.24	0.29
Number of Banks	16	16	16	16	16
Bank fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	-	YES
Mean VIF	1.57	1.73	1.60	1.73	1.73
Sargen-Hansen Test (p-value)	12.916 (0.1148)	17.747 (0.0382)	16.589 (0.0202)	17.747 (0.0382)	17.747 (0.0382)
Model Used	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.11: The Effects of The BoE's Stress Tests on Total Loans, Net Loans to Customers, and Net Loans to Banks Lending – Dynamic Analysis

The table reports the effect of each stress testing exercise by the BoE for each year since 2014. The dependent variables are total loans growth, net loans to customers growth, net loans to banks growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Stress Period is a time dummy variable designated as 1 for each year and 0 otherwise. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. In addition, for brevity the explanatory variables are included but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Total Loans Growth %		**Net Loans to Customers Growth %**		**Net Loans to Banks Growth %**	
	(1)	(2)	(1)	(2)	(1)	(2)
Stressed Bank BoE * 2014 Stress Period	5.10	9.14	-0.73	3.90	21.13	17.06
	(7.81)	(8.09)	(7.43)	(7.46)	(13.77)	(19.71)
Stressed Bank BoE * 2015 Stress Period	-3.96	2.01	-12.69*	-6.45	4.35	31.22
	(6.28)	(6.36)	(6.19)	(5.31)	(22.49)	(29.32)
Stressed Bank BoE * 2016 Stress Period	-0.21	0.09	-3.71	-2.44	11.00	14.46
	(5.90)	(7.25)	(5.36)	(6.39)	(16.21)	(22.38)
Stressed Bank BoE * 2017 Stress Period	-1.32	2.15	-5.03	-1.02	9.82	10.47
	(6.62)	(7.47)	(5.17)	(5.94)	(17.37)	(22.72)
Stressed Bank BoE * 2018 Stress Period	-5.37	2.55	-8.52	1.24	21.22	14.22
	(6.96)	(6.82)	(6.69)	(6.33)	(24.59)	(10.34)
Stressed Bank BoE * 2014 Stress Period Failed Bank BoE		-7.36**		-8.45***		7.25
		(2.74)		(2.54)		(15.22)
Stressed Bank BoE * 2015 Stress Period Failed Bank BoE		-10.85***		-11.40***		-47.20*
		(3.73)		(3.46)		(23.62)
Stressed Bank BoE * 2016 Stress Period Failed Bank BoE		-0.99		-2.82		-5.98
		(5.89)		(5.45)		(19.60)
Stressed Bank BoE * 2017 Stress Period Failed Bank BoE		-6.51		-7.56		-1.24
		(5.45)		(5.47)		(22.57)
Stressed Bank BoE * 2018 Stress Period Failed Bank BoE		-14.53**		-17.94***		12.39
		(6.53)		(5.41)		(39.34)
Constant	250.11	270.49	245.86	271.67	298.50	280.19
	(180.93)	(176.62)	(187.67)	(180.29)	(369.52)	(354.50)
Observations	184	184	184	184	173	173
R-Squared	0.30	0.31	0.30	0.31	0.26	0.28
Number of banks	19	19	19	19	18	18
Bank fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Bank Characteristics	YES	YES	YES	YES	YES	YES
Macro Characteristics	YES	YES	YES	YES	YES	YES
Mean VIF	1.43	2.04	1.42	2.03	1.39	2.02
Sargen-Hansen Test (p-value)	15.670 (0.0474)	16.006 (0.0668)	18.977 (0.0150)	20.466 (0.0152)	27.989 (0.0005)	37.103 (0.0000)
Model Used	FE	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.12: The Effects of The BoE's Stress Tests on Mortgage Loans, Consumer Loans, and Corporate Loans Lending – Dynamic Analysis

The table reports the effect of each stress testing exercise by the BoE for each year since 2014. The dependent variables are mortgage loans growth, consumer loans growth, and corporate loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for 12 banks. The Stress Period is a time dummy variable designated as 1 for each year and 0 otherwise. The Failed Bank BoE variable is a dummy variable designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all explanatory variables and the difference-in-difference interaction. Model (2) includes all explanatory variables, the difference-in-difference interaction, and the triple difference to control the effects of failing the stress test. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. In addition, for brevity the explanatory variables are included but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Mortgage Loans Growth %		**Consumer Loans Growth %**		**Corporate Loans Growth %**	
	(1)	(2)	(1)	(2)	(1)	(2)
Stressed Bank BoE * 2014 Stress Period	-2.37	3.10	24.12*	28.72*	-4.66	-6.53
	(7.73)	(7.36)	(13.10)	(13.60)	(17.78)	(24.38)
Stressed Bank BoE * 2015 Stress Period	-0.32	3.68	12.11	16.45	-26.29**	-32.07*
	(10.33)	(10.01)	(10.71)	(10.84)	(11.48)	(17.70)
Stressed Bank BoE * 2016 Stress Period	3.36	7.95	16.78	19.88	-50.64	-57.67
	(11.13)	(11.82)	(14.93)	(16.16)	(35.21)	(37.83)
Stressed Bank BoE * 2017 Stress Period	1.10	6.44	26.11*	20.63*	-22.93	-23.52
	(9.47)	(9.94)	(12.38)	(10.42)	(16.34)	(26.49)
Stressed Bank BoE * 2018 Stress Period	4.63	11.08	13.53	18.62	-31.58	-37.07
	(10.63)	(10.91)	(10.47)	(11.21)	(18.73)	(28.86)
Stressed Bank BoE * 2014 Stress Period Failed Bank BoE		-10.21		-8.01		3.60
		(6.78)		(5.37)		(17.35)
Stressed Bank BoE * 2015 Stress Period Failed Bank BoE		-7.98*		-7.65		10.44
		(4.55)		(6.26)		(15.92)
Stressed Bank BoE * 2016 Stress Period Failed Bank BoE		-8.77		-5.42		12.59
		(8.27)		(11.26)		(23.42)
Stressed Bank BoE * 2017 Stress Period Failed Bank BoE		-10.17**		9.40		1.43
		(3.71)		(13.44)		(23.66)
Stressed Bank BoE * 2018 Stress Period Failed Bank BoE		-13.62**		-8.94		11.28
		(5.97)		(8.09)		(28.88)
Constant	144.41	170.55	447.86	450.07	691.24*	676.79*
	(238.66)	(242.35)	(401.83)	(409.51)	(332.73)	(338.34)
Observations	172	172	145	145	154	154
R-Squared	0.16	0.17	0.16	0.17	0.31	0.31
Number of banks	18	18	16	16	16	16
Bank fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Bank Characteristics	YES	YES	YES	YES	YES	YES
Macro Characteristics	YES	YES	YES	YES	YES	YES
Mean VIF	1.42	2.00	1.46	2.08	1.43	2.00
Sargen-Hansen Test (p-value)	68.527 (0.0000)	91.665 (0.0000)	32.753 (0.0001)	53.335 (0.0000)	23.563 (0.0050)	29.998 (0.0009)
Model Used	FE	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

3.6 Robustness Tests

The robustness tests assess the effect of the EBA's stress testing exercises on UK bank lending. As explained, I focus on 4 UK banks participating in the EBA's stress testing exercises as opposed to the 7 banks stress-tested by the BoE. The difference-in-difference term is slightly modified compared to the variable reported in the baseline results. The difference-in-difference interaction defines the treatment period from 2010, and the treatment group includes 4 banks with 15 banks in the control group.

From the empirical results reported in tables 3.13-3.18, I do not find any statistically significant results for the effects of stress testing. At first, I intend to see if the results corroborate with the results from Acharya et al. (2018), which suggests that I expect similar results showing that stress testing reduces loan growth. However, I do not find this to be the case, so I cannot support the hypothesis of the Risk Management Hypothesis where the banks reduce loans after a stress test with respect to the model specification. In line with the BoE specification, I also test for the effect of each year. The results are reported in tables 3.19 and 3.20. I find that the results are statistically insignificant for most of the results. Although regarding net loans to banks, I find that stress testing increases bank lending for the EBA stress-tested banks relative to the alternative control banks by approximately 46 p.p. and 38 p.p. in 2010 and 2014, respectively. There may be evidence of a 'flight to quality' as the set of EBA stress-tested banks may allocate their lending activity for bank loans relative to the alternative lending types associated with heightened risk. In line with the effectiveness of stress testing over time, evidence may show that the earliest stress testing exercises are deemed more influential. The result is statistically significant for the earliest year, and 2014 when the BoE began its national stress testing framework in conjunction with the EBA stress testing framework.

One limitation of this section is that a triple difference (bank failing the stress test) cannot be applied as seen in the BoE's model specification. Under the EBA stress testing exercises, no UK bank had failed or was below the respective hurdle rate set by the EBA. Although one paper connected to answering the limitation is by Mésonnier and Monks (2015), who analyse the effects of the EBA capital exercise. The authors find that undercapitalised banks (which can otherwise be interpreted as banks that fail a stress test) will reduce their loan growths relative to banks with sufficient capital levels (which can be interpreted as banks that pass). The main motive behind the reduced lending is that banks adopt strategies to improve capital ratios while simultaneously reducing lending (Beccalli et al., 2018). The analysis from Mésonnier and Monks

(2015) coincides with the main results from the BoE stress specification, where I see that banks that fail will reduce lending. I, therefore, hypothesise that if I could capture the effects of failing or passing via a triple difference, banks that fail the stress test will reduce their lending. One disadvantage of Mésonnier and Monks (2015) is that they discuss the effect on lending in general and do not disaggregate the lending into different types, such as mortgage or corporate loans.

Table 3.13: The Effects of The EBA's Stress Tests on Total Loans Lending

The table reports the effects of the EBA's stress tests on bank lending. The dependent variable is total loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Post Stress Period EBA is a time dummy variable designated as 1 for 2010-2018 and 0 for 2005-2009. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Total Loans Change %		
	(1)	(2)	(3)
Size	-17.36**	-17.36**	-15.78**
	(7.31)	(7.31)	(6.04)
Profitability	2.62	2.62	2.73
	(1.69)	(1.69)	(1.65)
Credit risk	1.67	1.67	1.14
	(1.85)	(1.85)	(1.36)
Efficiency	-5.18	-5.18	-3.57
	(5.20)	(5.20)	(4.41)
Capital	-0.23	-0.23	0.10
	(0.52)	(0.52)	(0.33)
Economic conditions (GDP Growth)	14.20		-0.25
	(63.52)		(0.54)
Economic conditions (Bank Rate)	-3.16		3.83*
	(18.31)		(2.06)
Stressed Bank EBA * Post Stress Period EBA	-3.80	-3.80	-2.67
	(11.09)	(11.09)	(12.41)
Constant	181.34	211.10**	178.44**
	(152.34)	(82.85)	(70.05)
Observations	184	184	184
R-Squared	0.29	0.29	0.26
Number of Banks	19	19	19
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	-
Mean VIF	1.72	1.64	1.72
Sargen-Hansen Test (p-value)	20.809	19.813	20.809
	(0.0077)	(0.0030)	(0.0077)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.14: The Effects of The EBA's Stress Tests on Net Loans to Customers Lending

The table reports the effects of the EBA's stress tests on bank lending. The dependent variable is net loans to customers growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Post Stress Period EBA is a time dummy variable designated as 1 for 2010-2018 and 0 for 2005-2009. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Net Loans to Customers Change %		
	(1)	(2)	(3)
Size	-22.10***	-22.10***	-20.67***
	(7.01)	(7.01)	(5.92)
Profitability	-0.05	-0.05	0.14
	(3.73)	(3.73)	(3.88)
Credit risk	1.86	1.86	1.22
	(1.99)	(1.99)	(1.50)
Efficiency	-10.39	-10.39	-7.78
	(6.85)	(6.85)	(5.76)
Capital	-0.11	-0.11	0.29
	(0.51)	(0.51)	(0.19)
Economic conditions (GDP Growth)	55.89		-0.43
	(59.89)		(0.55)
Economic conditions (Bank Rate)	-17.21		3.51*
	(16.50)		(2.01)
Stressed Bank EBA * Post Stress Period EBA	-7.55	-7.55	-6.45
	(12.19)	(12.19)	(13.61)
Constant	173.02	268.64***	240.12***
	(155.64)	(84.07)	(71.11)
Observations	184	184	184
R-Squared	0.29	0.29	0.25
Number of Banks	19	19	19
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	-
Mean VIF	1.71	1.63	1.71
Sargen-Hansen Test (p-value)	22.418	19.385	22.418
	(0.0042)	(0.0036)	(0.0042)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.15: The Effects of The EBA's Stress Tests on Net Loans to Banks Lending

The table reports the effects of the EBA's stress tests on bank lending. The dependent variable is net loans to banks growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Post Stress Period EBA is a time dummy variable designated as 1 for 2010-2018 and 0 for 2005-2009. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Net Loans to Banks Change %		
	(1)	(2)	(3)
Size	7.21	7.21	6.23
	(15.91)	(15.91)	(15.37)
Profitability	8.37	8.37	8.17
	(5.54)	(5.54)	(6.30)
Credit risk	-0.64	-0.64	0.39
	(1.88)	(1.88)	(2.15)
Efficiency	30.92*	30.92*	25.58
	(15.46)	(15.46)	(14.95)
Capital	0.10	0.10	-0.77
	(1.07)	(1.07)	(1.07)
Economic conditions (GDP Growth)	-397.13		4.17**
	(263.29)		(1.85)
Economic conditions (Bank Rate)	136.50		6.34
	(81.93)		(3.85)
Stressed Bank EBA * Post Stress Period EBA	22.41	22.41	20.75
	(13.65)	(13.65)	(12.95)
Constant	519.40	-95.87	-116.03
	(566.54)	(195.63)	(193.38)
Observations	173	173	173
R-Squared	0.27	0.27	0.17
Number of Banks	18	18	18
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	-
Mean VIF	1.66	1.60	1.66
Sargen-Hansen Test (p-value)	31.734	30.099	31.734
	(0.0001)	(0.0000)	(0.0001)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.16: The Effects of The EBA's Stress Tests on Mortgage Loans Lending

The table reports the effects of the EBA's stress tests on bank lending. The dependent variable is mortgage loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Post Stress Period EBA is a time dummy variable designated as 1 for 2010-2018 and 0 for 2005-2009. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Mortgage Loans Change %		
	(1)	(2)	(3)
Size	-15.81	-15.81	-14.02
	(10.60)	(10.60)	(9.62)
Profitability	2.28	2.28	1.86
	(2.73)	(2.73)	(2.04)
Credit risk	2.23	2.23	2.29
	(2.44)	(2.44)	(1.70)
Efficiency	4.13	4.13	3.82
	(9.93)	(9.93)	(8.37)
Capital	-0.18	-0.18	-0.13
	(0.68)	(0.68)	(0.48)
Economic conditions (GDP Growth)	-31.71		-1.48**
	(58.24)		(0.68)
Economic conditions (Bank Rate)	6.88		0.68
	(15.52)		(1.66)
Stressed Bank EBA * Post Stress Period EBA	-19.83	-19.83	-19.65
	(14.51)	(14.51)	(16.80)
Constant	236.27	169.04	162.91
	(211.59)	(117.26)	(111.44)
Observations	172	172	172
R-Squared	0.20	0.20	0.18
Number of Banks	18	18	18
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	-
Mean VIF	1.75	1.72	1.75
Sargen-Hansen Test (p-value)	31.989	12.677	31.989
	(0.0001)	(0.0485)	(0.0001)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.17: The Effects of The EBA's Stress Tests on Consumer Loans Lending

The table reports the effects of the EBA's stress tests on bank lending. The dependent variable is consumer loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Post Stress Period EBA is a time dummy variable designated as 1 for 2010-2018 and 0 for 2005-2009. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Consumer Loans Change %		
	(1)	(2)	(3)
Size	-7.75	-7.75	-1.40
	(10.19)	(10.19)	(14.69)
Profitability	-1.76	-1.76	-1.90
	(2.39)	(2.39)	(1.83)
Credit risk	-0.07	-0.07	0.38
	(0.98)	(0.98)	(0.78)
Efficiency	-4.88	-4.88	-6.07
	(7.24)	(7.24)	(5.63)
Capital	0.32	0.32	0.39
	(0.93)	(0.93)	(0.56)
Economic conditions (GDP Growth)	-114.74		-1.52
	(140.36)		(0.99)
Economic conditions (Bank Rate)	30.42		4.54
	(44.99)		(2.94)
Stressed Bank EBA * Post Stress Period EBA	1.31	1.31	2.43
	(9.72)	(9.72)	(9.69)
Constant	284.92	66.56	13.97
	(263.20)	(130.19)	(182.06)
Observations	145	145	145
R-Squared	0.14	0.14	0.05
Number of Banks	16	16	16
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	-
Mean VIF	1.75	1.70	1.75
Sargen-Hansen Test (p-value)	47.571	24.517	47.571
	(0.0000)	(0.0004)	(0.0000)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.18: The Effects of The EBA's Stress Tests on Corporate Loans Lending

The table reports the effects of the EBA's stress tests on bank lending. The dependent variable is corporate loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Post Stress Period EBA is a time dummy variable designated as 1 for 2010-2018 and 0 for 2005-2009. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Corporate Loans Change %		
	(1)	(2)	(3)
Size	-19.45	-19.45	-19.57
	(14.95)	(14.95)	(14.57)
Profitability	-15.84	-15.84	-15.84
	(13.35)	(13.35)	(13.81)
Credit risk	1.59	1.59	0.74
	(2.28)	(2.28)	(1.58)
Efficiency	8.29	8.29	13.90
	(16.44)	(16.44)	(17.01)
Capital	0.11	0.11	0.45
	(1.30)	(1.30)	(0.81)
Economic conditions (GDP Growth)	-134.69		-2.13
	(128.42)		(1.29)
Economic conditions (Bank Rate)	50.60		11.13*
	(37.16)		(6.25)
Stressed Bank EBA * Post Stress Period EBA	13.86	13.86	13.34
	(23.70)	(23.70)	(24.44)
Constant	424.40	235.09	191.46
	(295.23)	(174.95)	(178.23)
Observations	154	154	154
R-Squared	0.27	0.27	0.23
Number of Banks	16	16	16
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	-
Mean VIF	1.72	1.66	1.72
Sargen-Hansen Test (p-value)	10.126 (0.2563)	12.177 (0.0581)	10.126 (0.2563)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.19: The Effects of The EBA's Stress Tests on Total Loans, Net Loans to Customers, and Net Loans to Banks Lending – Dynamic Analysis

The table reports the effect of each stress testing exercise by the EBA for each year since 2010. The dependent variables are total loans growth, net loans to customers growth, net loans to banks growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Stress Period is a time dummy variable designated as 1 for each year and 0 otherwise. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. In addition, for brevity the explanatory variables are included but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Total Loans Growth %	**Net Loans to Customers Growth %**	**Net Loans to Banks Growth %**
Stressed Bank EBA * 2010 Stress Period	-5.38	-8.71	47.48**
	(12.98)	(14.49)	(17.29)
Stressed Bank EBA * 2011 Stress Period	-7.83	-2.40	-5.49
	(14.82)	(18.81)	(15.74)
Stressed Bank EBA * 2012 Stress Period	-5.55	-5.01	13.56
	(15.69)	(18.93)	(20.36)
Stressed Bank EBA * 2013 Stress Period	-2.22	-7.41	24.32
	(12.48)	(13.99)	(14.60)
Stressed Bank EBA * 2014 Stress Period	0.62	-5.08	37.67***
	(13.71)	(15.75)	(11.31)
Stressed Bank EBA * 2015 Stress Period	-5.53	-14.19	-3.70
	(9.55)	(8.52)	(18.61)
Stressed Bank EBA * 2016 Stress Period	-1.46	-4.93	17.08
	(10.84)	(11.24)	(17.81)
Stressed Bank EBA * 2017 Stress Period	-1.57	-6.22	23.36
	(10.68)	(9.86)	(20.75)
Stressed Bank EBA * 2018 Stress Period	-5.49	-11.75	43.97
	(11.45)	(11.42)	(42.92)
Constant	202.59	235.57	270.36
	(135.09)	(136.04)	(334.76)
Observations	184	184	173
R-Squared	0.30	0.29	0.30
Number of banks	19	19	18
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	YES
Bank Characteristics	YES	YES	YES
Macro Characteristics	YES	YES	YES
Mean VIF	1.50	1.49	1.47
Sargen-Hansen Test (p-value)	21.285	22.957	36.101
	(0.0064)	(0.0034)	(0.0000)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 3.20: The Effects of The EBA's Stress Tests on Mortgage Loans, Consumer Loans, and Corporate Loans Lending – Dynamic Analysis

The table reports the effect of each stress testing exercise by the EBA for each year since 2010. The dependent variables are mortgage loans growth, consumer loans growth, and corporate loans growth and all explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions (proxied by Real GDP growth and Bank Rate). The Stressed Bank EBA variable is a dummy variable designated as 1 for 4 banks and 0 for 15 banks. The Stress Period is a time dummy variable designated as 1 for each year and 0 otherwise. Model (1) includes all explanatory variables and the difference-in-difference interaction. The sample scope of the results is from 2005-2018. Bank fixed effects and time fixed effects are controlled for in all the models but are not reported. In addition, for brevity the explanatory variables are included but are not reported. All models include clustered standard errors, which are reported in the parentheses. Table 3.1 reports the description and summary statistics for all variables.

	Mortgage Loans Growth %	**Consumer Loans Growth %**	**Corporate Loans Growth %**
Stressed Bank EBA * 2010 Stress Period	-19.33	-7.01	11.55
	(18.67)	(13.32)	(20.01)
Stressed Bank EBA * 2011 Stress Period	-23.95	-6.27	18.32
	(21.56)	(15.02)	(22.72)
Stressed Bank EBA * 2012 Stress Period	-24.00	-5.72	19.83
	(21.69)	(24.19)	(28.85)
Stressed Bank EBA * 2013 Stress Period	-30.47	-16.13	22.69
	(20.14)	(18.75)	(29.01)
Stressed Bank EBA * 2014 Stress Period	-25.44	7.01	20.64
	(16.71)	(12.18)	(28.29)
Stressed Bank EBA * 2015 Stress Period	-17.92	6.73	9.47
	(12.09)	(10.04)	(23.38)
Stressed Bank EBA * 2016 Stress Period	-16.92	11.17	-2.98
	(13.85)	(13.93)	(37.22)
Stressed Bank EBA * 2017 Stress Period	-14.45	22.17	7.32
	(11.93)	(13.02)	(26.70)
Stressed Bank EBA * 2018 Stress Period	-10.02	-0.43	20.97
	(15.35)	(10.25)	(27.08)
Constant	167.74	404.54	334.03
	(194.50)	(333.72)	(318.91)
Observations	172	145	154
R-Squared	0.21	0.16	0.28
Number of banks	18	16	16
Bank fixed effects	YES	YES	YES
Time fixed effects	YES	YES	YES
Bank Characteristics	YES	YES	YES
Macro Characteristics	YES	YES	YES
Mean VIF	1.53	1.55	1.52
Sargen-Hansen Test (p-value)	39.342	53.193	10.829
	(0.0000)	(0.0000)	(0.2876)
Model Used	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

3.7 Policy Recommendations

The main objective of the supervisory stress testing exercises is to assess the resiliency of an individual bank or the banking system to an adverse shock. The exercise provides information to the supervisory authorities on the banks' capability to withstand the shock measured by the capital the bank holds post-stress test. It is assumed that banks that fail the stress test are reducing lending to mitigate credit risk and improve their capital ratios. The reduction in credit risk helps enhance the individual bank's financial stability, which can impede contagion within the banking system. A reduction in lending may lead to less investment made by firms, which causes a contraction in GDP growth. However, the stress testing exercises show that the banks' main aim is to reduce credit risk, which supports the purpose of the supervisory stress testing exercises.

The literature also states that the earlier stress tests were more effective in reducing bank lending, I, therefore, control for this and scrutinise each stress test exercise from the year of its inception. I see that there are no noticeable differences between the earlier stress tests and the latter stress tests. In other words, the effects of stress testing on bank lending are the same for the earliest stress testing exercises and the most recent stress testing exercise. The results contrast the findings of the U.S. banking system, where the stress testing exercises were most effective in reducing lending for the earliest stress tests. Therefore, the stress testing exercises for the UK banking system effectively reduce lending for banks that fail the stress test to reduce credit risk and improve their capital ratios. Possible policy implications should consider the effectiveness of the stress testing exercises as a tool that may affect bank lending in the future. The literature that studies the U.S. banking system finds that stress testing was more influential in the early stages of the exercise.

3.8 Conclusions

I observe that supervisory stress testing exercises since the GFC have led to a reduction in bank lending. A reduction in lending can reduce the credit available in the economy, reducing real GDP growth. Currently, there is limited research on the specific effects of stress testing on bank lending, and the extant research has only assessed the U.S. banking system. I contribute to the literature by examining the effects of stress testing on bank lending by analysing a new financial jurisdiction, namely, the UK banking system. The chapter diverges from the current literature by including the effects of two stress testing timelines. The chapter tests the effect of the BoE's stress testing exercises on UK bank lending as the main specification and the EBA's stress testing framework for robustness checks.

The chapter employs the difference-in-difference model to assess the impact of stress testing, which examines the lending behaviour of stress-tested banks compared to those that are not stress tested. First, I test for the effects of the stress testing exercise and find that the effects are statistically insignificant. I find statistically significant results when assessing the impact of banks failing the stress test. Banks that fail the stress test tend to reduce loans for most loan types relative to banks that pass the stress test. The empirical results support the limited literature that assesses the U.S banking system, and I find a similar theme, where banks that fail reduce lending.

The literature documents that the stress testing exercises for the U.S banking system are losing their efficiency concerning bank lending over time. I see no discernible difference with each stress testing exercise from the results. The earliest stress testing period and the most recent period show statistically significant results and show that banks who fail will reduce lending irrespective of the period. The finding diverges from the results seen for the U.S. banking system.

I attempt to fill the gap in the literature by focusing on the UK banking system and show that banks that fail will reduce lending, which may lead to a contraction in GDP growth as the supply of bank lending is constrained. However, the purpose of the supervisory stress testing exercises is to assess a banks' capital adequacy to an adverse shock and see if the bank remains above the regulatory capital threshold. It can be concluded that the supervisory stress testing is meeting its goal in enhancing financial stability, as the banks who fail will reduce lending to mitigate credit risk, which can cause harm to a bank and the banking system as a whole.

Chapter 4

The Effect of The EBA's Stress Testing Framework on Bank Lending and Credit Risk: An analysis of the EU Banking System

4.1 Introduction

For the second empirical chapter, I examine the effects of stress testing on bank lending for the EU banking system. A subsection of EU banks must undergo regulatory stress tests conducted by the EBA. The chapter aims to contribute to the existing discussion on the effects of supervisory stress testing on bank lending and identify whether similar patterns emerge across different financial jurisdictions. Studying EU banks is particularly important in this regard, given that the existing literature has not fully explored the European case.

The emerging yet limited literature finds that the stress testing programme has prompted a reduction in bank lending. Nonetheless, the rationale behind this finding is neither comprehensively explained nor elaborated. I draw on Acharya et al. (2018) and argue that the motivation behind the stress-tested banks' decision to reduce bank lending is to control potential credit-risk difficulties.

I support this argument in two steps. First, I examine if stress testing affects bank lending. Second, I proceed to estimate the influence that stress tests may have on banks' credit risk.

Methodologically, similar to chapter 3, I follow the difference-in-difference approach. However, to enhance the identification structure, I include also an alternative methodological approach that has been recently applied in the literature, which examines how exposed stress-tested banks are (Cortés et al., 2019). In sum, I study the effects of stress testing across two banking groups (difference-in-difference specification) and among stress-tested banks (stress test exposure).

An advantage of measuring the lending behaviour of EU banks to the supervisory stress tests is that I can capture the geographical heterogeneity among the stress-tested banks in our sample as I observe that the participating banks are located across 20 EU member states. For this reason, I am interested in understanding whether the effect of stress testing on EU banks' lending policy varies because of the bank's geographical location, which is a new contribution to the literature.

Certain EU regions may be riskier or financially unstable than their counterparts for sovereign risk reasons. I address this problem by partitioning our banks into GIIPS (Greece, Ireland, Italy, Portugal and Spain) and non-GIIPS countries and addressing possible differences. This novel contribution to the literature provides a new perspective on how stress-tested banks can be organised with respect to the methodological approach and incentivise regulators to monitor banks differently.

As discussed above, I make several improvements to distinguish the respective chapter from the previous empirical chapter. First, I analyse a new financial jurisdiction that has not been addressed to our knowledge. Second, I include two methodological approaches compared to the one adopted in the previous chapter. Third, I consider the effects of stress testing on credit risk, as the literature suggests that a reduction in bank lending controls credit risk issues. Finally, the chapter evaluates the effect of stress testing on a larger sample of banks spread across many countries situated across the EU. Comparing this to the previous chapter that considers a few banks for the UK, I have the advantage of further dissecting our sample and addressing differences (heterogeneity) among countries.

The results of the chapter report that stress-tested banks reduce lending for specific loan types compared to non-stress tested banks. For instance, the corporate loans by the stress-tested banks fall by 24 p.p. relative to non-stress tested banks. Remarkably, when I measure the dynamic effect of stress testing, I find statistically significant results across the whole period, which provides evidence that corroborates with the related literature.

Next, I proceed to measure the change in credit risk and find that contrary to the hypothesis by Acharya et al. (2018), stress-tested banks are facing greater credit risk problems, which confirm that credit risk increases by 2 p.p. relative to non-stress tested banks.

Unsurprisingly, when I dissect the empirical strategies to estimate the effects between GIIPS stress-tested banks and non-GIIPS stress-tested banks, I find that GIIPS banks lend less than their counterparts and experience a greater rise in credit risk.

The chapter is structured as follows, Section 4.2. outlines the research questions and objectives of the empirical chapter. Section 4.3. discusses the data that I employ and describes the steps I follow to define the sample of banks designated as stress-tested banks. Section 4.4. presents the methodology of the chapter, which outlines both methodological specifications that I address. Section 4.5. reports the paper's empirical results, divided into two parts: difference-in-difference specification and stress test exposure specification. Section 4.6. briefly overviews further robustness tests by analysing alternative credit risk proxies. Section 4.7. provides policy suggestions and the final section concludes the chapter.

4.2 Research Questions and Objectives

The research questions and objectives are as follows:

- Do supervisory stress tests affect bank lending and credit risk for banks participating in the EBA stress tests?
  - Formally, to test if there are visible differences, I examine two banking groups (stress-tested and non-stress tested banks) in two different periods (pre-stress test and post-stress test) using the difference-in-difference approach.
  - I hypothesise that stress-tested banks will reduce bank lending relative to non-stress-tested banks, as evidenced by the relevant literature and the results of the first empirical chapter.

- Does failing the stress test (or being undercapitalised) affect bank lending behaviour or increase credit risk?
  - I hypothesise that banks that fail the stress test will reduce lending because their weaker capital positions place the banks in a fragile position and ultimately forces banks to concentrate on building capital. A shift in attention to building bank capital affects the banks' lending practices.
  - For the UK stress testing regime—which the BoE manages—the central bank imposes an explicit capital threshold that banks must meet to pass the stress test. If the post-stress capital ratio of

the participating banks falls below the threshold for several reasons, the banks are viewed to have failed the stress test. However, in the case of EU stress tests, the EBA only imposed explicit thresholds for the earliest stress tests and did not continue this practice of imposing explicit thresholds in the latest stress testing frameworks. To overcome the issue, I develop an alternative variable that categorises banks that would have failed if the practice of imposing capital thresholds continued to exist. Banks that fall below the 5.5% CET1 ratio are designated as banks that fail, which can otherwise be viewed as undercapitalised.

- Is there observed heterogeneity among stress-tested banks?
  - By using the stress-test exposure variable (second methodological approach), I further disaggregate the variable and classify banks into high-stress test exposure banks (that experience a large reduction in the capital ratio) and low-stress test exposure banks (that experience a smaller change in the capital ratio as a consequence of the stress test). In this regard, I isolate only the stress-tested banks and then attempt to identify differences among stress-tested banks.

- Is there observed heterogeneity with stress-tested banks across different EU countries?
  - Several EU countries participate in the EU supervisory stress testing exercises. I differentiate among EU countries and assess if the exercises conducted on the stress-tested banks vary depending on the EU country that the bank is located. I assess if peripheral countries in the EU—namely being among the GIIPS countries—affect bank lending and credit risk changes relative to their counterparts.

4.3 Data

In relation to the data employed to address the effect of stress testing on bank lending and credit in this respective chapter, I access data from the Orbis Bank Focus database (formerly known as BankScope), similar to the previous chapter, which provides statistics on bank-level characteristics. In regards to the type of banks that I select for the final sample, I follow several criteria that follow the EBA's selection criteria for the banks that participate in their stress testing programme. Importantly, I ensure that the sample of selected banks is similar to the first empirical chapter and the related literature.

First, given data availability, I employ data from the 2006-2018 period for the bank characteristics, which are recorded annually. Furthermore, I used World Bank data on macroeconomic variables such as unemployment levels or GDP growth. For all banks in the sample, the main objective is to ensure that the whole sample is as homogenous as possible and includes the largest banks in the EU system that are simultaneously involved in the EBA stress testing exercise[12]. Therefore, in line with the previous chapter and literature, I include banks above the 10 BN EUR threshold, which enables the empirical chapter to analyse the largest banks that may be subject to similar regulations. Importantly, the threshold is identical to the threshold used in the emerging stress-testing literature that attempts to understand relations between stress-tested and non-stress tested banks (Cornett et al., 2018)[13].

In the second step, to ensure that I follow the same selection criteria used by the regulators and the previous chapter, all banks included in the sample must be represented by their consolidated balance sheets for each financial institution in the sample. This practice follows the methodology of EU stress, whereby all participating banks must report their banking activities on the highest consolidation basis, including data of their respective subsidiaries (Committee of European Banking Supervisors, 2010)[14]. Accordingly, I deleted any subsidiary of a bank when its parent company is included in the sample, thus ensuring that the bank is not susceptible to being ‘double-counted’. The third step is to ensure that all banks in the sample are of the same type or specialisation as defined by the Orbis Bank Focus, thus ensuring that the banks are as homogenous as possible. The stress-tested banks that participate in the EBA exercises are comprised of several specialisations of banks, as recorded by Orbis Bank Focus. The specialisations or types of banks include: Bank holding companies, commercial banks, cooperative banks, savings banks, and specialised governmental credit institutions. As the stress-tested banks are part of the five specialisations listed above, I ensure that the final sample of banks must fall under these categories to ensure that the sample is as similar as possible. Finally, after cleaning the data and removing banks with insufficient data, I obtained a final

12 Intuitively, the largest banks would also be a part of the Single Supervisory Mechanism, given their systemic importance.

13 Cornett et al. (2018) also employ larger thresholds relative to the 10 EUR Billion threshold that I employ.

14 See Cerutti and Schmieder (2014) who suggest that bank stress testing should account for unconsolidated data, thus stressing the subsidiary of banks in isolation.

sample of 282 banks selected via the above criteria. The final sample of banks will be divided into two groups for the empirical analysis. The first group, the treatment group, will include the set of stress-tested banks that the EBA examines. The second group, otherwise defined as the control banks, will consist of the remaining banks structurally similar to the stress-tested banks but not examined by the EBA.

One challenge of the empirical chapter entailed overcoming the issue of segregating the sample of banks into one of the two groups in cases where stress-tested banks might have participated in the EBA stress tests at least once during 2010-2018[15]. In the following subsection, I elaborate on how I identified the class of banks deemed to fall under the stress-tested bank category (treatment group) and those included in the non-stress tested category (control group).

4.3.1 Selection of Stress-Tested Banks

The supervisory stress tests by the EBA were first introduced in 2009, but no detailed information on specific banks was released. From 2010, detailed and disaggregated data on the selection of EU banks and the subsequent outcome of the exercise was disclosed publicly by the EBA. The advantage of releasing disaggregated information by the EBA is that the names of the participating banks, the initial capital ratio of banks and the post-capital ratio of banks against the stress are publicly released. Such detailed information is beneficial to capturing the effect of the stress on a banks' capability to withstand a shock. Naturally, the data can be exploited to ascertain the effect of stress testing, as I demonstrate in the second stage of the empirical chapter.

Since the 2010 stress tests, I observe that there have been changes in the number of banks that participate across each stress test. Table 4.1 summarises the year a stress test occurred, the number of banks included in the stress test, and the origin of the countries where the participating banks are headquartered.

From the table, I see that there are changes between the number of banks included in each stress test, where the largest number of banks (123 banks) are tested in the 2014 stress test, and the smallest number of banks (48 banks) in 2018. Certain banks may have been stressed at least once and then removed from the tests for

[15] The first EU stress test was introduced in 2009 and developed by the Committee of European Banking Supervisors (CEBS), although the stress test was limited in nature, and does not include details of the names of the banks that participated in the test. Therefore, no information on capital ratios is available for the banks.

many different reasons, such as inactivity or mergers and acquisitions.

Table 4.1: Summary of the EU Stress Testing Timeline

Year	Number of Banks	Country Origin of the Bank
2010	91	Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom
2011	90	Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom
2014	123	Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom
2016	51	Austria, Belgium, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Spain, Sweden, United Kingdom
2018	48	Austria, Belgium, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Spain, Sweden, United Kingdom

Selecting the criteria for banks included in the group of stress-tested banks is somewhat challenging. To alleviate this problem, I follow the selection criteria adopted by Borges et al. (2019), who study how the EU stress testing exercises affect market reactions. The authors implement an event study methodology for three stress testing frameworks (2010, 2011, and 2014). Subsequently, the authors explain that the sample of the banks that they consider must participate in all three stress tests. Said differently, the participating banks in their sample have been stressed every year since the start of the EU stress testing framework, where data is publicly disclosed.

In turn, I adopt this approach but slightly divert from Borges et al. (2019). First, I included banks that have been stressed in all five stress testing frameworks addressed in table 4.1. Although for the latter stress tests, Greek and Portuguese banks are not included in the 2016 stress test. In addition, Portuguese banks are not included in the 2018 stress test, but the Greek banks re-enter the stress test and are stressed separately from the main cluster of banks due to regulatory purposes[16]. However, I included these banks from these countries in our sample to help complete our identification strategy that analyses GIIPS (Greece, Ireland, Italy, Portugal and Spain) banks that are particularly vital in understanding possible differences

[16] The results of the Greek banks that are stressed in 2018 are publicly released by the ECB, and the information presented concerns 4 Greek banks that were have been included since the inception of the EU stress tests. Furthermore, the same format concerning the release of the stress test results is presented in excel files: https://www.bankingsupervision.europa.eu/press/pr/date/2018/html/ssm.pr180505.en.html

when considering the EU banks.

Finally, the number of stress-tested banks that I examined include 39 banks from 16 countries which are reported in table 4.2. The inclusion of these banks is first achievable because I included banks that participate in every stress test (including the Greek and Portuguese banks), and their allocation in the group is conditional on bank data being available from Orbis Bank Focus. All remaining banks in the sample are allocated to the non-stress tested banks group, which will be used as our control group for the difference-in-difference identification strategy.

Table 4.2: Stress-tested Banks

	Bank	**Country**
1	Erste Group Bank Ag	Austria
2	KBB Groep Nv/ KBC Groupe Sa	Belgium
3	Danske Bank A/S	Denmark
4	Jyske Bank A/S (Group)	Denmark
5	Op Financial Group	Finland
6	BNP Paribas Sa	France
7	Credit Agricole	France
8	Societe Generale	France
9	BPCE Group	France
10	Deutsche Bank Ag	Germany
11	Commerzbank Ag	Germany
12	Landesbank Baden-Wuerttemberg	Germany
13	Bayerische Landesbank	Germany
14	Norddeutsche Landesbank Girozentrale Nord/Lb	Germany
15	Eurobank Ergasias Sa	Greece
16	National Bank of Greece Sa	Greece
17	Piraeus Bank Sa	Greece
18	Alpha Bank Ae	Greece
19	OTP Bank Plc	Hungary
20	Bank of Ireland	Ireland
21	Allied Irish Banks Plc	Ireland
22	Unicredit Spa	Italy
23	Intesa Sanpaolo	Italy
24	Unione Di Banche Italiane Spa	Italy
25	ING Groep Nv	Netherlands
26	ABN Amro Bank Nv	Netherlands
27	Powszechna Kasa Oszczednosci Bank Polski Sa - Pko Bp Sa	Poland
28	Caixa Geral De Depositos	Portugal
29	Banco Comercial Portugues, Sa	Portugal
30	Banco Bpi Sa	Portugal
31	Banco Santander Sa	Spain
32	Banco De Sabadell Sa	Spain
33	Svenska Handelsbanken Ab	Sweden
34	Skandinaviska Enskilda Banken Ab	Sweden
35	Swedbank Ab	Sweden
36	HSBC Holdings Plc	United Kingdom
37	Barclays Plc	United Kingdom
38	Lloyds Banking Group Plc	United Kingdom
39	Royal Bank of Scotland Group Plc (The)	United Kingdom

The principal data concerning the performance against the stress test are detailed by the EBA, who publish documents such as methodologies, frequent questions and answers, and results of the stress test via excel files. The information recorded on the excel files is utilised for the second stage of the methodological approach, which helps construct the stress test exposure variable. All related documents are made available on the ECB webpage[17].

4.3.2 Banking and Macro-Economic Variables

In relation to the variables that I employ, I use the same set of variables recently used in the bank lending, stress testing literature, and first empirical chapter. Furthermore, I include alternative control variables similarly addressed. The construction of the stress testing variables is discussed in further detail in the methodology section. Table 4.3 provides a summary of the data used in this chapter.

4.3.2.1 Dependent Variables

In the first step, I analyse the effect of stress testing on bank lending. In order to complete this, I examine the impact of the exercise on total loans, mortgage loans, corporate loans, consumer loans, and bank loans.

In the second step, I contribute to the literature by examining the effect of the exercises on credit risk. In a recent paper, Acharya et al. (2018) find that stress-tested banks reduce lending to the economy and explain that the rationale behind a banks' decision to reduce lending is to mitigate credit risk.

Though, Acharya et al. (2018) have not used econometric methods to test this hypothesis. To test this hypothesis, I examine the changes in credit risk due to stress testing and assess if there are potentially statistically significant results. I complete this objective by examining credit risk changes proxied by variables such as the non-performing loans ratio. With this in mind, I use the non-performing loan ratio as a proxy for credit risk and assess if banks that participate in the EU stress tests posit significant differences concerning credit risk. The robustness results section also examines additional credit risk proxies.

[17] For the results of the EU stress test from 2009-2018, see https://eba.europa.eu/risk-analysis-and-data/eu-wide-stress-testing

4.3.2.2 Independent Variables

The first control variable that I use is the size of the bank, which is calculated as the natural log of a bank's total assets. The size of a bank may be a crucial element that shapes banks' lending policy. In fact, larger banks may reduce lending as they diversify into different banking activities to support their risk management practices. Larger banks may also engage in other activities that increase profit relative to traditional lending. On the other hand, an increase in size may lead to a rise in bank lending, as Brei et al. (2013) have studied. In this regard, implicit government guarantees for 'too big to fail' banks may persuade larger banks to engage in riskier bank lending. The first empirical chapter shows an increase in a bank's size leads to a reduction in bank lending, which is statistically significant.

Next, I use a bank's profit as a control variable, which is calculated using the return on assets (profit divided by total assets). Profitable banks may have more retained capital because of increased profit margins. In turn, this aspect enables banks to lend more loans to customers (Kim and Sohn, 2017). The results presented in the first empirical chapter find that profitability is positively correlated with bank lending. Hence, results should yield a positive relationship between profitability and bank lending in the EU case.

Bank credit risk is also a general control variable used within the literature. I use the non-performing loan ratio as a proxy for the bank's credit risk profile for the econometric model. In the UK case, I document that the effect of credit risk on bank lending is mixed, dependent on the group (treatment or control) of the banks I assessed. Although, I should expect to see that an increase in credit risk will cause a decrease in bank lending, as explained by the bank lending literature (Roulet, 2018).

As a proxy for the efficiency of the banks, I developed a variable used in the literature (Acharya et al., 2018), which is total costs divided by total assets. I hypothesise that as banks become less cost-efficient, this will inhibit banks from reducing lending.

I calculated total equity over total assets to represent bank capital as an explanatory variable. The composition of the capital variable is unlike the one constructed in the first empirical chapter, where I applied the CET1 ratio. In this chapter, I use total equity over total assets for the EU sample of banks because of issues concerning data availability.

In contrast to the first chapter, I introduce the liquidity ratio, which is defined as liquid assets over total assets for each bank. In a recent paper, Nguyen et al. (2020) have studied the change in liquidity positions for US banks that are part of the US Federal Reserve's stress test programme. The authors find that the stress-tested banks adopt strategies that increase their liquidity reserves for the liability side of the balance sheet to create a more stable funding base. Hence, it is important to capture and control the liquidity variable and the bank lending behaviour. On the other hand, Puri et al. (2017) have examined a cluster of German saving banks and found that smaller and less liquid banks often reduce bank lending during the US subprime mortgage crisis.

The final bank-specific control variable is the funding variable proxied by deposits over total assets. This variable contributes to our econometric model and improves from the first empirical chapter. The funding variable is essential to consider as banks with a more stable funding source are more likely to increase bank lending.

As explored in the literature and first empirical chapter, I include macro-economic control variables that act as exogenous shocks to the bank. There are several variables that I can include to serve as robust controls. In the methodology, I employ the unemployment rate of the EU jurisdiction and the Euro base rate.

Table 4.3: Summary Statistics

Variable	Description	Observations	Mean	Std. Deviation	Min	Max
Panel A: All 282 banks for the complete sample (2006-2018)						
Dependent Variables						
Total loans change	Percentage change between the current and previous year.	2,440	2.02	15.85	-40.47	87.66
Mortgage loans change	Percentage change between the current and previous year.	960	6.28	31.98	-42.94	233.98
Consumer loans change	Percentage change between the current and previous year.	1,348	5.11	40.78	-66.24	283.25
Corporate loans change	Percentage change between the current and previous year.	1,236	6.52	45.24	-76.84	325.96
Bank loans change	Percentage change between the current and previous year.	2,409	3.87	49.79	-79.83	251.63
Credit Risk (NPL Ratio)	Impaired loans over gross loans.	2,517	4.97	7.09	0.00	45.02
Credit Risk (Loan Loss Provisions Ratio)	Loan loss provisions over total loans.	2,399	0.67	1.03	0.00	6.41
Credit Risk (Loan Loss Reserves Ratio)	Loan loss reserves over gross loans.	2,637	2.68	3.09	0.01	18.07
Independent Variables						
Size	Natural log of the banks' total assets.	2,778	10.70	1.52	8.12	14.39
Profitability	Profit over total assets. Similarly known as return on assets (ROA).	2,740	0.42	0.75	-2.82	2.62
Credit risk (NPL Ratio)	Impaired loans over gross loans.	2,517	4.97	7.09	0.00	45.02
Efficiency	Operating expenses over total assets.	2,739	1.63	1.07	0.08	6.53
Capital	Equity over total assets.	2,740	7.72	4.27	1.08	26.28
Liquidity	Liquid assets over total assets.	2,741	31.38	15.67	6.70	83.95
Funding	Customer deposits over total assets.	2,710	46.56	21.96	0.43	89.78
Economic conditions (Unemployment)	The unemployment rate for the EU jurisdiction.	3,666	9.20	1.34	7.20	11.32
Economic conditions (Bank Rate)	Euro interest rate set by the ECB.	3,666	1.08	1.33	0.00	4.00
Stress Testing Terms						
Stressed Bank	Dummy variable designated as 1 for the 39 EU stress-tested banks (treatment group) and 0 for the remaining banks (control group).	3,666	0.14	0.35	0.00	1.00
Post Stress Period	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2006-2009 (pre-stress test).	3,666	0.69	0.46	0.00	1.00
GIIPS	Dummy for the banks from Greece, Ireland, Italy, Portugal and Spain.	3,666	0.22	0.41	0.00	1.00
Inadequate Ratio (Failed)	Designated as 1 for banks that fall below 5.5% ratio.	3,666	0.00	0.04	0.00	1.00
Stress test exposure CET1 - Median	Designated as 1 for above-median of the Stress test CET1 exposure, and 0 otherwise	146	0.50	0.50	0.00	1.00
Stress test exposure Tier 1 - Median	Designated as 1 for above-median of the Stress test Tier 1 exposure, and 0 otherwise	185	0.50	0.50	0.00	1.00

Stress test exposure Total Capital - Median	Designated as 1 for above-median of the Stress test Total Capital exposure, and 0 otherwise	185	0.50	0.50	0.00	1.00
Panel B: Stress-tested banks (treatment banks) before the treatment period (2006-2009)						
Dependent Variables						
Total loans change	Percentage change between the current and previous year.	111	7.26	17.92	-27.69	87.66
Mortgage loans change	Percentage change between the current and previous year.	20	13.22	53.11	-18.05	233.98
Consumer loans change	Percentage change between the current and previous year.	18	-6.37	28.11	-66.24	79.13
Corporate loans change	Percentage change between the current and previous year.	17	7.07	38.74	-32.09	144.99
Bank loans change	Percentage change between the current and previous year.	107	-0.85	43.36	-63.29	251.63
Credit Risk (NPL Ratio)	Impaired loans over gross loans.	148	2.70	1.92	0.14	9.22
Credit Risk (Loan Loss Provisions Ratio)	Loan loss provisions over total loans.	145	0.67	0.70	0.00	4.90
Credit Risk (Loan Loss Reserves Ratio)	Loan loss reserves over gross loans.	150	1.70	1.05	0.13	6.79
Independent Variables						
Size	Natural log of the banks' total assets.	150	12.42	1.33	8.72	14.39
Profitability	Profit over total assets. Similarly known as return on assets (ROA).	150	0.56	0.68	-1.44	2.62
Credit risk (NPL Ratio)	Impaired loans over gross loans.	148	2.70	1.92	0.14	9.22
Efficiency	Operating expenses over total assets.	149	1.85	1.35	0.08	6.53
Capital	Equity over total assets.	149	5.23	2.49	1.11	13.06
Liquidity	Liquid assets over total assets.	150	31.19	12.83	9.30	82.63
Funding	Customer deposits over total assets.	149	39.95	13.85	16.34	81.85
Economic conditions (Unemployment)	The unemployment rate for the EU jurisdiction.	156	8.10	0.80	7.20	9.12
Economic conditions (Bank Rate)	Euro interest rate set by the ECB.	156	2.75	1.15	1.00	4.00
Stress Testing Terms						
Stressed Bank	Dummy variable designated as 1 for the 39 EU stress-tested banks (treatment group) and 0 for the remaining banks (control group).	156	1.00	0.00	1.00	1.00
Post Stress Period	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2006-2009 (pre-stress test).	156	0.00	0.00	0.00	0.00
GIIPS	Dummy for the banks from Greece, Ireland, Italy, Portugal and Spain.	156	0.36	0.48	0.00	1.00
Inadequate Ratio (Failed)	Designated as 1 for banks that fall below 5.5% ratio.	156	0.00	0.00	0.00	0.00
Stress test exposure CET1 - Median	Designated as 1 for above-median of the Stress test CET1 exposure, and 0 otherwise	0	-	-	-	-
Stress test exposure Tier 1 - Median	Designated as 1 for above-median of the Stress test Tier 1 exposure, and 0 otherwise	0	-	-	-	-

Stress test exposure Total Capital - Median	Designated as 1 for above-median of the Stress test Total Capital exposure, and 0 otherwise	0	-	-	-	-
Panel C: Stress-tested banks (treatment banks) after the treatment period (2010-2018)						
Dependent Variables						
Total loans change	Percentage change between the current and previous year.	350	-1.35	10.10	-32.33	87.66
Mortgage loans change	Percentage change between the current and previous year.	197	0.75	10.87	-22.03	87.42
Consumer loans change	Percentage change between the current and previous year.	224	-0.12	26.44	-66.24	283.25
Corporate loans change	Percentage change between the current and previous year.	210	2.71	39.32	-76.84	325.96
Bank loans change	Percentage change between the current and previous year.	342	-3.01	30.72	-65.64	135.80
		351	8.25	10.21	0.33	45.02
Credit Risk (NPL Ratio)	Impaired loans over gross loans.	328	1.05	1.35	0.00	6.41
Credit Risk (Loan Loss Provisions Ratio)	Loan loss provisions over total loans.	351	4.14	4.50	0.01	18.07
Credit Risk (Loan Loss Reserves Ratio)	Loan loss reserves over gross loans.	350	-1.35	10.10	-32.33	87.66
Independent Variables						
Size	Natural log of the banks' total assets.	351	12.47	1.24	10.14	14.39
Profitability	Profit over total assets. Similarly known as return on assets (ROA).	351	0.17	0.81	-2.82	2.62
Credit risk (NPL Ratio)	Impaired loans over gross loans.	351	8.25	10.21	0.33	45.02
Efficiency	Operating expenses over total assets.	351	1.61	0.93	0.47	6.53
Capital	Equity over total assets.	351	6.30	2.73	1.08	15.81
Liquidity	Liquid assets over total assets.	351	29.60	8.77	11.00	51.14
Funding	Customer deposits over total assets.	351	46.56	14.00	17.95	78.38
Economic conditions (Unemployment)	The unemployment rate for the EU jurisdiction.	351	9.68	1.25	7.27	11.32
Economic conditions (Bank Rate)	Euro interest rate set by the ECB.	351	0.34	0.42	0.00	1.00
Stress Testing Terms						
Stressed Bank	Dummy variable designated as 1 for the 39 EU stress-tested banks (treatment group) and 0 for the remaining banks (control group).	351	1.00	0.00	1.00	1.00
Post Stress Period	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2006-2009 (pre-stress test).	351	1.00	0.00	1.00	1.00
GIIPS	Dummy for the banks from Greece, Ireland, Italy, Portugal and Spain.	351	0.36	0.48	0.00	1.00
Inadequate Ratio (Failed)	Designated as 1 for banks that fall below 5.5% ratio.	351	0.02	0.14	0.00	1.00
Stress test exposure CET1 - Median	Designated as 1 for above-median of the Stress test CET1 exposure, and 0 otherwise	146	0.50	0.50	0.00	1.00
Stress test exposure Tier 1 - Median	Designated as 1 for above-median of the Stress test Tier 1 exposure, and 0 otherwise	185	0.50	0.50	0.00	1.00

Stress test exposure Total Capital - Median	Designated as 1 for above-median of the Stress test Total Capital exposure, and 0 otherwise	185	0.50	0.50	0.00	1.00
Panel D: Non-stress tested banks (control banks) before the treatment period (2006-2009)						
Dependent Variables						
Total loans change	Percentage change between the current and previous year.	287	5.81	18.91	-40.47	87.66
Mortgage loans change	Percentage change between the current and previous year.	41	12.69	43.10	-22.70	233.98
Consumer loans change	Percentage change between the current and previous year.	54	13.35	60.12	-66.24	283.25
Corporate loans change	Percentage change between the current and previous year.	36	8.43	37.17	-76.84	122.09
Bank loans change	Percentage change between the current and previous year.	286	5.73	55.06	-79.83	251.63
Credit Risk (NPL Ratio)	Impaired loans over gross loans.	343	3.62	5.74	0.00	45.02
Credit Risk (Loan Loss Provisions Ratio)	Loan loss provisions over total loans.	349	0.68	1.02	0.00	6.41
Credit Risk (Loan Loss Reserves Ratio)	Loan loss reserves over gross loans.	386	1.84	1.62	0.01	9.57
Independent Variables						
Size	Natural log of the banks' total assets.	410	10.57	1.47	8.12	13.59
Profitability	Profit over total assets. Similarly known as return on assets (ROA).	401	0.58	0.70	-1.93	2.62
Credit risk (NPL Ratio)	Impaired loans over gross loans.	343	3.62	5.74	0.00	45.02
Efficiency	Operating expenses over total assets.	401	1.56	1.17	0.08	6.53
Capital	Equity over total assets.	402	6.24	4.05	1.08	26.28
Liquidity	Liquid assets over total assets.	402	35.33	18.14	6.70	83.95
Funding	Customer deposits over total assets.	399	40.73	21.78	0.43	89.78
Economic conditions (Unemployment)	The unemployment rate for the EU jurisdiction.	972	8.10	0.80	7.20	9.12
Economic conditions (Bank Rate)	Euro interest rate set by the ECB.	972	2.75	1.15	1.00	4.00
Stress Testing Terms						
Stressed Bank	Dummy variable designated as 1 for the 39 EU stress-tested banks (treatment group) and 0 for the remaining banks (control group).	972	0.00	0.00	0.00	0.00
Post Stress Period	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2006-2009 (pre-stress test).	972	0.00	0.00	0.00	0.00
GIIPS	Dummy for the banks from Greece, Ireland, Italy, Portugal and Spain.	972	0.20	0.40	0.00	1.00
Inadequate Ratio (Failed)	Designated as 1 for banks that fall below 5.5% ratio.	972	0.00	0.00	0.00	0.00
Stress test exposure CET1 - Median	Designated as 1 for above-median of the Stress test CET1 exposure, and 0 otherwise	0	-	-	-	-
Stress test exposure Tier 1 - Median	Designated as 1 for above-median of the Stress test Tier 1 exposure, and 0 otherwise	0	-	-	-	-

Stress test exposure Total Capital - Median	Designated as 1 for above-median of the Stress test Total Capital exposure, and 0 otherwise	0	-	-	-	-
Panel E: Non-stress tested banks (control banks) after the treatment period (2010-2018)						
Dependent Variables						
Total loans change	Percentage change between the current and previous year.	1,692	1.72	15.92	-40.47	87.66
Mortgage loans change	Percentage change between the current and previous year.	702	7.26	34.21	-42.94	233.98
Consumer loans change	Percentage change between the current and previous year.	1,052	6.00	42.14	-66.24	283.25
Corporate loans change	Percentage change between the current and previous year.	973	7.27	46.80	-76.84	325.96
Bank loans change	Percentage change between the current and previous year.	1,674	5.26	52.22	-79.83	251.63
Credit Risk (NPL Ratio)	Impaired loans over gross loans.	1,675	4.76	6.60	0.00	45.02
Credit Risk (Loan Loss Provisions Ratio)	Loan loss provisions over total loans.	1,577	0.58	0.96	0.00	6.41
Credit Risk (Loan Loss Reserves Ratio)	Loan loss reserves over gross loans.	1,750	2.66	3.01	0.01	18.07
Independent Variables						
Size	Natural log of the banks' total assets.	1,867	10.26	1.23	8.12	14.39
Profitability	Profit over total assets. Similarly known as return on assets (ROA).	1,838	0.42	0.74	-2.82	2.62
Credit risk (NPL Ratio)	Impaired loans over gross loans.	1,675	4.76	6.60	0.00	45.02
Efficiency	Operating expenses over total assets.	1,838	1.62	1.04	0.08	6.53
Capital	Equity over total assets.	1,838	8.52	4.43	1.08	26.28
Liquidity	Liquid assets over total assets.	1,838	30.87	16.19	6.70	83.95
Funding	Customer deposits over total assets.	1,811	48.39	23.44	0.43	89.78
Economic conditions (Unemployment)	The unemployment rate for the EU jurisdiction.	2,187	9.68	1.25	7.27	11.32
Economic conditions (Bank Rate)	Euro interest rate set by the ECB.	2,187	0.34	0.42	0.00	1.00
Stress Testing Terms						
Stressed Bank	Dummy variable designated as 1 for the 39 EU stress-tested banks (treatment group) and 0 for the remaining banks (control group).	2,187	0.00	0.00	0.00	0.00
Post Stress Period	Time dummy variable designated as 1 for 2010-2018 (post-stress test) and 0 for 2006-2009 (pre-stress test).	2,187	1.00	0.00	1.00	1.00
GIIPS	Dummy for the banks from Greece, Ireland, Italy, Portugal and Spain.	2,187	0.20	0.40	0.00	1.00
Inadequate Ratio (Failed)	Designated as 1 for banks that fall below 5.5% ratio.	2,187	0.00	0.00	0.00	0.00
Stress test exposure CET1 - Median	Designated as 1 for above-median of the Stress test CET1 exposure, and 0 otherwise	0	-	-	-	-
Stress test exposure Tier 1 - Median	Designated as 1 for above-median of the Stress test Tier 1 exposure, and 0 otherwise	0	-	-	-	-

Stress test exposure Total Capital - Median	Designated as 1 for above-median of the Stress test Total Capital exposure, and 0 otherwise	0	-	-	-	-

4.4 Methodology

This chapter explores the effect of stress testing on bank lending between two groups of banks (stress-tested and non-stress tested banks) and within stress-tested banks.

First, I analyse the effect of stress testing on bank lending using a difference-in-difference approach, similar to the first empirical chapter. The approach examines the lending behaviour between stress-tested and non-stress tested banks across two different periods, pre-treatment and post-treatment.

As a second methodological approach, I develop a stress test exposure variable, which Cortés et al. (2019) employ to study the impact of stress testing on small business lending. The stress test exposure variable calculates the difference between the capital ratio of participating bank at the beginning of the stress test (before entering the stress test) and the post-capital ratio (the capital ratio after the outcome of simulated stress). As a result, I observe only the stress-tested banks to investigate heterogeneity among such financial organizations.

The two subsections below provide further clarity regarding the two methodological approaches I use in this chapter.

4.4.1 Difference-in-Difference

To construct the difference-in-difference model, I first create two banks groups: the stress-tested and the non-stress tested. For the treatment group of banks, I designated the 39 stress-tested banks that are selected following the criteria outlined in the data section of the chapter. Another component of the difference-in-difference specification that must be identified is the treatment period concerning the period the EBA stress testing began. For the treatment period, I designated a dummy variable as 1 for the years 2010-2018, which can alternatively be viewed as the post-stress period. The pre-treatment period is, therefore, the remaining years 2006-2009[18].

[18] The EU stress tests first occurred in 2009 and were administered by the Committee of European Banking Supervisors. However, the stress test was small in scope and did not explicitly release the names of the banks that were included in the stress test, which means that no detailed results cannot be used for empirical analysis. Therefore, I highlight 2010 as our first year of the stress test in which detailed statistics of participating banks were made available to the public.

Equation (4.1) outlines the econometric model of the chapter, where i, j, and t are defined as the bank, country, and period, respectively. The coefficient β_3 outlines the difference-in-difference interaction of interest. Besides the primary model, I slightly modify the equation to capture the effect of a bank resulting with inadequate capital (a proxy for failing the stress test) and the effect of being a member of the GIIPS countries that are stress-tested to assess if there are discernible results. The β_4 coefficient showed in equations (4.2) and (4.3) outline the triple difference-in-difference interaction for the banks with inadequate capital and a stress-tested bank that is based within the GIIPS countries, respectively.

In the stress testing exercises, national regulators often use a quantitative or qualitative metric to either pass or fail a stress-tested bank. In the exercises, the regulator sets a hurdle rate, where a bank must ensure that its capital levels (most often the CET1 ratio) meet a set threshold. If banks fail to meet the threshold by falling under the rate, the banks are determined to have failed the stress test, leading to negative ramifications. As discussed in the literature review section, bank failure can influence market reaction and affect bank performance. In the earliest EBA exercises, the regulator set a capital threshold that banks must meet to 'pass' the exercises. However, the EBA has decided to remove this threshold for the latest stress tests. Therefore, in one way, the banks that participate in the stress test cannot explicitly pass or fail, as there is no threshold.

To capture the effect of failing the stress test if the EBA continued its practice of setting hurdle rates, I developed the 'inadequate capital' variable, which serves as a dummy variable for banks that hold less than 5.5% CET1 capital post-stress. The inadequate capital variable also considers the post-stress test capital for the latest exercises, where the EBA removes the hurdle rate.

Said differently, banks that fall into this category would be a proxy for banks that have failed the stress test if the EBA continued its practice of implementing a threshold. More specifically, I choose the 5.5% threshold, as the last EBA exercise in 2014 employed the 5.5% CET1 ratio as its hurdle rate.

$$
\begin{aligned}
Loan\ Type\ Growth_{i,j,t} = {} & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\
& + \beta_3 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t \\
& + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\
& + \alpha_3 Country\ Fixed\ Effects_j \\
& + \varepsilon_{i,j,t}
\end{aligned} \tag{4.1}
$$

$$
\begin{aligned}
Loan\ Type\ Growth_{i,j,t} = {} & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\
& + \beta_3 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t \\
& + \beta_4 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t * Inadequate\ Capital_i \\
& + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\
& + \alpha_3 Country\ Fixed\ Effects_j \\
& + \varepsilon_{i,j,t}
\end{aligned} \tag{4.2}
$$

$$
\begin{aligned}
Loan\ Type\ Growth_{i,j,t} = {} & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\
& + \beta_3 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t \\
& + \beta_4 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t * GIIPS_j \\
& + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\
& + \alpha_3 Country\ Fixed\ Effects_j \\
& + \varepsilon_{i,j,t}
\end{aligned} \tag{4.3}
$$

This section of the thesis explores the effect of stress testing on bank lending. Acharya et al. (2018) is the first paper to postulate that stress-tested banks' reduction in bank lending mitigates credit risk problems. However, they do not produce statistical results to support their hypothesis.

I test for the hypothesis and investigate the effects of stress testing on credit risk following the same approach for the lending models. The empirical models are shown below with equations (4.4), (4.5), and (4.6).

$$
\begin{aligned}
Credit\ Risk_{i,j,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\
& + \beta_3 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t \\
& + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\
& + \alpha_3 Country\ Fixed\ Effects_j \\
& + \varepsilon_{i,j,t}
\end{aligned} \tag{4.4}
$$

$$
\begin{aligned}
Credit\ Risk_{i,j,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\
& + \beta_3 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t \\
& + \beta_4 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t * Inadequate\ Capital_i \\
& + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\
& + \alpha_3 Country\ Fixed\ Effects_j \\
& + \varepsilon_{i,j,t}
\end{aligned} \tag{4.5}
$$

$$
\begin{aligned}
Credit\ Risk_{i,j,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\
& + \beta_3 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t \\
& + \beta_4 Stress\ Tested\ Bank_i * Post\ Stress\ Period_t * GIIPS_j \\
& + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\
& + \alpha_3 Country\ Fixed\ Effects_j \\
& + \varepsilon_{i,j,t}
\end{aligned} \tag{4.6}
$$

4.4.2 Stress Test Exposure

The stress test exposure of banks or its variation is first adopted by Cortés et al. (2019), who use the variable to assess the effects of stress testing. I report three different variables for the stress test exposure variable based on the CET1 capital exposure, Tier 1 capital exposure, and Total capital exposure made available by the EBA (represented in ratio form).

For this second methodological approach, I remove the control group banks that are included in the first methodological approach. I solely focus on the stress-tested banks that are part of the total sample of banks. The objective is to evaluate if heterogeneities among stress-tested banks are present and if these heterogeneities affect bank lending practices, among other possible outcomes[19].

To explain how the stress test exposure variable is constructed. For illustrative purposes, I show how I calculate the stress test exposure for two different banks by analysing the EBA 2011 stress test as an example. Figures 4.1, 4.2, and 4.3 present the Lloyds Banking Group plc results, which show the CET1 ratio, Tier 1 ratio, and Total ratio, respectively. Figures 4.4, 4.5, and 4.6 present the results of the National Bank of Greece for the CET1 ratio, Tier 1 ratio, and Total ratio, respectively. Let us take, for example, figure 4.1. I find that for Lloyds Banking Group plc, the starting CET1 capital ratio of the bank is 10.16%. After the bank's balance sheet is stressed against the 2011 framework, I see that the bank's CET1 ratio results in 7.72%. I calculated the stress test exposure of this bank as the pre-stress test ratio minus the post-stress ratio. For Lloyds Banking Group plc's stress test exposure, this is 2.45%. The second bank I use to describe the stress test exposure is the National Bank of Greece. Figure 4.4 shows that the pre-test CET1 ratio of the bank is 11.94%, while the CET1 ratio of the bank is 7.67% after the effects of the adverse stress. Hence, the exposure of the bank is 4.27%.

When comparing the exposure of the stress test between Lloyds Banking Group plc and the National Bank of Greece with respect to the CET1 ratio, I find that the National Bank of Greece's exposure to the stress test is larger. In other words, the National Bank of Greece is more exposed to the stress test relative to Lloyds Banking Group plc. Intuitively, the larger the exposure, the more exposed the bank is to the stress test, and this exposure can be statistically analysed in econometric modelling. Figures 4.2, 4.3, 4.5, and 4.6 follow the same approach but outline the Tier 1 and Total capital ratio, respectively.

[19] See for example, Liu et al. (2019) who document the difference in lending behaviour among stress-tested banks when taking into account the monetary policy regime.

Figure 4.1: Lloyds Banking Group Plc – CET1 Capital Ratio

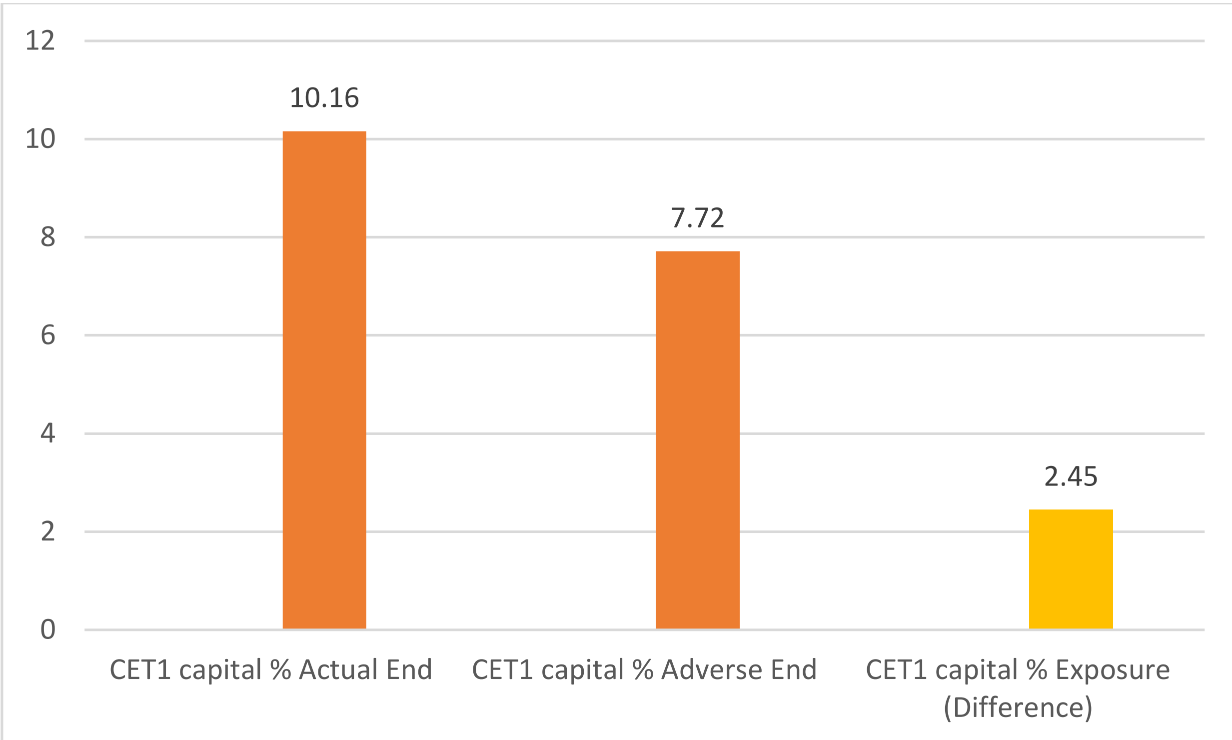


Figure 4.2: Lloyds Banking Group Plc – Tier 1 Capital Ratio

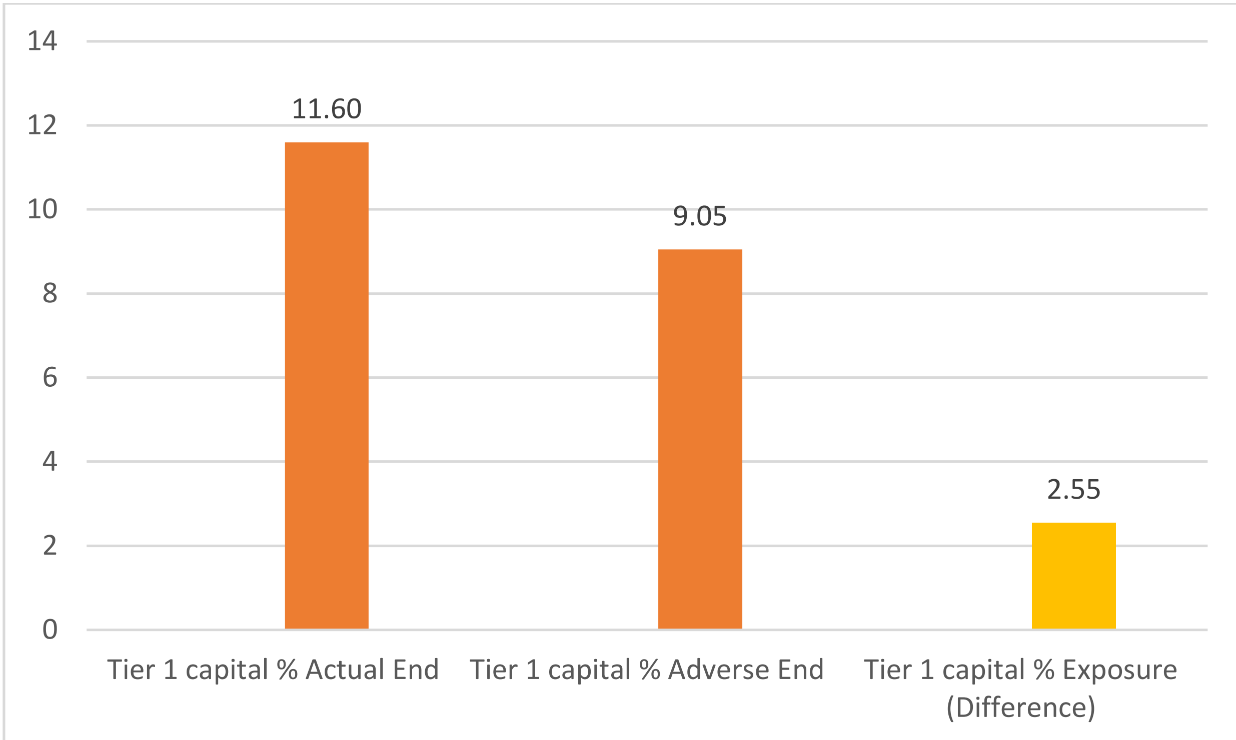


Figure 4.3: Lloyds Banking Group Plc – Total Capital Ratio

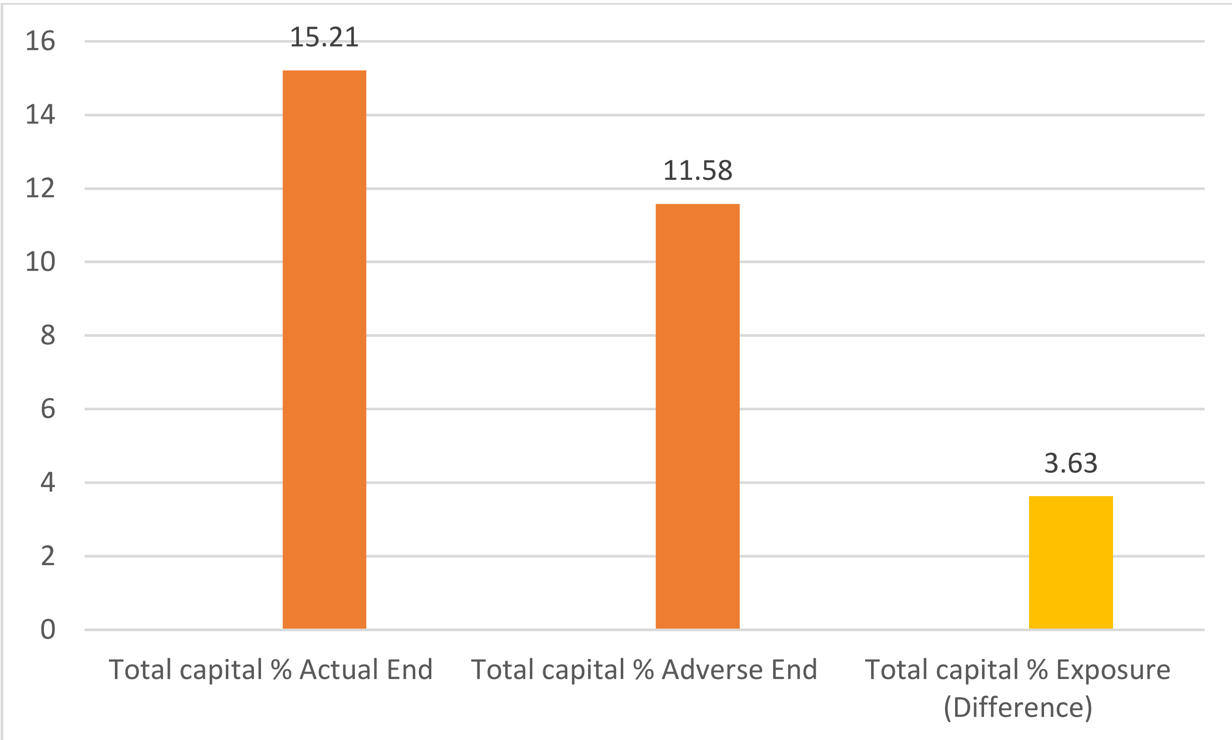


Figure 4.4: National Bank of Greece – CET1 Capital Ratio

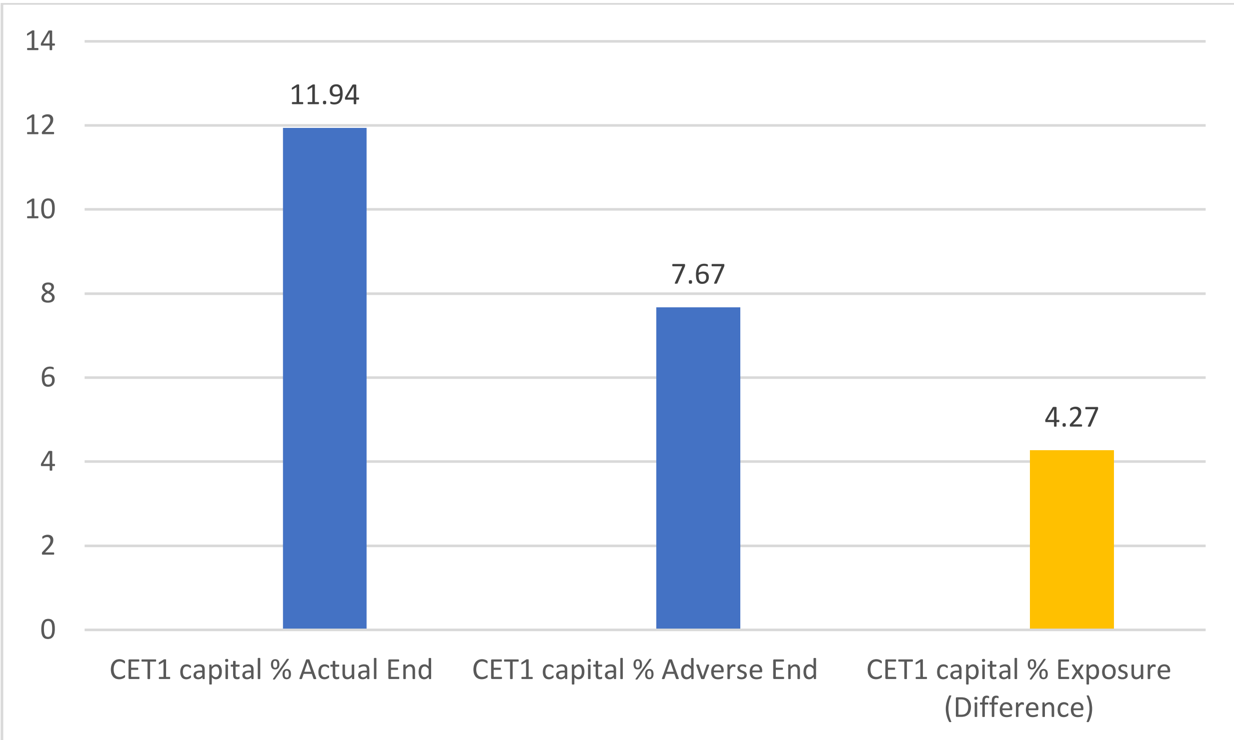


Figure 4.5: National Bank of Greece – Tier 1 Capital Ratio

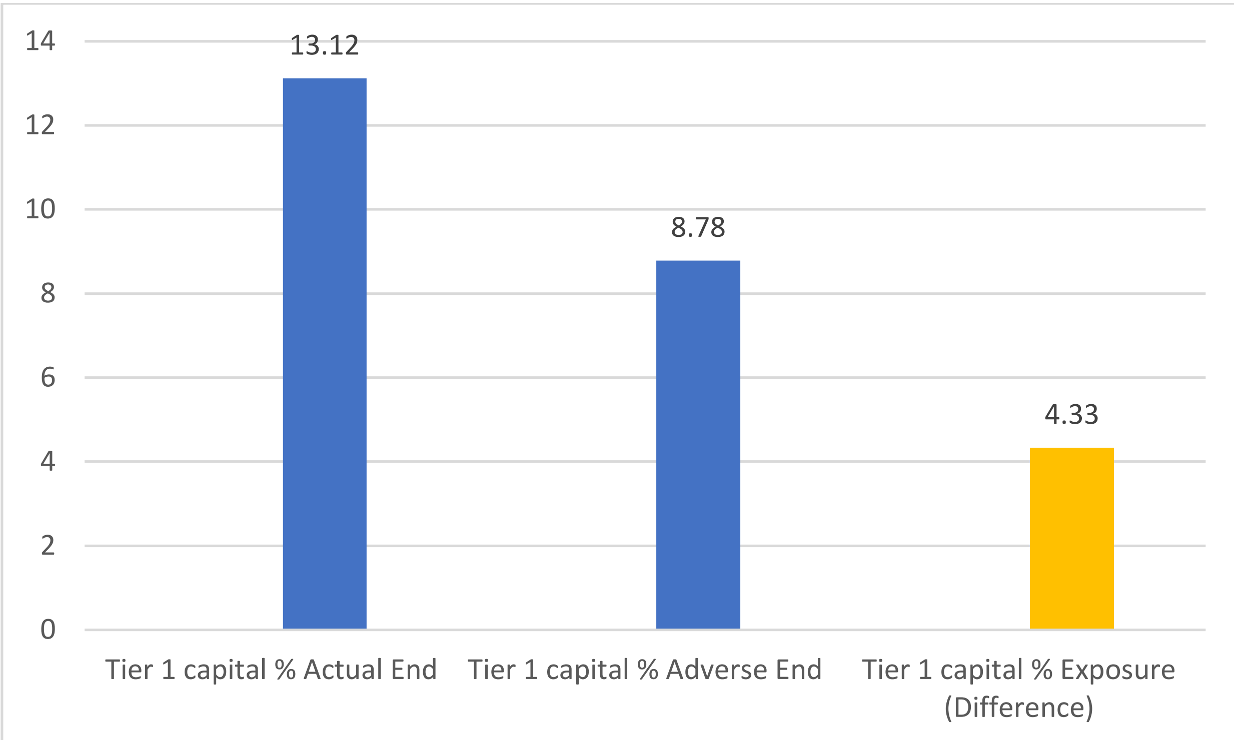
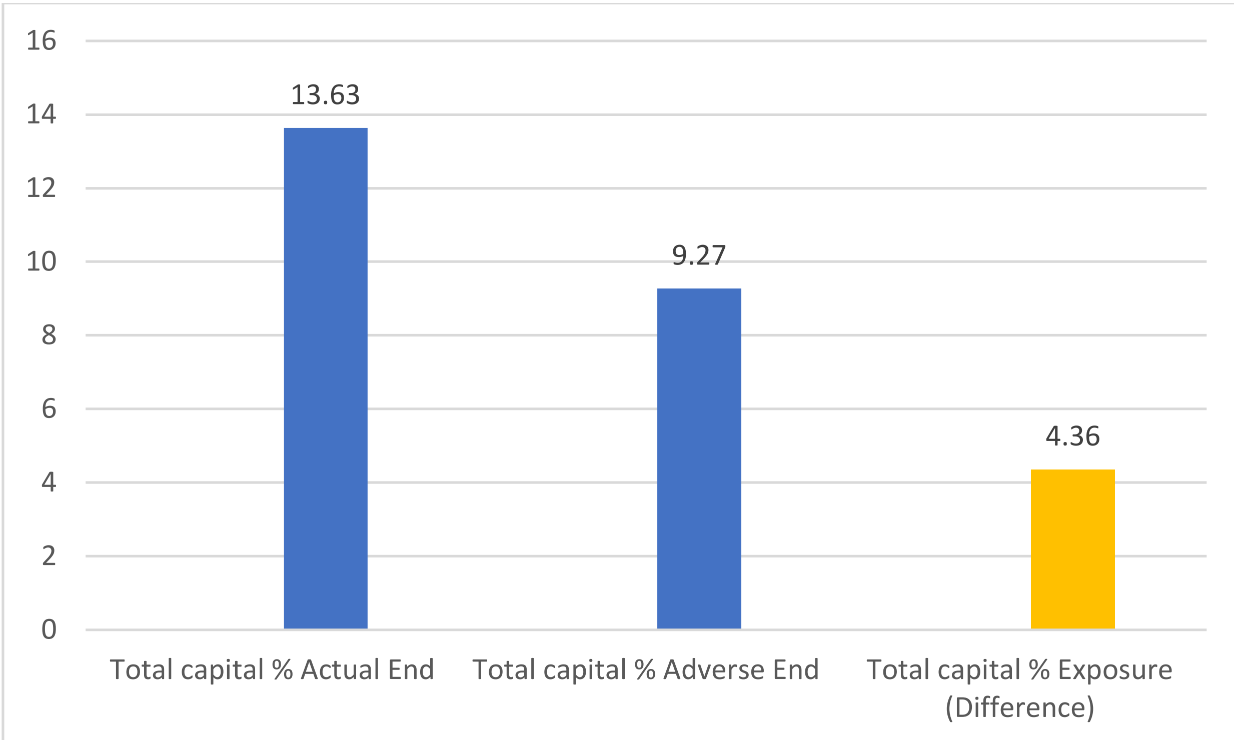


Figure 4.6: National Bank of Greece – Total Capital Ratio



In essence, for the stress test exposure variable, I hypothesise that if banks are highly exposed to the stress test, there is a significant effect on bank lending behaviour and credit risk. With regard to the econometric analysis, I use a dummy variable for stress-tested banks. Banks designated as 1 are highly exposed to the stress test (above the median of the stress test exposure). Banks that are designated as 0 are less exposed to the stress test. Equations (4.7) – (4.10) follow the same econometric model as the difference-in-difference model. Nonetheless, I substitute the difference-in-difference interaction and use the stress test exposure to control for possible heterogeneities among stress-tested banks. Moreover, I hypothesise that there are inherent differences among the highly-exposed stress-tested banks that may persist. I, therefore, control for the effect of banks being highly-exposed and originating from GIIIPS countries. As with the previous section, I hypothesise that highly exposed banks and those originating from the GIIPS region will perform worse than their counterparts.

$$\begin{aligned} Loan\ Type\ Growth_{i,j,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\ & + \beta_3 Stress\ Test\ Exposure\ Median_{i,j,t-1} \\ & + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\ & + \alpha_3 Country\ Fixed\ Effects_j \\ & + \varepsilon_{i,j,t} \end{aligned} \tag{4.7}$$

$$\begin{aligned} Loan\ Type\ Growth_{i,j,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\ & + \beta_3 Stress\ Test\ Exposure\ Median_{i,j,t-1} \\ & + \beta_4 Stress\ Test\ Exposure\ Median_{i,j,t-1} * GIIPS_j \\ & + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\ & + \alpha_3 Country\ Fixed\ Effects_j \\ & + \varepsilon_{i,j,t} \end{aligned} \tag{4.8}$$

$$\begin{aligned} Credit\ Risk_{i,j,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\ & + \beta_3 Stress\ Test\ Exposure\ Median_{i,j,t-1} \\ & + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\ & + \alpha_3 Country\ Fixed\ Effects_j \\ & + \varepsilon_{i,j,t} \end{aligned} \tag{4.9}$$

$$\begin{aligned} Credit\ Risk_{i,j,t} = \ & \beta_0 + \beta_1 Bank\ Specific\ Variables_{i,j,t-1} + \beta_2 Macro\ Variables_{t-1} \\ & + \beta_3 Stress\ Test\ Exposure\ Median_{i,j,t-1} \\ & + \beta_4 Stress\ Test\ Exposure\ Median_{i,j,t-1} * GIIPS_j \\ & + \alpha_1 Bank\ Fixed\ Effects_i + \alpha_2 Time\ Fixed\ Effects_t \\ & + \alpha_3 Country\ Fixed\ Effects_j \\ & + \varepsilon_{i,j,t} \end{aligned} \tag{4.10}$$

4.5 Empirical Results

The empirical results are divided into two sections that reflect the two methodological approaches.

First, I analyse the effects of the difference-in-difference specification that captures the change in bank lending behaviour and credit risk due to the stress testing regime between two different groups across two periods.

The second section focuses solely on the stress-tested banks that are a part of our sample. To differentiate amongst the set of stress-tested banks, I construct the stress test exposure variable, which is analogous to the methodological approach set by Cortés et al. (2019).

4.5.1 Difference-in-Difference Specification: Loan Growth

For the first stage of the empirical regressions concerning the difference-in-difference approach, I examine the effect of stress testing on bank lending.

Tables 4.4 - 4.6 report the main dependent variables: total loans, mortgage loans, corporate loans, consumer loans, and bank loans. Five model specifications for each dependent variable are presented, including varying stress testing specifications and double interactions. For the main model specification, I include the basic difference-in-difference interaction, which is akin to the specification used in the first empirical chapter, shown in model (1).

For nearly all model specifications, I do not find statistically significant results for the effect of stress testing on bank lending. Except for corporate loans, I report that the effect of stress testing on bank lending leads to a fall in corporate lending by approximately 24 p.p. relative to the control group included in our sample. In the first empirical chapter, I similarly find that UK banks that participated in the supervisory stress tests will reduce corporate loans relative to the control banks. Acharya et al. (2018) present similar results but focus on two different but connected loan types: commercial real estate and consumer and industrial loans. The authors find that the U.S. stress-tested banks reduce lending for these loan categories relative to non-stress tested banks. Furthermore, Acharya et al. (2018) postulate that reducing a certain type of loan mitigates and controls credit risk issues that would potentially arise if banks were to engage in risky lending. The decrease in corporate lending by stress-tested banks could be a potential sign of this, as the banks look to mitigate elevated credit risk.

The results across the three jurisdictions that I have considered so far show a visible change in corporate loans by the stress-tested banks, where there has been a shift in banks' lending policy against the backdrop of the stress testing frameworks irrespective of the financial jurisdiction. If I had to analyse other jurisdictions across the globe, I would hypothesise that this relationship may persist elsewhere, given the initial evidence.

Next, I modify the difference-in-difference interaction to create a triple difference-in-difference interaction. For the triple difference-in-difference interaction, I include the effect of a stress-tested bank falling under the 5.5% CET1 capital threshold, which can be translated as a bank that holds inadequate capital. One motivation to include this interaction is to measure banks that may have failed if the later EU stress tests included a pass/fail threshold (hurdle rate[20]). The results for the triple difference-in-difference interaction are reported in model (2). Yet again, I find that there are no statistically significant results for banks that are evaluated to have inadequate capital levels after being stressed for the majority of the loan types. However, there are statistically significant results for corporate loans. Banks that fall below the 5.5% CET1 threshold reduce lending by roughly 22 p.p. relative to banks that have CET1 capital ratios that are above the 5.5% threshold.

Importantly, this demonstrates that there are heterogeneities among stress-tested banks, which suggests that the stress test result can influence a banks' lending policy. Furthermore, the triple difference-in-difference interaction is embedded within the econometric approach for cross-comparison purposes with our first empirical chapter and the emerging literature.

Regarding the first empirical chapter, including the effects of failing the stress test was imperative for the UK stress-tested banks. I find statistically significant results which signal that failed banks will cut back on bank lending relative to banks that pass the stress test and non-stress tested banks. To compare the findings of failing the stress test with the U.S. stress tests, Acharya et al. (2018) document that failing the stress test often reduces bank lending. Specifically, the authors show that failed banks will reduce consumer and industrial loans closely linked to the corporate loans reported in table 4.5.

20 See for example, the BoE's stress testing frameworks that provides the methodology and results of the UK stress-tested banks which highlights the hurdle rates (pass/fail thresholds) that banks are expected to meet.

The reduction of corporate loans by the stress-tested banks is related to the analysis made by Casey and O'Toole (2014), who examine corporate loans that originate from banks across 11 EU countries. The authors first explain that there has been a shift in corporate lending since the financial crisis in the EU, where banks have been adopting strategies to reduce corporate loans. In contrast, this may seem adverse for firms that seek loans for various purposes. Casey and O'Toole (2014) highlight that such firms will pursue other means to source funds, such as relying on trade credit to fund business activity. Initially, stress-tested banks' reduction in corporate loans may be viewed as a negative consequence caused by the stress tests. However, the reduction in corporate loans does not necessarily assume that firms will be largely affected by the lack of funds made available by the banks, as other substitutes such as trade credit are accessible.

Failing a stress test can often play a pivotal role in stress-tested banks' future decision-making, as banks may face greater scrutiny by the markets, where negative reactions can affect a banks' returns, such as profits (Morgan et al., 2014). The fall in profits, coupled with negative market reaction, may exacerbate the problems the bank face, and this might cause banks to make difficult decisions, such as a reduction in lending.

Failing the stress test can warrant further scrutiny by the markets, as the release of the stress tests may suggest the performance of banks under a potential adverse scenario. Naturally, the effect of failing or being deemed to hold insufficient capital can cause long-lasting damage to the weaker banks. The damage to the banks may encourage banks to focus on improving their capital base thus, banks may seek to reduce risky loans. Goncharenko et al. (2018) find that such a release of results can be detrimental, often more harmful to the large systemic banks.

The final variation of the triple difference-in-difference interaction focuses on a set of stress-tested banks located in the GIIPS countries. The findings indicate that banks across GIIPS countries show greater credit and sovereign risk signs than the other developed countries. The effect of stress testing on bank lending for the GIIPS countries is presented in model (3). For this stage of the empirical regressions, I find no statistically significant results for stress-tested banks from GIIPS countries. Consequently, it could be concluded that there are no observable heterogeneities across stress-tested banks for the country level.

For the control variables, I include the size of the bank and find that the majority of the model specifications show that an increase in bank size leads to a reduction in bank lending. For instance, in models (1), (2), and (3), when a banks' size increases by 1%, the fall in total loans growth is approximately 12 p.p., for mortgage loans the reduction is approximately 26 p.p. The statistically significant result for bank size is visible throughout table 4.4 - 4.6. The same results are present in the first empirical chapter for the UK banks, where an increase in bank size reduces lending.

The bank's credit risk is proxied by the non-performing loan ratio, and I observe that there are statistically significant results for a few of the dependent variables. In terms of mortgage loans, an increase in credit risk will approximately reduce mortgage loan originations by 0.75 p.p.

I divert from the first empirical chapter and add two more new banking characteristics considered by the literature, which concerns a bank's liquidity (Acharya et al., 2018; Nguyen et al., 2020). The second variable inspects the strength of a banks' funding structure, which is proxied by the customer deposits held by the bank. The increase in bank liquidity is positively correlated with total loans, mortgage loans, and corporate loans. If banks hold greater liquid assets, this suggests that banks with greater cash reserves can lend out more loans to customers, as shown in table 4.4 - 4.6.

The bank's funding structure is instrumental for banks, as their funding base allows them to continue their banking activities and ultimately provides them with cash to borrow to potential borrowers. For total loans, an increase of 1% of funding proxied by the deposits held by the bank increases total loans by 0.17 p.p.

I include two macroeconomic variables analogous to the variables used in the first empirical chapter. For the Euro Bank Rate, I find that banks are incentivised to originate more total loans when there is an increase in the Bank Rate, total loans growth increases by approximately 3.3 p.p., shown across models (1), (2), and (3).

I report the effect of profitability, efficiency, capital, and unemployment on bank lending growth but find no statistically significant results for all model specifications across the five dependent variables. For brevity, I do not discuss the results of the control variables for the next set of results.

Table 4.4: EU Stress Testing on Bank Lending – Difference in Difference Specification

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are total loans and mortgage loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %					**Mortgage loans change %**				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Size	-12.23***	-12.22***	-12.17***	-12.18***	-12.19***	-26.02***	-26.02***	-25.99***	-25.90***	-25.20***
	(2.81)	(2.81)	(2.81)	(2.78)	(2.81)	(8.64)	(8.65)	(8.62)	(8.50)	(8.21)
Profitability	0.20	0.16	0.14	0.17	0.22	-1.96	-1.95	-1.95	-1.94	-1.94
	(0.86)	(0.86)	(0.86)	(0.86)	(0.86)	(2.19)	(2.21)	(2.20)	(2.20)	(2.15)
Credit risk	-0.16	-0.16	-0.13	-0.16	-0.17	-0.76**	-0.75**	-0.76**	-0.76**	-0.86**
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.31)	(0.31)	(0.32)	(0.31)	(0.33)
Efficiency	0.09	0.08	0.06	0.14	0.15	-2.91	-2.90	-2.89	-2.81	-2.62
	(1.39)	(1.39)	(1.39)	(1.39)	(1.39)	(4.88)	(4.88)	(4.84)	(4.52)	(4.49)
Capital	-0.03	-0.03	-0.03	-0.03	-0.02	1.16	1.16	1.15	1.15	1.27
	(0.39)	(0.39)	(0.39)	(0.39)	(0.39)	(1.45)	(1.45)	(1.45)	(1.44)	(1.45)
Liquidity	0.18**	0.18**	0.19**	0.18**	0.18**	0.70**	0.70**	0.70**	0.71**	0.71**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.29)	(0.29)	(0.30)	(0.30)	(0.29)
Funding	0.17**	0.18**	0.18**	0.17**	0.17**	-0.33	-0.33	-0.33	-0.33	-0.34
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)
Economic conditions (Unemployment)	-0.00	-0.01	-0.01	0.00	0.01	-3.86	-3.86	-3.85	-3.86	-3.75
	(1.11)	(1.11)	(1.11)	(1.11)	(1.12)	(2.75)	(2.75)	(2.75)	(2.75)	(2.73)
Economic conditions (Bank Rate)	3.28***	3.29***	3.31***	3.43***	3.46***	-0.12	-0.12	-0.13	0.14	1.16
	(0.80)	(0.80)	(0.80)	(0.74)	(0.77)	(2.30)	(2.31)	(2.37)	(1.94)	(2.03)
*Stress Bank EBA * Post Stress Period EBA*	-1.78	-1.70	-0.33			-2.51	-2.51	-2.80		
	(2.09)	(2.09)	(2.32)			(13.18)	(13.19)	(14.61)		
*Stress Bank EBA * Post Stress Period EBA * ST Failed*		-4.12					0.43			
		(5.38)					(7.67)			
*Stress Bank EBA * Post Stress Period EBA * GIIPS*			-3.98					1.12		
			(3.17)					(9.08)		

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
*ST Failed * Post Stress Period EBA*				-4.42					0.41	
				(5.39)					(7.67)	
*GIIPS * Post Stress Period EBA*					0.36					12.40
					(2.51)					(8.02)
Constant	120.45***	120.51***	119.68***	119.61***	119.56***	322.40***	322.45***	322.06***	320.31***	308.06***
	(34.89)	(34.90)	(34.95)	(34.34)	(34.41)	(99.41)	(99.68)	(98.66)	(96.45)	(92.29)
Observations	2,232	2,232	2,232	2,232	2,232	909	909	909	909	909
R-Squared	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11
Number of banks	259	259	259	259	259	140	140	140	140	140
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.48	1.45	1.57	1.39	1.43	1.46	1.43	1.61	1.35	1.42
Sargen-Hansen Test (p-value)	59.133	59.403	59.548	52.350	49.901	28.911	29.994	30.284	29.905	29.334
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0013)	(0.0016)	(0.0014)	(0.0009)	(0.0011)
Model Used	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.5: EU Stress Testing on Bank Lending – Difference in Difference Specification (continued)

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are corporate loans and consumer loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Corporate loans change %					**Consumer loans change %**				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Size	-36.99***	-36.83***	-37.55***	-34.99***	-35.86***	-21.44**	-21.40**	-21.20**	-21.39**	-20.79**
	(8.20)	(8.27)	(8.55)	(8.57)	(8.72)	(10.16)	(10.17)	(10.41)	(10.15)	(10.21)
Profitability	-2.62	-2.96	-2.72	-2.92	-2.62	1.29	1.13	1.34	1.13	1.32
	(2.40)	(2.42)	(2.43)	(2.41)	(2.40)	(2.19)	(2.24)	(2.21)	(2.24)	(2.16)
Credit risk	-0.40	-0.46*	-0.37	-0.50*	-0.40	-0.60	-0.63	-0.61	-0.63	-0.66
	(0.24)	(0.25)	(0.24)	(0.27)	(0.25)	(0.60)	(0.61)	(0.61)	(0.61)	(0.63)
Efficiency	-0.85	-0.89	-1.30	-0.71	-0.93	-3.75	-3.77	-3.56	-3.76	-3.32
	(4.91)	(4.89)	(5.09)	(5.23)	(5.25)	(4.52)	(4.51)	(4.70)	(4.51)	(4.62)
Capital	1.33	1.35	1.35	1.36	1.33	1.54	1.53	1.52	1.53	1.61
	(0.84)	(0.84)	(0.85)	(0.86)	(0.86)	(1.53)	(1.52)	(1.53)	(1.52)	(1.52)
Liquidity	1.20***	1.21***	1.21***	1.22***	1.22***	0.20	0.20	0.20	0.20	0.20
	(0.32)	(0.33)	(0.33)	(0.33)	(0.33)	(0.32)	(0.32)	(0.32)	(0.32)	(0.31)
Funding	0.45	0.46	0.47	0.44	0.42	-0.42	-0.41	-0.42	-0.41	-0.41
	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)
Economic conditions (Unemployment)	-1.39	-1.36	-1.40	-1.34	-1.40	-2.29	-2.28	-2.28	-2.28	-2.21
	(5.35)	(5.35)	(5.35)	(5.35)	(5.35)	(5.00)	(5.01)	(5.01)	(5.01)	(5.01)
Economic conditions (Bank Rate)	-4.35	-4.26	-4.18	-1.39	-2.26	-4.61	-4.58	-4.63	-4.56	-3.51
	(4.26)	(4.24)	(4.32)	(4.45)	(4.60)	(3.18)	(3.19)	(3.18)	(3.00)	(3.11)
*Stress Bank EBA * Post Stress Period EBA*	-24.31***	-24.15***	-20.44**			-0.26	-0.22	-2.37		
	(8.56)	(8.55)	(8.49)			(8.41)	(8.41)	(8.26)		
*Stress Bank EBA * Post Stress Period EBA * ST Failed*		-22.12***					-10.73			
		(8.09)					(11.69)			
*Stress Bank EBA * Post Stress Period EBA * GIIPS*			-12.87					6.29		
			(10.33)					(11.89)		

*ST Failed * Post Stress Period EBA*				-22.40***					-10.73	
				(8.14)					(11.68)	
*GIIPS * Post Stress Period EBA*					-8.66					10.88
					(9.59)					(10.39)
Constant	351.53***	349.40***	357.41***	325.47***	338.00***	265.26*	264.65*	262.75*	264.52*	253.41*
	(113.26)	(114.09)	(116.08)	(116.91)	(118.61)	(145.38)	(145.51)	(147.57)	(145.74)	(146.90)
Observations	1,173	1,173	1,173	1,173	1,173	1,280	1,280	1,280	1,280	1,280
R-Squared	0.06	0.07	0.06	0.06	0.06	0.03	0.03	0.03	0.03	0.03
Number of banks	183	183	183	183	183	195	195	195	195	195
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.45	1.43	1.62	1.35	1.41	1.43	1.40	1.58	1.32	1.37
Sargen-Hansen Test (p-value)	39.579	46.568	39.091	34.862	29.575	31.274	31.158	34.158	21.530	24.805
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0010)	(0.0005)	(0.0010)	(0.0003)	(0.0177)	(0.0057)
Model Used	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.6: EU Stress Testing on Bank Lending – Difference in Difference Specification (continued)

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variable is bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include robust standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Bank loans change %				
	(1)	(2)	(3)	(4)	(5)
Size	-2.16**	-2.18**	-2.13**	-2.78***	-2.79***
	(1.04)	(1.04)	(1.04)	(0.87)	(0.87)
Profitability	1.75	1.65	1.79	1.64	1.78
	(1.93)	(1.94)	(1.92)	(1.94)	(1.92)
Credit risk	0.20	0.20	0.19	0.19	0.14
	(0.20)	(0.20)	(0.21)	(0.20)	(0.21)
Efficiency	0.24	0.24	0.29	0.13	0.21
	(1.32)	(1.32)	(1.33)	(1.32)	(1.32)
Capital	-0.19	-0.19	-0.20	-0.21	-0.20
	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)
Liquidity	-0.23***	-0.23***	-0.23***	-0.22***	-0.23***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Funding	0.02	0.02	0.02	0.02	0.02
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Economic conditions (Unemployment)	-0.09	-0.10	-0.09	-0.11	-0.09
	(4.50)	(4.50)	(4.50)	(4.50)	(4.50)
Economic conditions (Bank Rate)	-0.77	-0.76	-0.78	-0.42	0.22
	(1.65)	(1.65)	(1.65)	(1.58)	(1.76)
*Stress Bank EBA * Post Stress Period EBA*	-4.63	-4.49	-5.62		
	(3.32)	(3.33)	(3.82)		
*Stress Bank EBA * Post Stress Period EBA * ST Failed*		-12.56			
		(8.27)			
*Stress Bank EBA * Post Stress Period EBA * GIIPS*			3.01		
			(5.14)		

*ST Failed * Post Stress Period EBA*				-13.83*	
				(8.32)	
*GIIPS * Post Stress Period EBA*					7.08
					(6.62)
Constant	32.05	32.34	31.73	38.57	38.52
	(42.33)	(42.35)	(42.32)	(42.44)	(42.45)
Observations	2,215	2,215	2,215	2,215	2,215
R-Squared	0.04	0.04	0.04	0.04	0.04
Number of banks	-	-	-	-	-
Bank fixed effects	-	-	-	-	-
Time fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
Mean VIF	1.47	1.44	1.56	1.38	1.42
Sargen-Hansen Test (p-value)	-	-	-	-	-
Model Used	OLS	OLS	OLS	OLS	OLS

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

With the emerging stress testing literature that focuses on the exercise's effect on bank lending, there is a debate that the stress testing frameworks may have been more effective for the earliest periods (Calem et al., 2019; Acharya et al., 2018, among others). As a result of this conjecture, I employ a similar methodology addressed in the first empirical chapter for the UK stress tests. Although, I conclude that there were no strong results to suggest that UK supervisory stress tests were diminishing over time. For this empirical chapter regarding the EU banks, I employ the same methodology and consider the dynamic effects of stress testing to assess if they were more effective in the earlier periods.

Table 4.7 reports the effect of each stress testing framework since the inception of the EU stress tests that began in 2009. For 2011, I find that total loans decreased by approximately 4.9 p.p., which may provide evidence suggesting that the earliest stress tests had a significant effect on the stress-tested banks. Surprisingly, I find no-repeat results for the decline in total loans until 2018, which shows a reduction of nearly 5.5 p.p. in total loans.

In contrast to the findings presented in table 4.4, I turn my attention to mortgage loan origination. Remarkably, I find an increase in mortgage originations relative to the banks in the control group for the earliest stress testing years. For example, I see that for the first 2010 stress test that includes a richer set of data, I find that the stress-tested bank will increase mortgage loans by 27.2 p.p. In the next stress testing year, there is also an increase in mortgage lending by 28 p.p. and 21 p.p. for 2011 and 2013, respectively. After these stress testing years, I find no other statistically significant results indicating that stress testing on mortgage lending reduces throughout time. The finding corroborates with the evidence shown for the U.S. administered stress tests, which highlights that bank lending decisions were most influential for the earliest stress test, and the effect of the exercises weakens across time (Calem et al., 2019; Acharya et al., 2018).

There is a decrease in two stress testing years regarding corporate loans, where corporate loans are reduced by 34 p.p. and 21 p.p. for 2011 and 2016, respectively. One reason behind the fall in corporate lending in 2011 is examined by Petrella and Resti (2013), who document the benefits and improvements made for the 2011 EU stress test compared to the previous 2010 EU stress test. The authors explain that the 2011 stress test was more influential and stronger in terms of the structure of the stress testing framework, as more granular data on the banks were released to the public relative to the 2010 stress test. The data allows for greater analysis and is more informative for the public and markets; hence the banks may have felt the need to cut back on corporate lending for this year, specifically.

In addition, Borges et al. (2019) document the economic motivation behind this result and specifically address why there may be noticeable changes across each stress testing framework. The authors explain that specifically for the EBA stress tests, the framework's success and failure were conditional on the structure of the stress testing methodology. The first stress tests (2009 and 2010) failed to provide detailed information on the methodology used and proved inadequate with releasing detailed disaggregated information on the participating banks included in the respective frameworks. The results can also be categorised by the shift from the EBA in deciding to remove the explicit threshold that banks had to meet to pass the stress test.

The empirical results shown in table 4.7 is reported for comparative purposes and is analogous to the first empirical chapter on UK banks. While I make every effort to compare the results to the literature, it is imperative to highlight that direct cross-comparison is not possible. Candelon and Sy (2015) explain variations between stress testing programmes, such as the EU and U.S. exercises. The authors find regarding the structure of the stress tests by each regulator; the exercises cannot be compared. This, in turn, may provide different implications of the effect of stress testing on bank lending, which is conditional on the structure of the stress test.

Petrella and Resti (2013) discuss the shortcomings of the 2010 stress test that was viewed to have a marginal impact on the EU banks and the market reaction that was initially anticipated. The limitation of the first stress test was as a result of the data, which was seen to be less granular. To alleviate the limitations of the 2010 stress test, the 2011 stress test provided the markets with more granular disaggregated information, which caused a stronger market reaction and allowed greater scrutiny and insight on the banks' balance sheet if they were to face a hypothetical adverse shock. Petrella and Resti (2013) explain that stress tests cannot be viewed as similar each year. It is of paramount importance to acknowledge that the effect of stress tests on bank lending decisions may not show similar findings for every year[21].

[21] To corroborate the claim, there are several papers that find for the U.S. stress tests. Notably, the first round of stress tests was the most effective, with SCAP 2009 stress testing being viewed as the exercise that caused a stronger market reaction. See for example, Neretina et al. (2015).

Table 4.7: EU Stress Testing on Bank Lending – Year by Year – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are total loans, mortgage loans, consumer loans, corporate loans, and bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %	**Mortgage loans change %**	**Corporate loans change %**	**Consumer loans change %**	**Bank loans change %**
*Stress Bank EBA * Post Stress Period 2009*	-1.65	41.66	28.34	17.35	2.88
	(4.53)	(31.05)	(23.49)	(23.13)	(7.26)
*Stress Bank EBA * Post Stress Period 2010*	-1.05	27.24**	-0.61	11.25	8.13
	(3.41)	(12.81)	(13.62)	(10.17)	(7.80)
*Stress Bank EBA * Post Stress Period 2011*	-4.85*	28.06**	-33.99*	-20.37	-8.63
	(2.85)	(13.18)	(19.05)	(23.28)	(9.72)
*Stress Bank EBA * Post Stress Period 2012*	-1.89	10.19	-15.24	8.96	-5.87
	(3.25)	(11.39)	(12.12)	(16.78)	(6.02)
*Stress Bank EBA * Post Stress Period 2013*	0.49	20.54*	-11.82	10.91	-14.06**
	(3.01)	(11.18)	(11.46)	(14.75)	(6.94)
*Stress Bank EBA * Post Stress Period 2014*	-0.34	13.58	-7.07	13.30	-4.81
	(3.69)	(10.77)	(10.53)	(14.71)	(6.14)
*Stress Bank EBA * Post Stress Period 2015*	-1.50	9.54	-10.41	6.24	-4.65
	(3.24)	(10.92)	(13.61)	(14.53)	(6.18)
*Stress Bank EBA * Post Stress Period 2016*	-3.17	7.84	-20.85*	12.10	0.23
	(3.01)	(10.91)	(11.28)	(15.15)	(7.18)
*Stress Bank EBA * Post Stress Period 2017*	-3.50	8.96	-14.77	9.26	-8.09
	(2.78)	(10.68)	(10.63)	(15.61)	(5.76)
*Stress Bank EBA * Post Stress Period 2018*	-5.51*	1.19	10.41	9.95	-1.65
	(3.14)	(10.34)	(17.74)	(17.65)	(6.91)
Constant	126.74***	340.02***	296.04***	257.47*	23.85
	(36.37)	(99.52)	(111.62)	(151.80)	(48.19)
Observations	2,232	909	1,173	1,280	2,215
R-Squared	0.12	0.13	0.08	0.03	0.04
Number of banks	259	140	183	195	-
Bank fixed effects	YES	YES	YES	YES	-
Time fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES
Mean VIF	1.32	1.32	1.30	1.28	1.31
Sargen-Hansen Test (p-value)	279.724 (0.0000)	43.125 (0.0001)	70.539 (0.0000)	48.310 (0.0000)	-

Model Used	FE	FE	FE	FE	OLS

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

In the next step, I continue with the dynamic analysis but now estimate banks classified to have inadequate capital. One caveat of the section is the CET1 ratio was not included in the first 2010 stress test but was later introduced in the 2011 stress testing exercise and succeeding tests. There have been several years with omitted data, as banks have converged to building their capital ratios since the financial crisis[22].

Table 4.8 reports that for 2012, banks that fail will reduce bank loans compared to the banks that pass the stress test by nearly 31 p.p. I focus on 2015, in which there was a stress test in the previous year. I find that there are significant differences among stress-tested banks. For total loans, mortgage loans, and corporate loans, there is a decrease in lending of 12 p.p., 7 p.p., and 35 p.p., respectively, by banks deemed to have an inadequate capital level. Unsurprisingly, banks that fail or hold inadequate capital levels are in a financially difficult position to continue their lending activity.

During the stress test, troubled banks must resort to other strategies to ensure they are financially viable and prioritise by enhancing their capital base. In summary, banks with different capital buffers post-stress tests will adopt differing lending strategies (Liu et al., 2019). The first empirical chapter on the UK banking system reports very similar findings and relates to the findings shown in Table 4.8. UK stress-tested banks that fail the stress test will look to further curb credit risk problems that may arise from the stress testing exercises, incentivising such banks to take action; this may include reducing loans.

In a similar vein, a bank that is disclosed to have inadequate capital post-stress test could face a negative market reaction that may affect banks' behaviour such as lending. Goncharenko et al. (2018) document that banks viewed as weaker than their peers will feel the repercussions resulting from inadequate capital levels. I do not control our sample's differences among stress-tested banks by disaggregating them into G-SIB and non-G-SIB banks. Accordingly, Goncharenko et al. (2018) provide evidence to suggest that there are heterogeneities across these two groups of banks, as larger and more complex banks face a stronger negative reaction compared to smaller, less sophisticated stress-tested banks.

An examination of an earlier stress test reviewed by Connolly (2017) finds differences between banks that pass and those that fail. To relate to the results, I find that this is true for the banks that hold inadequate

[22] There is also a number of other EU banks that have failed the EBA stress tests, because of the Tier 1 threshold set in 2010, and the subsequent CET1 threshold set in the 2011 and 2014 stress tests. However, these banks are not included, due to data availability, merger of banks, and the selection criteria I use for our banks.

capital ratios after the stress test. Connolly (2017) explains that banks that fail or hold less capital will seek to reduce lending and are in a difficult financial position compared to banks that pass.

Table 4.8: EU Stress Testing on Bank Lending – Year by Year (Failed) – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are total loans, mortgage loans, consumer loans, corporate loans, and bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %	**Mortgage loans change %**	**Corporate loans change %**	**Consumer loans change %**	**Bank loans change %**
*Stress Bank EBA * Post Stress Period 2009*	-1.65	41.84	28.27	17.38	2.77
	(4.53)	(31.05)	(23.47)	(23.15)	(7.26)
*Stress Bank EBA * Post Stress Period 2010*	-1.06	27.31**	-0.71	11.27	8.01
	(3.41)	(12.84)	(13.63)	(10.18)	(7.79)
*Stress Bank EBA * Post Stress Period 2011*	-4.86*	28.05**	-33.90*	-20.29	-8.76
	(2.85)	(13.23)	(19.07)	(23.28)	(9.72)
*Stress Bank EBA * Post Stress Period 2012*	-2.22	8.86	-15.65	9.41	-4.05
	(3.26)	(11.41)	(12.25)	(17.04)	(6.18)
*Stress Bank EBA * Post Stress Period 2013*	0.45	20.66*	-12.53	10.65	-14.15**
	(3.01)	(11.23)	(11.50)	(14.71)	(6.95)
*Stress Bank EBA * Post Stress Period 2014*	-0.41	13.51	-7.89	13.08	-4.87
	(3.69)	(10.81)	(10.58)	(14.70)	(6.14)
*Stress Bank EBA * Post Stress Period 2015*	-0.34	10.61	-6.25	7.18	-4.39
	(3.22)	(11.15)	(14.25)	(14.52)	(6.42)
*Stress Bank EBA * Post Stress Period 2016*	-3.22	7.93	-21.59*	11.85	0.13
	(3.01)	(10.93)	(11.37)	(15.09)	(7.18)
*Stress Bank EBA * Post Stress Period 2017*	-3.53	9.07	-15.43	8.99	-8.18
	(2.78)	(10.71)	(10.70)	(15.60)	(5.78)
*Stress Bank EBA * Post Stress Period 2018*	-5.54*	1.24	9.62	9.66	-1.71
	(3.15)	(10.37)	(17.89)	(17.67)	(6.92)
*Stress Bank EBA * Post Stress Period 2009 * ST Failed*	-	-	-	-	-
*Stress Bank EBA * Post Stress Period 2010 * ST Failed*	-	-	-	-	-
*Stress Bank EBA * Post Stress Period 2011 * ST Failed*	-	-	-	-	-
*Stress Bank EBA * Post Stress Period 2012 * ST Failed*	3.97	13.22	-3.14	-7.29	-24.79***
	(9.45)	(17.80)	(7.52)	(15.81)	(8.15)

*Stress Bank EBA * Post Stress Period 2013 * ST Failed*	-	-	-	-	-
*Stress Bank EBA * Post Stress Period 2014 * ST Failed*	-	-	-	-	-
*Stress Bank EBA * Post Stress Period 2015 * ST Failed*	-11.92**	-6.97*	-34.94*	-9.14	-3.41
	(5.38)	(4.00)	(17.93)	(12.10)	(10.30)
*Stress Bank EBA * Post Stress Period 2016 * ST Failed*	-	-	-	-	-
*Stress Bank EBA * Post Stress Period 2017 * ST Failed*	-	-	-	-	-
*Stress Bank EBA * Post Stress Period 2018 * ST Failed*	-	-	-	-	-
Constant	124.77***	332.04***	284.02**	257.27*	24.42
	(36.13)	(98.55)	(112.26)	(152.82)	(48.24)
Observations	2,232	909	1,173	1,280	2,215
R-Squared	0.12	0.13	0.08	0.03	0.04
Number of banks	259	140	183	195	-
Bank fixed effects	YES	YES	YES	YES	-
Time fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES
Mean VIF	-	-	-	-	-
Sargen-Hansen Test (p-value)	-	-	-	-	-
Model Used	FE	FE	FE	FE	OLS

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

The final dynamic analysis I discuss is related to the differences among the stress-tested banks dependent on the banks' geographical location. First, I hypothesise that stress-tested banks from alternative regions across the EU will behave differently due to several circumstances.

Table 4.9 reports statistically strong results for the stress-tested banks from the GIIPS countries. Turning my attention to total loans, I find a decrease in total loans from the first year by approximately 14 p.p. compared to the stress-tested banks from the remaining countries. Following this result, a similar pattern emerges from the results, in which the total loans for the GIIPS stress-tested banks continue to reduce lending for consecutive years.

Mortgage loan originations show a similar relationship, as there has been a decline in mortgage lending since the start of the stress testing regime. There is a 25 p.p. reduction in mortgage lending compared to non-GIIPS stress-tested banks in 2010, and this magnitude in the fall of loan originations is very similar across all years.

Finally, the GIIPS stress-tested banks cut back on corporate lending relative to non-GIIPS banks, and this magnitude is much stronger than the alternative loan types discussed above. For instance, there was a decline in corporate loans by roughly 66 p.p. and 66 p.p. in 2009 and 2018, respectively. In 2009, an argument can be made to suggest that the onset of the financial crisis may have impacted the drop in corporate loans, and the drop in corporate loans was further amplified for the stress-tested banks that are part of the GIIPS region.

The results shown are instrumental and provide very important insight into the observable differences for stress-tested banks across the EU. The contribution of the findings to the literature shows that stress-tested banks do not behave similarly. I find that stress-tested banks may make different management decisions for lending induced by failing the stress test. Albeit, the results show that the country origin of the stress-tested banks is an important determinant. I support our hypothesis and show differences among stress-tested banks across different countries, which is important for policy implications.

For table 4.7, I postulate that to some extent, there is evidence to suggest that the stress testing exercise is effective for the earlier years, but the influence of the exercises may decline over time. However, on the other hand, when considering the dynamic results of stress-tested banks that are included in the GIIPS group, the effectiveness of stress testing is robust and persistent throughout the whole period.

The dynamic analysis of the effect of stress testing on bank lending indicates that the exercises are effective over time, especially in the latest years. Although for the U.S. banking system, the stress testing exercises were influential in the earliest stress testing periods, the exercises' influence diminished over time. Nonetheless, the results of the previous chapter concerning the UK banking system and the respective chapter that analyses the EU banking system oppose the evidence shown for the U.S. banking system. The analysis in the thesis highlights that the effectiveness of stress testing on bank lending is also statistically significant in the latest stress testing exercises.

On the contrary, the stress testing exercises may not influence the statistically significant results for the latest years. Alternative events such as political interventions and regulations may have significantly impacted bank lending and credit risk.

In 2014, the EBA introduced the Single Supervisory Mechanism (SSM), ensuring that the largest systemic banks within the EU are supervised under one uniform framework to mitigate financial risk and build individual and collective financial resilience within these banks (Okolelova and Bikker, 2020). The launch of the SSM may have produced negative or positive outcomes for lending activity as opposed to the stress testing framework that the respective chapter examines. Said differently, unexplored factors may explain the dynamic analysis results.

Avgeri et al. (2021) study the effect of the SSM on a sample of EU banks that must abide by the supervisory framework as a consequence of being a systemically important institution. Although the authors do not directly investigate the relationship between the SSM and bank lending behaviour, the paper argues that the profitability of EU banks monitored by the SSM increases compared to those that the SSM does not monitor. Furthermore, Avgeri et al. (2021) show that periphery-domiciled EU countries are more profitable than their counterparts. Though there may be no examination of a direct link between the SSM and bank lending, the positive effect on bank profitability is intuitively linked to lending activity, as bank lending is a core activity of a banking institution. The implementation of the regulatory framework produces a shift in bank behaviour via increased profitability (especially for periphery-domiciled banks).

On the other hand, the SSM can indirectly generate negative externalities such as a reduction in lending activity. Avgeri et al. (2021) find that the implementation of prudential regulations such as the SSM can cause operational strain on banks as they prepare themselves for incoming regulations. The burden of increased strain on operational activity can produce knock-on effects such as a change in lending standards and the decision to invest in alternative assets, among other actions. Therefore, the SSM may have shifted banks' lending activity in the latest years of the chapter's sample and provides one rationale in explaining the results as opposed to the stress testing framework I examine.

Fiordelisi et al. (2017) document the effect of the SSM on lending activity and posit that the SSM regulations have unintentionally impacted bank lending. More broadly, the authors observe that the announcement of the SSM from the European Central Bank has affected the activities of banks scrutinised under the SSM. The paper investigates the lending behaviour of EU banks by analysing two groups of banks. The first group of banks are under the supervision of the SSM due to the systemic structure (SSM-banks) and a cluster of control banks that are less systemic but will continue to be monitored by their respective national supervisory authorities (non-SSM banks) (Sáiz et al., 2019).

Accordingly, Fiordelisi et al. (2017) shed light on the impact of SSM and argue that the regulation has instigated a reduction in lending for SSM-banks relative to the control banks monitored by their respective national authorities. More specifically, the reduction in lending activity by the SSM-monitored banks occurs due to the introduction of the Capital Assessment programme announced in late 2013. The SSM-monitored banks reduce bank lending to enhance their capital foundations, preparing them for the Capital Assessment programme, which was part of the SSM. The paper points out that although the SSM framework was established to increase financial resilience and improve supervisory oversight by the authorities, there has been an unintended impact on lending activity. Consequently, banks seek to reduce loan originations and loan loss reserves to help support capital formation in anticipation of the Capital Assessment programme.

In line with Avgeri et al. (2021), the paper also implies that the effect of incoming regulations can often produce unexpected externalities due to the nature of the regulations. As shown by Fiordelisi et al. (2017), the introduction of the SSM may have influenced lending activity in the latest years as opposed to the stress testing framework that the respective chapter considers.

Table 4.9: EU Stress Testing on Bank Lending – Year by Year (GIIPS) – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are total loans, mortgage loans, consumer loans, corporate loans, and bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %	**Mortgage loans change %**	**Corporate loans change %**	**Consumer loans change %**	**Bank loans change %**
*Stress Bank EBA * Post Stress Period 2009*	3.91	58.81	50.07*	24.89	0.68
	(6.03)	(38.73)	(29.90)	(25.37)	(7.97)
*Stress Bank EBA * Post Stress Period 2010*	3.34	34.72**	6.82	14.62	9.90
	(4.13)	(13.75)	(13.81)	(9.69)	(8.56)
*Stress Bank EBA * Post Stress Period 2011*	-0.54	27.11**	-18.59	-25.37	-18.64**
	(3.00)	(13.00)	(16.25)	(23.69)	(9.11)
*Stress Bank EBA * Post Stress Period 2012*	-0.30	17.34	1.32	9.45	-8.87
	(3.17)	(11.75)	(10.36)	(18.73)	(6.00)
*Stress Bank EBA * Post Stress Period 2013*	1.66	24.12**	-10.03	6.61	-8.61
	(3.19)	(11.54)	(12.14)	(14.26)	(8.25)
*Stress Bank EBA * Post Stress Period 2014*	3.18	21.03*	1.87	13.73	-9.65
	(4.76)	(11.62)	(10.03)	(14.64)	(7.48)
*Stress Bank EBA * Post Stress Period 2015*	2.63	19.04*	-8.01	8.65	-7.31
	(3.32)	(11.46)	(11.05)	(14.09)	(7.47)
*Stress Bank EBA * Post Stress Period 2016*	0.18	15.85	-8.26	10.58	2.66
	(3.43)	(11.26)	(11.87)	(14.89)	(8.96)
*Stress Bank EBA * Post Stress Period 2017*	-0.23	16.88	-5.06	13.05	-7.34
	(3.10)	(10.92)	(10.66)	(16.23)	(7.07)
*Stress Bank EBA * Post Stress Period 2018*	-1.20	9.01	35.50	25.38	-0.87
	(3.35)	(10.78)	(28.16)	(22.02)	(8.04)
*Stress Bank EBA * Post Stress Period 2009 * GIIPS*	-14.34**	-57.03	-65.79**	-19.78	6.25
	(6.51)	(36.04)	(28.41)	(23.67)	(11.67)
*Stress Bank EBA * Post Stress Period 2010 * GIIPS*	-11.38**	-25.02*	-25.19*	-8.49	-4.11
	(4.93)	(13.81)	(14.59)	(13.83)	(13.18)
*Stress Bank EBA * Post Stress Period 2011 * GIIPS*	-11.30***	4.92	-48.20**	17.71	27.61*
	(4.14)	(21.37)	(19.65)	(19.77)	(16.65)
*Stress Bank EBA * Post Stress Period 2012 * GIIPS*	-3.64	-22.82*	-47.01***	0.32	8.53
	(6.56)	(12.46)	(13.88)	(20.25)	(10.89)

*Stress Bank EBA * Post Stress Period 2013 * GIIPS*	-2.63	-15.34	-16.01	10.45	-14.47
	(5.81)	(13.22)	(16.13)	(17.03)	(8.81)
*Stress Bank EBA * Post Stress Period 2014 * GIIPS*	-9.48	-25.87**	-30.93**	-0.54	13.43
	(5.78)	(12.87)	(13.85)	(17.46)	(8.58)
*Stress Bank EBA * Post Stress Period 2015 * GIIPS*	-11.00*	-30.54**	-14.88	-4.86	7.54
	(6.02)	(13.17)	(24.44)	(17.98)	(9.18)
*Stress Bank EBA * Post Stress Period 2016 * GIIPS*	-8.76**	-26.27**	-38.82**	5.47	-6.28
	(4.40)	(12.01)	(15.90)	(18.46)	(12.13)
*Stress Bank EBA * Post Stress Period 2017 * GIIPS*	-8.47**	-26.03**	-32.03**	-7.12	-1.68
	(3.77)	(13.00)	(14.48)	(19.17)	(8.40)
*Stress Bank EBA * Post Stress Period 2018 * GIIPS*	-11.46**	-26.40**	-66.48**	-33.34	-1.79
	(4.61)	(12.35)	(30.71)	(25.03)	(10.45)
Constant	121.11***	323.80***	299.16***	242.80	23.48
	(35.86)	(95.96)	(114.10)	(153.33)	(48.29)
Observations	2,232	909	1,173	1,280	2,215
R-Squared	0.13	0.14	0.09	0.04	0.04
Number of banks	259	140	183	195	-
Bank fixed effects	YES	YES	YES	YES	-
Time fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES
Mean VIF	1.61	1.67	1.73	1.67	1.62
Sargen-Hansen Test (p-value)	270.865 (0.0000)	56.941 (0.0000)	65.613 (0.0000)	47.048 (0.0001)	-
Model Used	FE	FE	FE	FE	OLS

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

4.5.2 Difference-in-Difference Specification: Credit Risk

A contribution to the literature is that I intend to disentangle the effect of stress testing on bank behaviour. Acharya et al. (2018) explain that the rationale behind the stress-tested banks' decision to reduce bank lending is associated with mitigating a banks' credit risk profile. Nonetheless, the drawback of their analysis is that they do not test for this hypothesis and question the validity of their assumption. Consequently, the next step is to assess if stress testing affects credit risk.

The empirical results adopt a similar approach to the aforementioned bank lending subsection. I also implement the difference-in-difference strategy and conduct the same econometric models but substitute the dependent variables for credit risk proxied by the non-performing loan ratio[23].

Table 4.10 reports the effect of stress testing on the non-performing loans ratio, Model (1) presents the primary difference-in-difference interaction of key interest. I find statistically significant results, where stress-tested banks have experienced an increase in the non-performing loan ratio by 2 p.p. compared to non-stress tested banks. The hypothesis by Acharya et al. (2018) suggests that banks are reducing their loans to mitigate potential credit risk issues. Although, the results show that this is not the case because rather than managing credit risk problems, the stress-tested banks are experiencing greater credit risk problems than non-stress tested banks.

In Model (2), I include the effect of the stress-tested banks that are deemed to have inadequate capital levels via the triple difference-in-difference interaction but find no statistically significant results.

To account for the stress-tested banks that reside from GIIPS countries, I use an alternative triple difference-in-difference interaction and find statistically significant results that mainly corroborate our findings for the loan growth subsection. I see an increase in credit risk by 9 p.p. for stress-tested banks from GIIPS than non-GIIPS stress-tested banks, thus suggesting noticeable differences among stress-tested banks, supporting the hypothesis outlined in the research objectives.

[23] Further robustness tests account for different proxies of credit risk of the bank in question, and are reported in the Robustness tests section below.

Table 4.10: EU Stress Testing on Credit Risk – Difference in Difference Specification

The table reports the effect of the EBA's supervisory stress testing on credit risk, using the difference-in-difference specification. The dependent variable is the non-performing loan ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Non-performing loans ratio %				
	(1)	(2)	(3)	(4)	(5)
Size	0.22	0.22	0.12	0.17	-0.01
	(1.03)	(1.04)	(0.96)	(1.05)	(0.98)
Profitability	-3.06***	-3.03***	-2.79***	-3.08***	-2.86***
	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)
Efficiency	-1.03***	-1.03***	-0.94***	-1.11***	-0.94***
	(0.39)	(0.39)	(0.33)	(0.39)	(0.33)
Capital	0.60***	0.60***	0.57***	0.61***	0.62***
	(0.18)	(0.18)	(0.17)	(0.18)	(0.17)
Liquidity	-0.03	-0.03	-0.04	-0.03	-0.05*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Funding	-0.06**	-0.06**	-0.07**	-0.06**	-0.07**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Economic conditions (Unemployment)	0.67***	0.67***	0.68***	0.67**	0.68***
	(0.26)	(0.26)	(0.25)	(0.26)	(0.26)
Economic conditions (Bank Rate)	-0.14	-0.14	-0.19	-0.35*	0.18
	(0.21)	(0.21)	(0.20)	(0.19)	(0.17)
*Stress Bank EBA * Post Stress Period EBA*	2.44**	2.39**	-0.92		
	(1.22)	(1.21)	(0.58)		
*Stress Bank EBA * Post Stress Period EBA * ST Failed*		2.66			
		(1.85)			
*Stress Bank EBA * Post Stress Period EBA * GIIPS*			9.03***		
			(2.37)		
*ST Failed * Post Stress Period EBA*				3.10*	
				(1.84)	
*GIIPS * Post Stress Period EBA*					6.32***
					(1.22)
Constant	-1.45	-1.51	0.06	-0.34	0.06
	(12.72)	(12.75)	(11.73)	(12.85)	(12.14)

Observations	2,261	2,261	2,261	2,261	2,261
R-Squared	0.30	0.30	0.35	0.30	0.35
Number of banks	261	261	261	261	261
Bank fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
Mean VIF	1.53	1.49	1.62	1.43	1.48
Sargen-Hansen Test (p-value)	44.285 (0.0000)	48.821 (0.0000)	47.636 (0.0000)	48.875 (0.0000)	42.843 (0.0000)
Model Used	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Moreover, I also study the dynamic analysis of each year after the stress testing regime for the non-performing loan ratio, to ascertain if there are significant results across the period or if the effectiveness of the stress testing exercises is beginning to dampen over time. Table 4.11 reports the dynamic analysis of each year after the first stress testing period, and I find there are significant results for most of the years since the exercises. Specifically, for 2011 and 2012, there is growth in the non-performing loans ratio for the stress-tested banks relative to the non-stress tested banks by 1.88 p.p. and 1.94 p.p., respectively. Furthermore, the results show that for 2013, 2014, and 2018 there was an increase in the non-performing loans ratio for the stress-tested banks.

Table 4.11: EU Stress Testing on Bank Lending – Difference in Difference Specification

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are total loans, mortgage loans, consumer loans, corporate loans, and bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include robust standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Non-performing loans ratio %
*Stress Bank EBA * Post Stress Period 2009*	0.07
	(0.51)
*Stress Bank EBA * Post Stress Period 2010*	0.47
	(0.52)
*Stress Bank EBA * Post Stress Period 2011*	1.88**
	(0.80)
*Stress Bank EBA * Post Stress Period 2012*	1.94**
	(0.97)
*Stress Bank EBA * Post Stress Period 2013*	3.81**
	(1.52)
*Stress Bank EBA * Post Stress Period 2014*	3.83**
	(1.88)
*Stress Bank EBA * Post Stress Period 2015*	2.49
	(1.67)
*Stress Bank EBA * Post Stress Period 2016*	2.31
	(1.51)
*Stress Bank EBA * Post Stress Period 2017*	2.13
	(1.72)
*Stress Bank EBA * Post Stress Period 2018*	3.31*
	(1.70)
Constant	-3.79
	(12.82)
Observations	2,261
R-Squared	0.31
Number of banks	261
Bank fixed effects	YES
Time fixed effects	YES
Country fixed effects	YES
Control variables	YES

Mean VIF	1.33
Sargen-Hansen Test (p-value)	52.810 (0.0000)
Model Used	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.12 reports the effect of the triple difference-in-difference interaction, which inspects banks with inadequate capital levels when stressed against the adverse scenarios set by the EBA. I assess if there are significant findings for these banks across time. Interestingly, banks with inadequate capital levels will experience a fall in credit risk issues by 6 p.p. compared to banks with adequate capital levels concerning the adverse scenario in 2012. Initially, this result may make intuitive sense because banks that are seen to be weaker than the stronger banks will look to adjust their business activity or balance sheet to act more prudently, which may help alleviate any credit risk concerns that can hamper bank profitability or activity. As the effect of the 2012 year is affected by the 2011 EBA stress test, I highlight the study by Petrella and Resti (2013), who document that the 2011 EU stress test was significantly enhanced in contrast to the 2010 stress test. The earliest 2011 stress test that first introduced the CET1 ratio as a capital threshold was prominent in influencing bank behaviour to such an extent that weaker banks with proven inadequate capital levels behaved prudently and focused on mitigating credit risk issues.

However, the weaker banks' efforts in reducing credit risk are only evident for one year. Table 4.12 reports that in 2015, credit risk for weaker banks increased by 10 p.p. compared to the stronger banks. The results imply differences across periods, and banks with inadequate capital levels will experience greater credit risk issues in the later exercises.

Table 4.12: EU Stress Testing on Credit Risk – Year by Year (Failed) – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on credit risk, using the difference-in-difference specification. The dependent variable is the non-performing loan ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Non-performing loans ratio %
*Stress Bank EBA * Post Stress Period 2009*	0.08
	(0.51)
*Stress Bank EBA * Post Stress Period 2010*	0.48
	(0.52)
*Stress Bank EBA * Post Stress Period 2011*	1.88**
	(0.80)
*Stress Bank EBA * Post Stress Period 2012*	2.42**
	(1.08)
*Stress Bank EBA * Post Stress Period 2013*	3.80**
	(1.51)
*Stress Bank EBA * Post Stress Period 2014*	3.85**
	(1.89)
*Stress Bank EBA * Post Stress Period 2015*	1.47
	(1.43)
*Stress Bank EBA * Post Stress Period 2016*	2.32
	(1.52)
*Stress Bank EBA * Post Stress Period 2017*	2.12
	(1.72)
*Stress Bank EBA * Post Stress Period 2018*	3.31*
	(1.71)
*Stress Bank EBA * Post Stress Period 2009 * ST Failed*	-
*Stress Bank EBA * Post Stress Period 2010 * ST Failed*	-
*Stress Bank EBA * Post Stress Period 2011 * ST Failed*	-
*Stress Bank EBA * Post Stress Period 2012 * ST Failed*	-6.34***
	(2.20)
*Stress Bank EBA * Post Stress Period 2013 * ST Failed*	-

*Stress Bank EBA * Post Stress Period 2014 * ST Failed*	-
*Stress Bank EBA * Post Stress Period 2015 * ST Failed*	10.08***
	(2.68)
*Stress Bank EBA * Post Stress Period 2016 * ST Failed*	-
*Stress Bank EBA * Post Stress Period 2017 * ST Failed*	-
*Stress Bank EBA * Post Stress Period 2018 * ST Failed*	-
Constant	-1.72
	(11.92)
Observations	2,261
R-Squared	0.32
Number of banks	261
Bank fixed effects	YES
Time fixed effects	YES
Country fixed effects	YES
Control variables	YES
Mean VIF	-
Sargen-Hansen Test (p-value)	-
Model Used	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

The results of stress-tested banks headquartered in the GIIPS countries are reported in table 4.13, which confirm strong results for the GIIPS stress-tested banks relative to non-GIIPS stress-tested banks. For every year since the inception of the stress testing exercises, the GIIPS stress-tested banks non-performing loans ratio is higher than the non-GIIPS stress-tested banks. For example, table 4.13 shows that for 2009, the non-performing loan ratio was 1.37 p.p. higher than the alternative stress-tested banks. Furthermore, for the consecutive years, I find that the magnitude of the non-performing loan ratio increases significantly across all periods relative to the 2009 period. In 2014, the non-performing loan ratio was 14.22 p.p. higher than banks from non-GIIPS countries. More importantly, the results show fundamental differences across stress-tested banks, and there is discernible heterogeneity among banks. Table 4.9 shows that the GIIPS stress-tested banks reduce lending with respect to total loans, mortgage loans, and corporate loans. Although, I find that the credit risk of the stress-tested banks, more specifically GIIPS banks, do not manage credit risk as expected but rather experience a rise in credit risk difficulties. The results can indeed be attributed to the elevated levels of sovereign risk among the GIIPS countries, thus prompting further regulatory debate.

Table 4.13: EU Stress Testing on Credit Risk – Year by Year (GIIPS) – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on credit risk, using the difference-in-difference specification. The dependent variable is the non-performing loan ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Non-performing loans ratio %
*Stress Bank EBA * Post Stress Period 2009*	-0.54
	(0.59)
*Stress Bank EBA * Post Stress Period 2010*	-0.03
	(0.57)
*Stress Bank EBA * Post Stress Period 2011*	0.04
	(0.62)
*Stress Bank EBA * Post Stress Period 2012*	-0.40
	(0.63)
*Stress Bank EBA * Post Stress Period 2013*	-0.43
	(0.75)
*Stress Bank EBA * Post Stress Period 2014*	-1.44*
	(0.80)
*Stress Bank EBA * Post Stress Period 2015*	-2.54***
	(0.84)
*Stress Bank EBA * Post Stress Period 2016*	-2.02**
	(0.90)
*Stress Bank EBA * Post Stress Period 2017*	-2.14***
	(0.78)
*Stress Bank EBA * Post Stress Period 2018*	-1.05
	(0.74)
*Stress Bank EBA * Post Stress Period 2009 * GIIPS*	1.37**
	(0.64)
*Stress Bank EBA * Post Stress Period 2010 * GIIPS*	1.09*
	(0.61)
*Stress Bank EBA * Post Stress Period 2011 * GIIPS*	4.70***
	(1.48)
*Stress Bank EBA * Post Stress Period 2012 * GIIPS*	6.18***
	(1.87)
*Stress Bank EBA * Post Stress Period 2013 * GIIPS*	11.24***
	(3.03)

*Stress Bank EBA * Post Stress Period 2014 * GIIPS*	14.22***
	(3.84)
*Stress Bank EBA * Post Stress Period 2015 * GIIPS*	13.69***
	(3.26)
*Stress Bank EBA * Post Stress Period 2016 * GIIPS*	11.67***
	(2.80)
*Stress Bank EBA * Post Stress Period 2017 * GIIPS*	11.38***
	(3.52)
*Stress Bank EBA * Post Stress Period 2018 * GIIPS*	11.60***
	(3.30)
Constant	0.07
	(10.96)
Observations	2,261
R-Squared	0.39
Number of banks	261
Bank fixed effects	YES
Time fixed effects	YES
Country fixed effects	YES
Control variables	YES
Mean VIF	1.63
Sargen-Hansen Test (p-value)	61.639 (0.0000)
Model Used	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

4.5.3 Stress Test Exposure: Loan Growth

The second stage of the empirical analysis reviews the effect of stress testing by constructing the stress test exposure variable[24]. For this section of the empirical results, I isolate the 39 stress-tested banks from the total sample of banks. Principally, the main objective is to examine the 39 stress-tested and assess if there are heterogeneities among the stress-tested banks. The main method of defining the heterogeneity among stress-tested banks is to compare banks with a high-stress test exposure against a low-stress test exposure. I argue that banks with a high-stress test exposure will reduce lending more relative to low-stress test exposure, as these banks are in a difficult financial position due to the adverse scenario. Cortés et al. (2019) include an analogous variable with respect to our stress test exposure variables, although the authors combine the different capital ratios into one capital ratio. However, I diverge from the method adopted by Cortés et al. (2019) and preserve the capital variables that the EBA records, and ensure the inclusion of each capital variable (CET1 capital, Tier 1 capital, and Total capital) separately.

Table 4.14 reports the effect of the stress test exposure. I first consider the Total capital ratio which is recorded and publicly disclosed in all EBA stress testing frameworks from the start until the present period. Table 4.14 includes two model specifications for each dependent variable of interest to the research. Model (1) shows that banks designated as those who have a high-stress test exposure for the Total capital variable, and shows that these clusters of banks will reduce by 5.22 p.p. relative to those who have a low-stress test exposure for the Total capital variable. The result shows that the stress test heavily affects weaker performing banks.

In regards to Model (2), I include a bank being designated as having a high-stress test exposure and belonging to the GIIPS region. There are no statistical differences among high-exposure GIIPS banks and the remaining banks. Besides, the table shows the first stress test exposure variable loses its statistical significance.

With respect to mortgage loans, I find statistically significant results between two groups of stress-tested banks included in the high-stress test exposure. The results show that being a highly exposed bank and part

[24] Recall, the stress test exposure is calculated as the difference between the capital ratio of the bank before entering the stress test and after the stress test.

of the GIIPS region, mortgage loan originations decline by roughly 17 p.p. relative to the banks that are non-GIIPS. Interestingly, the effect of stress testing for mortgage originations seems to show contrasting findings. There are heterogeneities among stress-tested banks, indicating that the banks' country of origin could be a crucial element determining the change in loans. The results contribute to the literature and show there are differences among stress-tested banks that could be influenced by other factors such as where the bank operates.

For Banks loan change, there are statistically significant results for the high-stress test exposure, meaning that banks that fare worse from the stress test will increase bank loans by 13 p.p. compared to banks with low-stress test exposure. The behaviour of these groups of banks who increase bank loans by 13 p.p. compared to low-stress exposure banks may be due to a 'flight to quality' for these banks, who may desire to improve their composition of less-risky assets on their balance sheets.

As explained in the first empirical stage of the regressions, I also find that a select few of the banking characteristics are statistically significant when observing the sample of 39 banks. Concerning the majority of the independent variables reported in Table 4.14, the size of the bank has a negative correlation with the increase in loans. For instance, a 1% increase in the banks' size will cause a 19 p.p. reduction in total loan originations. Profitability affects loan growth positively for total loans change. The bank's efficiency shows an expected result, where an increase in bank efficiency (otherwise defined as a rise in banking expenses) will lead to a decline in lending for total loans and mortgage loans. Bank capital also inhibits bank lending. The capital buffers will be built to absorb losses or meet capital regulations, thus suggesting that banks will have fewer funds to lend to customers. Roulet (2018) documents the consequence of increases in capital reserves by European banks and notes that increases in capital negatively affect bank lending originations. The Bank rate set by the ECB negatively affects total lending, as Model (1) reports that a rise in the Euro rate by 1% will lead to a decrease in total lending by approximately 8 p.p.

I do not discuss the results of explanatory variables for the succeeding sections for brevity.

Table 4.14: EU Stress Testing on Bank Lending – Stress Test Exposure – Above - Difference in Total Capital

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the stress test exposure specification. The dependent variables are total loans, mortgage loans, consumer loans, corporate loans, and bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The stress test exposure concerning Total capital, is defined as the difference between the pre-stress test Total capital ratio and the post-stress test Total capital ratio. The stress test exposure – above, is designated as 1 for the banks that are above the median for stress test exposure. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main stress test exposure - above variable. Model (2) includes all controls, the main stress test exposure - above variable, and the main stress test exposure - above variable with GIIPS interaction. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %		**Mortgage loans change %**		**Corporate loans change %**		**Consumer loans change %**		**Bank loans change %**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Size	-19.15***	-18.28***	-36.87*	-3.74	-19.18	-19.92	-11.37**	-11.45**	-3.03	-3.04
	(5.89)	(5.46)	(19.09)	(2.93)	(20.76)	(20.01)	(4.91)	(4.89)	(5.05)	(5.09)
Profitability	2.70*	3.07*	3.94	-1.75	-1.21	-2.70	0.64	1.19	-1.08	-0.73
	(1.57)	(1.63)	(2.54)	(3.04)	(4.30)	(4.72)	(3.47)	(3.55)	(7.52)	(7.50)
Credit risk	0.28	0.41*	-0.12	-0.28	-0.08	-0.17	0.66	0.69	0.23	0.43
	(0.20)	(0.21)	(0.50)	(0.43)	(0.74)	(0.77)	(1.10)	(1.10)	(0.76)	(0.78)
Efficiency	-2.87*	-2.84*	-4.11***	-1.88**	-2.21	-1.81	-1.39	-1.54	-0.19	-0.31
	(1.59)	(1.59)	(1.16)	(0.74)	(3.77)	(3.62)	(5.11)	(5.12)	(3.30)	(3.36)
Capital	-2.03***	-2.38***	-3.48***	-1.49	1.40	1.20	-4.15	-4.12	-2.79	-3.08
	(0.70)	(0.73)	(0.85)	(1.24)	(2.79)	(2.76)	(2.74)	(2.76)	(2.72)	(2.67)
Liquidity	0.21	0.22	0.34	0.12	0.42	0.45	0.29	0.30	-0.60	-0.56
	(0.18)	(0.18)	(0.35)	(0.17)	(0.63)	(0.64)	(0.42)	(0.42)	(0.55)	(0.56)
Funding	-0.26	-0.17	-0.99*	0.15	-0.03	-0.26	0.11	0.18	-0.26	-0.22
	(0.25)	(0.26)	(0.50)	(0.16)	(0.96)	(0.98)	(0.58)	(0.60)	(0.41)	(0.41)
Economic conditions (Unemployment)	-0.63	-0.40	-0.34	0.48	7.23	6.00	-4.59	-3.97	-1.98	-1.69
	(0.92)	(0.90)	(1.30)	(1.38)	(6.65)	(5.68)	(3.12)	(3.23)	(3.93)	(3.91)
Economic conditions (Bank Rate)	-7.70**	-7.33**	-7.81	1.77	12.13	0.98	-27.39**	-24.25**	14.93	15.29
	(3.08)	(3.02)	(5.87)	(8.62)	(20.53)	(15.11)	(12.56)	(11.84)	(9.95)	(9.98)
Stress test exposure – Above - Difference in Total capital	-5.22**	-3.48	-5.36	-0.49	14.16	0.88	3.96	7.97	10.32	13.40*
	(2.39)	(2.46)	(3.18)	(4.32)	(15.33)	(8.97)	(6.07)	(6.96)	(6.63)	(7.13)
*Stress test exposure – Above - Difference in Total capital * GIIPS*		-5.96		-17.46*		28.17		-9.28		-9.80
		(3.59)		(9.69)		(21.73)		(8.00)		(12.77)
Constant	270.45***	253.96***	541.30**	44.60	135.16	175.96	193.81**	182.95**	92.51	85.73
	(85.57)	(80.36)	(254.07)	(40.71)	(239.81)	(240.90)	(83.23)	(85.70)	(87.11)	(87.46)
Observations	149	149	80	80	85	85	90	90	145	145
R-Squared	0.20	0.22	0.56	0.39	0.23	0.26	0.29	0.30	0.21	0.22
Number of banks	39	39	27	-	-	-	-	-	-	-
Bank fixed effects	YES	YES	YES	-	-	-	-	-	-	-

Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.92	2.05	2.14	2.30	2.21	2.35	2.06	2.20	1.89	2.03
Sargen-Hansen Test (p-value)	35.921 (0.0000)	39.298 (0.0000)	32.854 (0.0003)	-	-	-	-	-	-	-
Model Used	FE	FE	FE	OLS	OLS	OLS	OLS	OLS	OLS	OLS

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

In the subsequent tables, I modify the econometric model by examining slight variations of the stress testing exposure variable. Table 4.15 offers an alternative perspective on the effect of stress testing compared to the previous table by focusing on the Tier 1 capital ratio. The results show that the effect of stress testing on bank lending is not similar to the results shown in table 4.14. The majority of the table show insignificant results.

Table 4.15: EU Stress Testing on Bank Lending – Stress Test Exposure – Above - Difference in Tier 1 Capital

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the stress test exposure specification. The dependent variables are total loans, mortgage loans, consumer loans, corporate loans, and bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The stress test exposure concerning Tier 1 capital, is defined as the difference between the pre-stress test Tier 1 capital ratio and the post-stress test Tier 1 capital ratio. The stress test exposure – above, is designated as 1 for the banks that are above the median for stress test exposure. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main stress test exposure - above variable. Model (2) includes all controls, the main stress test exposure - above variable, and the main stress test exposure - above variable with GIIPS interaction. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %		**Mortgage loans change %**		**Corporate loans change %**		**Consumer loans change %**		**Bank loans change %**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Size	-18.82***	-18.82***	-37.44*	-39.31*	-17.52	-16.25	-10.83**	-10.65**	-2.90	-3.00
	(6.49)	(6.44)	(20.53)	(20.75)	(20.63)	(20.04)	(4.83)	(4.71)	(5.09)	(5.12)
Profitability	2.53	2.63	3.75	4.36	-2.30	-4.60	1.15	0.82	-0.91	-0.03
	(1.64)	(1.79)	(2.76)	(2.84)	(4.62)	(5.87)	(3.48)	(3.59)	(7.59)	(7.56)
Credit risk	0.25	0.27	-0.11	-0.06	-0.13	-0.24	0.69	0.67	0.22	0.55
	(0.20)	(0.23)	(0.53)	(0.54)	(0.71)	(0.74)	(1.09)	(1.08)	(0.74)	(0.73)
Efficiency	-3.11	-3.12	-4.31***	-4.48***	-2.39	-1.49	-1.74	-1.64	0.03	0.05
	(2.02)	(2.00)	(1.42)	(1.40)	(3.57)	(3.32)	(5.16)	(5.26)	(3.28)	(3.40)
Capital	-1.95***	-2.02**	-3.33***	-3.48***	1.75	2.29	-4.45	-4.38	-2.60	-3.17
	(0.69)	(0.75)	(0.77)	(0.79)	(2.71)	(3.08)	(2.90)	(2.80)	(2.71)	(2.68)
Liquidity	0.23	0.23	0.28	0.34	0.52	0.43	0.22	0.20	-0.58	-0.48
	(0.19)	(0.20)	(0.37)	(0.38)	(0.61)	(0.65)	(0.42)	(0.44)	(0.56)	(0.57)
Funding	-0.30	-0.29	-0.99*	-1.01*	0.06	-0.12	0.15	0.12	-0.25	-0.22
	(0.26)	(0.27)	(0.56)	(0.55)	(0.91)	(0.88)	(0.58)	(0.57)	(0.41)	(0.41)
Economic conditions (Unemployment)	-0.67	-0.66	-0.30	-0.24	9.36	8.44	-6.66*	-6.84*	-0.99	-0.85
	(0.96)	(0.96)	(1.56)	(1.57)	(8.09)	(7.42)	(3.54)	(3.70)	(4.22)	(4.20)
Economic conditions (Bank Rate)	-5.46*	-5.48*	-1.98	-1.85	11.88	8.82	-38.57**	-38.98**	14.46	13.96
	(2.96)	(2.96)	(4.29)	(4.25)	(16.08)	(14.31)	(15.39)	(15.77)	(9.78)	(9.71)
Stress test exposure – Above - Difference in Tier 1 capital	-1.70	-1.38	0.10	1.17	14.92	6.40	-7.46	-8.58	8.82	13.98*
	(2.53)	(2.36)	(2.21)	(2.47)	(12.05)	(8.55)	(6.19)	(8.18)	(6.77)	(7.21)
*Stress test exposure – Above - Difference in Tier 1 capital * GIIPS*		-0.94		-4.12		23.94		3.18		-15.61
		(4.13)		(4.28)		(20.97)		(9.47)		(12.39)
Constant	265.78***	265.47***	545.06*	567.78*	82.90	88.40	217.09**	218.18**	77.91	73.85
	(93.35)	(92.95)	(276.26)	(279.09)	(245.97)	(242.62)	(92.55)	(93.76)	(89.89)	(89.50)
Observations	149	149	80	80	85	85	90	90	145	145
R-Squared	0.16	0.16	0.53	0.54	0.23	0.26	0.30	0.30	0.21	0.22
Number of banks	39	39	27	27	-	-	-	-	-	-
Bank fixed effects	YES	YES	YES	YES	-	-	-	-	-	-

Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.97	2.09	2.17	2.30	2.27	2.39	2.16	2.28	1.96	2.09
Sargen-Hansen Test (p-value)	34.829 (0.0001)	35.050 (0.0001)	52.898 (0.0000)	88.070 (0.0000)	-	-	-	-	-	-
Model Used	FE	FE	FE	FE	OLS	OLS	OLS	OLS	OLS	OLS

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Following the same approach, I now evaluate the same econometric strategy but construct our stress test exposure variable to reflect the effect of stress testing on bank lending via the changes in the CET1 ratio. One disadvantage of using the CET1 ratio is that the earliest stress testing framework (2010) did not include the ratio for each participating bank in the respective stress test, thus limiting the number of data observations (relative to the Total capital and Tier 1 ratio). With this caveat in mind, I report the effect of stress testing on bank lending by examining the CET1 ratio in table 4.16. I see sufficient evidence to show a change in consumer lending growth by banks that are highly exposed to the stress test. Highly-exposed banks will reduce consumer lending by approximately 13 p.p. The result provides strong evidence to infer that there are differences among stress-tested banks, where highly-exposed banks will alter lending behaviour compared to less exposed banks. Similar to the results in table 4.15, I also find that highly-exposed banks will choose to increase their bank loan originations by approximately 19 p.p. relative to less exposed banks.

Table 4.16: EU Stress Testing on Bank Lending – Stress Test Exposure – Above - Difference in CET1 Capital

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the stress test exposure specification. The dependent variables are total loans, mortgage loans, consumer loans, corporate loans, and bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The stress test exposure concerning CET1 capital, is defined as the difference between the pre-stress test CET1 capital ratio and the post-stress test CET1 capital ratio. The stress test exposure – above, is designated as 1 for the banks that are above the median for stress test exposure. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main stress test exposure - above variable. Model (2) includes all controls, the main stress test exposure - above variable, and the main stress test exposure - above variable with GIIPS interaction. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %		**Mortgage loans change %**		**Corporate loans change %**		**Consumer loans change %**		**Bank loans change %**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Size	-30.42**	-28.23**	-47.55**	-46.59**	-15.55	-15.09	-39.00***	-44.96***	-12.71	-8.50
	(14.41)	(13.07)	(22.15)	(20.68)	(19.86)	(19.44)	(13.78)	(15.03)	(22.03)	(20.87)
Profitability	4.97**	5.33**	3.48	3.94	0.94	0.10	-4.25	-4.68	9.42	10.14
	(2.00)	(2.11)	(2.57)	(2.73)	(5.22)	(5.11)	(3.89)	(3.72)	(5.65)	(6.04)
Credit risk	0.34	0.34	-0.26	-0.22	-0.16	-0.22	0.47	0.51	0.66	0.64
	(0.47)	(0.45)	(0.46)	(0.46)	(0.73)	(0.78)	(0.73)	(0.71)	(1.05)	(1.03)
Efficiency	-3.89*	-3.73	-4.85***	-4.67***	-1.28	-1.37	-25.01***	-24.61***	-3.86	-3.56
	(2.30)	(2.22)	(1.75)	(1.57)	(5.44)	(4.91)	(3.49)	(3.50)	(3.77)	(3.77)
Capital	-2.75*	-2.87*	-1.27	-1.46	0.70	0.62	-4.26**	-3.95*	-5.29*	-5.48*
	(1.58)	(1.57)	(1.40)	(1.40)	(2.42)	(2.41)	(2.08)	(2.06)	(2.86)	(2.81)
Liquidity	0.14	0.13	0.85**	0.83**	0.29	0.36	0.60	0.67	-0.31	-0.30
	(0.29)	(0.29)	(0.39)	(0.37)	(0.63)	(0.64)	(0.45)	(0.46)	(0.90)	(0.90)
Funding	-0.63	-0.55	-0.88	-0.81	-0.29	-0.38	1.05	0.68	-0.47	-0.30
	(0.43)	(0.40)	(0.56)	(0.49)	(1.14)	(1.13)	(0.65)	(0.75)	(0.88)	(0.83)
Economic conditions (Unemployment)	-0.78	-0.52	-0.46	-0.26	8.81	7.89	-7.32*	-7.99*	0.99	1.56
	(1.20)	(1.18)	(1.60)	(1.58)	(7.79)	(6.93)	(4.27)	(4.16)	(4.97)	(4.82)
Economic conditions (Bank Rate)	-6.27**	-6.05**	-2.26	-2.15	1.66	1.31	0.18	-0.70	2.90	3.36
	(2.94)	(2.96)	(2.77)	(2.82)	(6.16)	(6.14)	(5.10)	(5.31)	(5.27)	(5.17)
Stress test exposure – Above - Difference in CET1 capital	-1.05	0.77	-3.87	-2.08	14.37	5.47	-12.63*	-16.78*	18.75***	22.50***
	(2.29)	(2.78)	(3.20)	(2.92)	(12.73)	(7.75)	(7.34)	(9.36)	(6.36)	(5.82)
*Stress test exposure – Above - Difference in CET1 capital * GIIPS*		-5.29		-5.77		21.44		13.35		-10.55
		(3.96)		(5.20)		(21.17)		(8.32)		(10.13)
Constant	435.98**	402.56**	638.74**	622.95**	99.91	111.42	567.45**	660.63***	198.51	132.84
	(194.27)	(174.99)	(296.51)	(274.60)	(246.91)	(247.77)	(212.23)	(233.06)	(316.73)	(297.74)
Observations	110	110	73	73	79	79	84	84	107	107
R-Squared	0.32	0.34	0.55	0.56	0.21	0.23	0.51	0.54	0.14	0.15
Number of banks	39	39	27	27			33	33	38	38
Bank fixed effects	YES	YES	YES	YES	-	-	YES	YES	YES	YES

Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.93	2.05	2.19	2.34	2.26	2.39	2.17	2.29	1.93	2.07
Sargen-Hansen Test (p-value)	17.537 (0.0409)	22.557 (0.0125)	23.378 (0.0094)	76.687 (0.0000)	-	-	92.673 (0.0000)	78.479 (0.0000)	16.780 (0.0523)	18.173 (0.0521)
Model Used	FE	FE	FE	FE	OLS	OLS	FE	FE	FE	FE

Clustered Standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

4.5.4 Stress Test Exposure: Credit Risk

In this section, I first report the effect of being highly exposed to the stress test, using the total capital ratio of the banks. The results show no statistically significant differences between highly-exposed stress-tested and less exposed banks (table 4.17).

In Model (2), there are differences between GIIPS and non-GIIPS banks that are highly-exposed, where GIIPS banks will experience rises in credit risk compared to non-GIIPS banks by 3.5 p.p. Unsurprisingly, the result aligns with the findings shown in table 4.10, which identifies that stress-tested banks that from GIIPS, face greater credit risk problems. The respective finding is also corroborated by the dynamic analysis shown in table 4.13, in which all periods yield statistically significant results.

Table 4.17: EU Stress Testing on Credit Risk - Stress Test Exposure – Above - Difference in Total Capital

The table reports the effect of the EBA's supervisory stress testing on credit risk, using the stress test exposure specification. The dependent variable is the non-performing loan ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The stress test exposure concerning Total capital, is defined as the difference between the pre-stress test Total capital ratio and the post-stress test Total capital ratio. The stress test exposure – above, is designated as 1 for the banks that are above the median for stress test exposure. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main stress test exposure - above variable. Model (2) includes all controls, the main stress test exposure - above variable, and the main stress test exposure - above variable with GIIPS interaction. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Non-performing loans ratio %	
	(1)	(2)
Size	5.22	3.96
	(4.52)	(4.51)
Profitability	-4.70***	-4.61***
	(1.21)	(1.19)
Efficiency	-0.66	-0.67
	(0.51)	(0.49)
Capital	2.00***	2.09***
	(0.57)	(0.56)
Liquidity	0.09	0.08
	(0.08)	(0.08)
Funding	-0.02	-0.10
	(0.12)	(0.12)
Economic conditions (Unemployment)	1.37***	1.08***
	(0.35)	(0.38)
Economic conditions (Bank Rate)	2.24**	1.88*
	(0.97)	(0.99)
Stress test exposure – Above - Difference in Total capital	0.88	-0.25
	(0.56)	(0.67)
*Stress test exposure – Above - Difference in Total capital * GIIPS*		3.50**
		(1.71)
Constant	-85.31	-63.29
	(62.24)	(60.60)
Observations	149	149
R-Squared	0.47	0.51
Number of banks	39	39
Bank fixed effects	YES	YES
Time fixed effects	YES	YES
Country fixed effects	YES	YES
Mean VIF	2.04	2.12
Sargen-Hansen Test (p-value)	54.921	53.958
	(0.0000)	(0.0000)
Model Used	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

The effect of stress testing on credit risk is defined by the Tier 1 capital ratio reported in table 4.18. Model (1) suggests that highly-exposed stress-tested banks face a rise in credit risk problems as proxied by the non-performing loans ratio relative to those less exposed banks. Highly exposed banks will find that their credit risk issues increase by 1.8 p.p. compared to their counterparts. Consequently, this result may suggest the stress testing exercises are causing further issues to banks that are participants of the EBA stress testing framework. Model (2) addresses the differences among highly-exposed banks that are GIIPS and non-GIIPS. The result shows inherent differences between these two sets of banks, as GIIPS banks will experience a rise in credit risk by 3.4 p.p. compared to non-GIIPS banks. The result verifies our hypothesis, which proposes that stress-tested banks are not homogenous, and differences between stress-tested banks will become apparent as I conduct the econometric regressions. In retrospect, I find that there are differences among countries in the EU. Table 4.19 reports the same econometric model but substitutes the main variable for capturing the variations in the CET1 ratio for the sample of the banks. Although, there are no statistical results.

Table 4.18: EU Stress Testing on Credit Risk - Stress Test Exposure – Above - Difference in Tier 1 Capital

The table reports the effect of the EBA's supervisory stress testing on credit risk, using the stress test exposure specification. The dependent variable is the non-performing loan ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The stress test exposure concerning Tier 1 capital, is defined as the difference between the pre-stress test Tier 1 capital ratio and the post-stress test Tier 1 capital ratio. The stress test exposure – above, is designated as 1 for the banks that are above the median for stress test exposure. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main stress test exposure - above variable. Model (2) includes all controls, the main stress test exposure - above variable, and the main stress test exposure - above variable with GIIPS interaction. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Non-performing loans ratio %	
	(1)	(2)
Size	5.62	4.70
	(4.67)	(4.84)
Profitability	-4.63***	-4.64***
	(1.19)	(1.16)
Efficiency	-0.66	-0.61
	(0.48)	(0.48)
Capital	2.04***	2.15***
	(0.56)	(0.54)
Liquidity	0.09	0.06
	(0.08)	(0.07)
Funding	-0.03	-0.08
	(0.13)	(0.13)
Economic conditions (Unemployment)	1.59***	1.36***
	(0.41)	(0.39)
Economic conditions (Bank Rate)	2.89***	2.73***
	(0.85)	(0.85)
Stress test exposure – Above - Difference in Tier 1 capital	1.80**	0.45
	(0.73)	(0.60)
*Stress test exposure – Above - Difference in Tier 1 capital * GIIPS*		3.39*
		(1.73)
Constant	-92.73	-76.97
	(64.65)	(65.96)
Observations	149	149
R-Squared	0.49	0.52
Number of banks	39	39
Bank fixed effects	YES	YES
Time fixed effects	YES	YES
Country fixed effects	YES	YES
Mean VIF	2.11	2.19
Sargen-Hansen Test (p-value)	57.087 (0.0000)	64.761 (0.0000)
Model Used	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.19: EU Stress Testing on Credit Risk - Stress Test Exposure – Above - Difference in CET1 Capital

The table reports the effect of the EBA's supervisory stress testing on credit risk, using the stress test exposure specification. The dependent variable is the non-performing loan ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The stress test exposure concerning CET1 capital, is defined as the difference between the pre-stress test CET1 capital ratio and the post-stress test CET1 capital ratio. The stress test exposure – above, is designated as 1 for the banks that are above the median for stress test exposure. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main stress test exposure - above variable. Model (2) includes all controls, the main stress test exposure - above variable, and the main stress test exposure - above variable with GIIPS interaction. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Non-performing loans ratio %	
	(1)	(2)
Size	3.11	3.45
	(4.75)	(4.76)
Profitability	-2.73**	-2.68**
	(1.22)	(1.16)
Efficiency	-0.47	-0.45
	(0.44)	(0.44)
Capital	2.60***	2.58***
	(0.51)	(0.49)
Liquidity	0.15	0.14
	(0.09)	(0.09)
Funding	-0.05	-0.03
	(0.14)	(0.13)
Economic conditions (Unemployment)	1.08***	1.12***
	(0.26)	(0.30)
Economic conditions (Bank Rate)	3.26***	3.29***
	(0.76)	(0.78)
Stress test exposure – Above - Difference in CET1 capital	-0.10	0.19
	(0.67)	(0.78)
*Stress test exposure – Above - Difference in CET1 capital * GIIPS*		-0.85
		(1.42)
Constant	-60.18	-65.41
	(64.62)	(65.12)
Observations	110	110
R-Squared	0.62	0.62
Number of banks	39	39
Bank fixed effects	YES	YES
Time fixed effects	YES	YES
Country fixed effects	YES	YES
Mean VIF	2.05	2.15
Sargen-Hansen Test (p-value)	104.572 (0.0000)	121.109 (0.0000)
Model Used	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

4.6 Robustness Tests

I focus solely on two alternative proxies for credit risk for robustness checks: loan loss provisions and loan loss reserves ratio. Table 4.20 reports the results of the alternative specifications where the results exhibit similar findings.

The loan loss provisions ratio for stress-tested banks increases by 1.73 p.p. relative to non-stress tested banks, which opposes the hypothesis assumed by Acharya et al. (2018). In addition, there are differences among stress-tested banks among EU countries. The GIIPS stress-tested countries observe an increase in their loan loss provisions ratio by 0.93 p.p. and their loan loss reserve ratio by 3.42 p.p. compared to non-GIIPS stress-tested banks.

I further break down the main stress testing difference-in-difference specification to assess if there are important differences between the control group and treatment bank across each year since the beginning of the stress testing programme (dynamic analysis). There has been an evident increase in credit risk issues for the stress-tested banks for the majority of the years compared to the non-stress tested banks. Table 4.21 reports the loan loss provisions and loan loss reserves ratio changes for all banks and documents statistically significant results for nearly all years. The results strongly oppose the notion that the stress testing tool is losing its effectiveness as a policy tool and the hypothesis proposed by Acharya et al. (2018).

Table 4.22 reports the effect of failing the stress test or the result of a bank deemed to have inadequate capital levels compared to their peers who participate in the stress test. As seen with the main findings, inadequate banks will reduce the loan loss reserves ratio to maintain credit risk issues. However, this result is short-lived because, for the succeeding years, I find that the cause of the 2014 stress test leads to a rise in credit risk problems for banks that experience capital inadequate levels.

As expected, there are also inherent differences among GIIPS stress-tested banks and non-GIIPS stress-tested banks. These are in line with the results reported in the main section of our empirical results. Table 4.23 reports credit risk has been rising for the GIIPS banks relative to non-GIIPS stress-tested banks. The results confirm the hypothesis that there are differences among stress-tested banks, which are driven by different elements such as the country characteristics.

The main baseline regressions consider 39 stress-tested banks, as each bank has been tested in every EBA stress testing exercise since its inception. In the robustness section, I also develop an additional stress testing group that expands on the original group. The new stress-tested group comprises 82 banks, where each bank has been stressed by the EBA at least once, is a part of the Orbis Bank Focus database, and is above the 10 BN EUR threshold. The results of these bank focus on the bank lending variables using the difference-in-difference specification for brevity. I find similar results to the baseline model but caution against the results (tables 4.24 - 4.26). The stress-tested banks tested routinely and those tested at least once will behave differently, given that they are subject to varying regulations.

Table 4.20: EU Stress Testing on Credit Risk – LLP and LLR – Difference in Difference Specification

The table reports the effect of the EBA's supervisory stress testing on credit risk, using the difference-in-difference specification. The dependent variables are the Loan Loss Provisions and Loan Loss Reserves ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Loan Loss Provisions Ratio %					**Loan Loss Reserves Ratio %**				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Size	0.12	0.12	0.10	0.11	0.08	0.14	0.14	0.10	0.12	0.07
	(0.12)	(0.12)	(0.12)	(0.12)	(0.11)	(0.36)	(0.36)	(0.34)	(0.37)	(0.36)
Profitability	-0.32***	-0.30***	-0.29***	-0.30***	-0.29***	-1.46***	-1.45***	-1.36***	-1.47***	-1.37***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
Efficiency	-0.09**	-0.09**	-0.08**	-0.09**	-0.08**	-0.39**	-0.39**	-0.36**	-0.42**	-0.35**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.17)	(0.16)	(0.14)	(0.17)	(0.14)
Capital	0.02	0.03	0.02	0.03	0.03	0.27***	0.27***	0.26***	0.27***	0.27***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Liquidity	-0.01**	-0.01*	-0.01**	-0.01*	-0.01**	-0.00	-0.00	-0.00	0.00	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Funding	-0.01	-0.01*	-0.01*	-0.01	-0.01*	-0.01	-0.01	-0.01	-0.01	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Economic conditions (Unemployment)	0.13**	0.13**	0.13**	0.13**	0.13**	0.26***	0.26***	0.27***	0.26***	0.27***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Economic conditions (Bank Rate)	0.02	0.01	0.01	-0.00	0.06**	-0.03	-0.03	-0.04	-0.10	0.10
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.08)	(0.09)	(0.08)	(0.08)	(0.07)
*Stress Bank EBA * Post Stress Period EBA*	0.19	0.15	-0.16			0.97**	0.95**	-0.30		
	(0.16)	(0.15)	(0.12)			(0.47)	(0.47)	(0.35)		
*Stress Bank EBA * Post Stress Period EBA * ST Failed*		1.73**					0.99			
		(0.69)					(1.20)			
*Stress Bank EBA * Post Stress Period EBA * GIIPS*			0.93***					3.42***		
			(0.27)					(0.88)		
*ST Failed * Post Stress Period EBA*				1.76**					1.17	
				(0.69)					(1.19)	
*GIIPS * Post Stress Period EBA*					0.72***					2.67***

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					(0.15)					(0.48)
Constant	-1.22	-1.24	-1.01	-1.15	-0.99	-1.75	-1.77	-1.22	-1.41	-1.42
	(1.49)	(1.49)	(1.42)	(1.47)	(1.37)	(4.51)	(4.51)	(4.22)	(4.60)	(4.44)
Observations	2,130	2,130	2,130	2,130	2,130	2,341	2,341	2,341	2,341	2,341
R-Squared	0.16	0.18	0.18	0.18	0.19	0.34	0.34	0.37	0.33	0.39
Number of banks	274	274	274	274	274	270	270	270	270	270
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.51	1.48	1.60	1.43	1.45	1.52	1.49	1.61	1.43	1.49
Sargen-Hansen Test (p-value)	59.696	69.699	56.817	74.066	53.979	51.699	66.740	52.721	70.057	45.264
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Model Used	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.21: EU Stress Testing on Credit Risk – LLP and LLR – Year by Year – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on credit risk, using the difference-in-difference specification. The dependent variables are the Loan Loss Provisions and Loan Loss Reserves ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Loan Loss Provisions ratio %	**Loan Loss Reserves ratio %**
*Stress Bank EBA * Post Stress Period 2009*	0.28*	0.08
	(0.15)	(0.21)
*Stress Bank EBA * Post Stress Period 2010*	0.20	0.15
	(0.17)	(0.22)
*Stress Bank EBA * Post Stress Period 2011*	0.64**	0.82**
	(0.26)	(0.40)
*Stress Bank EBA * Post Stress Period 2012*	0.12	0.65
	(0.18)	(0.49)
*Stress Bank EBA * Post Stress Period 2013*	0.26	1.42***
	(0.17)	(0.54)
*Stress Bank EBA * Post Stress Period 2014*	0.47*	1.47**
	(0.27)	(0.69)
*Stress Bank EBA * Post Stress Period 2015*	0.51*	1.06
	(0.30)	(0.68)
*Stress Bank EBA * Post Stress Period 2016*	0.18	1.07*
	(0.19)	(0.61)
*Stress Bank EBA * Post Stress Period 2017*	-0.03	1.02
	(0.19)	(0.69)
*Stress Bank EBA * Post Stress Period 2018*	0.18	1.31*
	(0.16)	(0.70)
Constant	-1.18	-2.47
	(1.39)	(4.56)
Observations	2,130	2,341
R-Squared	0.17	0.34
Number of banks	274	270
Bank fixed effects	YES	YES
Time fixed effects	YES	YES
Country fixed effects	YES	YES
Mean VIF	1.33	1.33
Sargen-Hansen Test (p-value)	1601.800	61.188
	(0.0000)	(0.0000)
Model Used	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.22: EU Stress Testing on Credit Risk – LLP and LLR – Year by Year (Failed) – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on credit risk, using the difference-in-difference specification. The dependent variables are the Loan Loss Provisions and Loan Loss Reserves ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Loan Loss Provisions ratio %	**Loan Loss Reserves ratio %**
*Stress Bank EBA * Post Stress Period 2009*	0.28*	0.09
	(0.15)	(0.21)
*Stress Bank EBA * Post Stress Period 2010*	0.20	0.16
	(0.17)	(0.22)
*Stress Bank EBA * Post Stress Period 2011*	0.64**	0.82**
	(0.26)	(0.40)
*Stress Bank EBA * Post Stress Period 2012*	0.10	0.84
	(0.17)	(0.53)
*Stress Bank EBA * Post Stress Period 2013*	0.26	1.42***
	(0.17)	(0.54)
*Stress Bank EBA * Post Stress Period 2014*	0.47*	1.48**
	(0.27)	(0.70)
*Stress Bank EBA * Post Stress Period 2015*	0.19	0.66
	(0.23)	(0.59)
*Stress Bank EBA * Post Stress Period 2016*	0.18	1.07*
	(0.19)	(0.62)
*Stress Bank EBA * Post Stress Period 2017*	-0.03	1.02
	(0.19)	(0.69)
*Stress Bank EBA * Post Stress Period 2018*	0.18	1.31*
	(0.16)	(0.71)
*Stress Bank EBA * Post Stress Period 2009 * ST Failed*	-	-
*Stress Bank EBA * Post Stress Period 2010 * ST Failed*	-	-
*Stress Bank EBA * Post Stress Period 2011 * ST Failed*	-	-
*Stress Bank EBA * Post Stress Period 2012 * ST Failed*	0.34	-2.58*
	(0.26)	(1.40)

*Stress Bank EBA * Post Stress Period 2013 * ST Failed*	-	-
*Stress Bank EBA * Post Stress Period 2014 * ST Failed*	-	-
*Stress Bank EBA * Post Stress Period 2015 * ST Failed*	2.87***	3.98***
	(0.83)	(1.39)
*Stress Bank EBA * Post Stress Period 2016 * ST Failed*	-	-
*Stress Bank EBA * Post Stress Period 2017 * ST Failed*	-	-
*Stress Bank EBA * Post Stress Period 2018 * ST Failed*	-	-
Constant	-0.89	-1.68
	(1.34)	(4.36)
Observations	2,130	2,341
R-Squared	0.20	0.35
Number of banks	274	270
Bank fixed effects	YES	YES
Time fixed effects	YES	YES
Country fixed effects	YES	YES
Mean VIF	-	-
Sargen-Hansen Test (p-value)	-	-
Model Used	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.23: EU Stress Testing on Credit Risk – LLP and LLR – Year by Year (GIIPS) – Difference in Difference Specification

The table reports the dynamic effect of the EBA's supervisory stress testing on credit risk, using the difference-in-difference specification. The dependent variables are the Loan Loss Provisions and Loan Loss Reserves ratio. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The Stress Bank EBA variable is a dummy variable designated as 1 for 39 banks and 0 for the remaining banks. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. The Post Stress Period for each year changes, and examines the first year of stress testing, until the most current period. For example, the Post Stress Period 2009 is designated as 1 for 2009 and 0 for the remaining years. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Loan Loss Provisions ratio %	**Loan Loss Reserves ratio %**
*Stress Bank EBA * Post Stress Period 2009*	0.22	-0.04
	(0.13)	(0.27)
*Stress Bank EBA * Post Stress Period 2010*	0.01	0.01
	(0.14)	(0.28)
*Stress Bank EBA * Post Stress Period 2011*	0.12	0.26
	(0.16)	(0.36)
*Stress Bank EBA * Post Stress Period 2012*	-0.21	0.04
	(0.15)	(0.43)
*Stress Bank EBA * Post Stress Period 2013*	-0.06	0.05
	(0.17)	(0.51)
*Stress Bank EBA * Post Stress Period 2014*	-0.02	-0.50
	(0.24)	(0.50)
*Stress Bank EBA * Post Stress Period 2015*	-0.17	-0.88*
	(0.20)	(0.48)
*Stress Bank EBA * Post Stress Period 2016*	-0.15	-0.68
	(0.16)	(0.52)
*Stress Bank EBA * Post Stress Period 2017*	-0.28**	-0.75*
	(0.14)	(0.41)
*Stress Bank EBA * Post Stress Period 2018*	-0.04	-0.38
	(0.16)	(0.36)
*Stress Bank EBA * Post Stress Period 2009 * GIIPS*	0.15	0.24
	(0.32)	(0.30)
*Stress Bank EBA * Post Stress Period 2010 * GIIPS*	0.47	0.32
	(0.35)	(0.32)
*Stress Bank EBA * Post Stress Period 2011 * GIIPS*	1.36**	1.41
	(0.54)	(0.87)
*Stress Bank EBA * Post Stress Period 2012 * GIIPS*	0.86***	1.55
	(0.29)	(1.08)

*Stress Bank EBA * Post Stress Period 2013 * GIIPS*	0.83***	3.61***
	(0.27)	(0.93)
*Stress Bank EBA * Post Stress Period 2014 * GIIPS*	1.33**	5.34***
	(0.55)	(1.30)
*Stress Bank EBA * Post Stress Period 2015 * GIIPS*	1.83***	5.31***
	(0.64)	(1.30)
*Stress Bank EBA * Post Stress Period 2016 * GIIPS*	0.89**	4.73***
	(0.36)	(1.08)
*Stress Bank EBA * Post Stress Period 2017 * GIIPS*	0.67**	4.76***
	(0.32)	(1.40)
*Stress Bank EBA * Post Stress Period 2018 * GIIPS*	0.53*	4.52***
	(0.29)	(1.47)
Constant	-0.92	-0.74
	(1.35)	(3.95)
Observations	2,130	2,341
R-Squared	0.20	0.41
Number of banks	274	270
Bank fixed effects	YES	YES
Time fixed effects	YES	YES
Country fixed effects	YES	YES
Mean VIF	1.62	1.62
Sargen-Hansen Test (p-value)	2455.446 (0.0000)	56.962 (0.0000)
Model Used	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.24: EU Stress Testing on Bank Lending – Difference in Difference Specification – 82 stress-tested banks

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are total loans and mortgage loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The 82 Stress Bank EBA variable is a dummy variable designated as 1 for 82 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Total loans change %					**Mortgage loans change %**				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Size	-12.39***	-12.39***	-12.39***	-12.18***	-12.19***	-25.56***	-25.56***	-25.42***	-25.90***	-25.20***
	(2.83)	(2.83)	(2.83)	(2.78)	(2.81)	(8.78)	(8.80)	(8.52)	(8.50)	(8.21)
Profitability	0.17	0.13	0.17	0.17	0.22	-1.96	-1.96	-1.89	-1.94	-1.94
	(0.85)	(0.85)	(0.85)	(0.86)	(0.86)	(2.15)	(2.17)	(2.14)	(2.20)	(2.15)
Credit risk	-0.14	-0.13	-0.14	-0.16	-0.17	-0.79**	-0.79**	-0.85**	-0.76**	-0.86**
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.34)	(0.33)	(0.34)	(0.31)	(0.33)
Efficiency	0.05	0.04	0.05	0.14	0.15	-2.66	-2.66	-2.62	-2.81	-2.62
	(1.37)	(1.37)	(1.37)	(1.39)	(1.39)	(4.87)	(4.88)	(4.78)	(4.52)	(4.49)
Capital	-0.06	-0.06	-0.06	-0.03	-0.02	1.18	1.18	1.24	1.15	1.27
	(0.39)	(0.39)	(0.39)	(0.39)	(0.39)	(1.45)	(1.45)	(1.45)	(1.44)	(1.45)
Liquidity	0.18**	0.18**	0.18**	0.18**	0.18**	0.72**	0.72**	0.71**	0.71**	0.71**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.30)	(0.30)	(0.30)	(0.30)	(0.29)
Funding	0.17*	0.17*	0.17*	0.17**	0.17**	-0.34	-0.34	-0.36	-0.33	-0.34
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.27)	(0.27)	(0.28)	(0.27)	(0.27)
Economic conditions (Unemployment)	-0.03	-0.04	-0.03	0.00	0.01	-3.84	-3.84	-3.80	-3.86	-3.75
	(1.11)	(1.11)	(1.11)	(1.11)	(1.12)	(2.74)	(2.74)	(2.73)	(2.75)	(2.73)
Economic conditions (Bank Rate)	2.86***	2.87***	2.86***	3.43***	3.46***	0.82	0.82	0.72	0.14	1.16
	(0.87)	(0.87)	(0.87)	(0.74)	(0.77)	(2.54)	(2.54)	(2.58)	(1.94)	(2.03)
*82 Stress Bank EBA * Post Stress Period EBA*	-3.96*	-3.92*	-4.01*			4.72	4.72	0.38		
	(2.20)	(2.20)	(2.38)			(12.99)	(13.00)	(15.08)		
*82 Stress Bank EBA * Post Stress Period EBA * ST Failed*		-4.06					0.26			
		(5.34)					(7.73)			
*82 Stress Bank EBA * Post Stress Period EBA * GIIPS*			0.15					10.50		
			(2.86)					(10.64)		
*ST Failed * Post Stress Period EBA*				-4.42					0.41	

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				(5.39)					(7.67)	
*GIIPS * Post Stress Period EBA*					0.36					12.40
					(2.51)					(8.02)
Constant	124.10***	124.16***	124.19***	119.61***	119.56***	314.25***	314.28***	313.70***	320.31***	308.06***
	(35.20)	(35.21)	(35.12)	(34.34)	(34.41)	(101.75)	(102.05)	(98.64)	(96.45)	(92.29)
Observations	2,232	2,232	2,232	2,232	2,232	909	909	909	909	909
R-Squared	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11
Number of banks	259	259	259	259	259	140	140	140	140	140
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.47	1.44	1.53	1.39	1.43	1.44	1.41	1.56	1.35	1.42
Sargen-Hansen Test (p-value)	53.906	55.129	54.629	52.350	49.901	28.226	29.515	29.171	29.905	29.334
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0017)	(0.0019)	(0.0021)	(0.0009)	(0.0011)
Model Used	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.25: EU Stress Testing on Bank Lending – Difference in Difference Specification - 82 stress-tested banks (continued)

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variables are corporate loans and consumer loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The 82 Stress Bank EBA variable is a dummy variable designated as 1 for 82 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include clustered standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Corporate loans change %					**Consumer loans change %**				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Size	-37.40***	-37.23***	-37.66***	-34.99***	-35.86***	-21.69**	-21.65**	-21.07**	-21.39**	-20.79**
	(8.38)	(8.46)	(8.62)	(8.57)	(8.72)	(10.00)	(10.01)	(10.06)	(10.15)	(10.21)
Profitability	-2.70	-3.03	-2.73	-2.92	-2.62	1.26	1.11	1.39	1.13	1.32
	(2.41)	(2.43)	(2.43)	(2.41)	(2.40)	(2.20)	(2.25)	(2.16)	(2.24)	(2.16)
Credit risk	-0.32	-0.38	-0.31	-0.50*	-0.40	-0.56	-0.59	-0.60	-0.63	-0.66
	(0.26)	(0.28)	(0.26)	(0.27)	(0.25)	(0.60)	(0.61)	(0.63)	(0.61)	(0.63)
Efficiency	-0.84	-0.88	-1.04	-0.71	-0.93	-3.89	-3.91	-3.28	-3.76	-3.32
	(4.95)	(4.94)	(5.04)	(5.23)	(5.25)	(4.47)	(4.46)	(4.60)	(4.51)	(4.62)
Capital	1.23	1.24	1.23	1.36	1.33	1.49	1.49	1.50	1.53	1.61
	(0.85)	(0.85)	(0.85)	(0.86)	(0.86)	(1.55)	(1.55)	(1.55)	(1.52)	(1.52)
Liquidity	1.19***	1.20***	1.20***	1.22***	1.22***	0.20	0.20	0.19	0.20	0.20
	(0.32)	(0.32)	(0.33)	(0.33)	(0.33)	(0.32)	(0.32)	(0.31)	(0.32)	(0.31)
Funding	0.46	0.47	0.47	0.44	0.42	-0.40	-0.40	-0.42	-0.41	-0.41
	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)	(0.36)	(0.37)	(0.36)	(0.36)	(0.36)
Economic conditions (Unemployment)	-1.47	-1.43	-1.47	-1.34	-1.40	-2.31	-2.30	-2.27	-2.28	-2.21
	(5.35)	(5.35)	(5.35)	(5.35)	(5.35)	(5.00)	(5.00)	(5.01)	(5.01)	(5.01)
Economic conditions (Bank Rate)	-4.66	-4.55	-4.63	-1.39	-2.26	-5.34	-5.30	-5.37	-4.56	-3.51
	(4.24)	(4.23)	(4.26)	(4.45)	(4.60)	(3.69)	(3.69)	(3.66)	(3.00)	(3.11)
*82 Stress Bank EBA * Post Stress Period EBA*	-23.26**	-22.95**	-21.34**			-5.61	-5.48	-13.34		
	(9.45)	(9.45)	(8.99)			(11.01)	(11.00)	(12.91)		
*82 Stress Bank EBA * Post Stress Period EBA * ST Failed*		-21.88***					-10.58			
		(8.14)					(11.61)			
*82 Stress Bank EBA * Post Stress Period EBA * GIIPS*			-5.95					20.37		
			(10.11)					(15.80)		
*ST Failed * Post Stress Period EBA*				-22.40***					-10.73	

				(8.14)					(11.68)	
*GIIPS * Post Stress Period EBA*					-8.66					10.88
					(9.59)					(10.39)
Constant	360.26***	357.89***	363.11***	325.47***	338.00***	269.90*	269.20*	262.79*	264.52*	253.41*
	(115.37)	(116.24)	(117.34)	(116.91)	(118.61)	(143.20)	(143.37)	(143.77)	(145.74)	(146.90)
Observations	1,173	1,173	1,173	1,173	1,173	1,280	1,280	1,280	1,280	1,280
R-Squared	0.06	0.07	0.06	0.06	0.06	0.03	0.03	0.03	0.03	0.03
Number of banks	183	183	183	183	183	195	195	195	195	195
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean VIF	1.44	1.41	1.52	1.35	1.41	1.41	1.38	1.49	1.32	1.37
Sargen-Hansen Test (p-value)	41.039	43.719	43.602	34.862	29.575	21.215	21.684	22.698	21.530	24.805
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0010)	(0.0196)	(0.0269)	(0.0195)	(0.0177)	(0.0057)
Model Used	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

*Clustered Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4.26: EU Stress Testing on Bank Lending – Difference in Difference Specification - 82 stress-tested banks (continued)

The table reports the effect of the EBA's supervisory stress testing on bank lending, using the difference-in-difference specification. The dependent variable is bank loans. The explanatory variables include Size of the bank (natural log of total assets), Profitability (Return on Assets), Credit Risk (non-performing loan ratio), Efficiency (operating expenses over total assets), Capital (equity over total assets). The Liquidity variable (liquid assets over total assets), and the Funding variable (customer deposits over total assets). For macroeconomic variables, I include two Economic conditions variables (proxied by the Unemployment rate and Euro bank rate). All control variables are lagged by one period. The 82 Stress Bank EBA variable is a dummy variable designated as 1 for 82 banks and 0 for the remaining banks. The Post Stress Period EBA is a time dummy variable and is designated as 1 for 2010-2018 and 0 for 2006-2009. The ST Failed (inadequate capital) variable is a dummy variable that is designated as 1 for the banks that fall below the 5.5% CET1 threshold, post-stress test, and 0 for banks that are above the threshold. The GIIPS variable is designated as 1 for Greece, Ireland, Italy and Spain, and 0 for the remaining countries. Model (1) includes all controls and the main difference-in-difference interaction. Model (2) includes all controls, the main difference-in-difference interaction, and the triple difference-in-difference to control for the effects of failing (inadequate capital) the stress test. Model (3) includes all control variables, the main difference-in-difference interaction, and an alternative triple difference-in-difference to control for the effect of being a stress-tested bank that originates from the GIIPS region. Bank fixed effects, time fixed effects, and country fixed effects are controlled for in all models but are not reported. All models include robust standard errors, which are reported in parentheses. Table 4.3 reports the description and summary statistics for all variables.

	Bank loans change %				
	(1)	(2)	(3)	(4)	(5)
Size	-1.62	-1.63	-1.57	-2.78***	-2.79***
	(1.04)	(1.05)	(1.04)	(0.87)	(0.87)
Profitability	1.63	1.53	1.73	1.64	1.78
	(1.92)	(1.93)	(1.91)	(1.94)	(1.92)
Credit risk	0.21	0.22	0.20	0.19	0.14
	(0.20)	(0.20)	(0.21)	(0.20)	(0.21)
Efficiency	0.19	0.20	0.28	0.13	0.21
	(1.32)	(1.32)	(1.33)	(1.32)	(1.32)
Capital	-0.14	-0.14	-0.16	-0.21	-0.20
	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)
Liquidity	-0.24***	-0.24***	-0.23***	-0.22***	-0.23***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Funding	0.02	0.02	0.02	0.02	0.02
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Economic conditions (Unemployment)	-0.10	-0.10	-0.08	-0.11	-0.09
	(4.49)	(4.49)	(4.49)	(4.50)	(4.50)
Economic conditions (Bank Rate)	-1.33	-1.33	-1.35	-0.42	0.22
	(1.70)	(1.71)	(1.70)	(1.58)	(1.76)
*82 Stress Bank EBA * Post Stress Period EBA*	-7.36**	-7.29**	-8.61***		
	(3.17)	(3.17)	(3.31)		
*82 Stress Bank EBA * Post Stress Period EBA * ST Failed*		-12.35			
		(8.18)			
*82 Stress Bank EBA * Post Stress Period EBA * GIIPS*			3.74		
			(5.13)		
*ST Failed * Post Stress Period EBA*				-13.83*	

				(8.32)	
*GIIPS * Post Stress Period EBA*					7.08
					(6.62)
Constant	28.20	28.38	27.80	38.57	38.52
	(42.19)	(42.21)	(42.16)	(42.44)	(42.45)
Observations	2,215	2,215	2,215	2,215	2,215
R-Squared	0.04	0.04	0.04	0.04	0.04
Number of banks	-	-	-	-	-
Bank fixed effects	-	-	-	-	-
Time fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
Mean VIF	1.46	1.43	1.52	1.38	1.42
Sargen-Hansen Test (p-value)	-	-	-	-	-
Model Used	OLS	OLS	OLS	OLS	OLS

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

4.7 Policy Recommendations

The chapter's results indicate that introducing the stress testing regime inhibits bank lending by the set of stress-tested banks in the sample for the EU. More generally, stress-tested banks are adopting lending practices that are conservative in principle, as I find from the results that the cluster of stress-tested banks is reducing loans, as verified by the supplementary dynamic analysis.

Furthermore, stress-tested banks have noticeably reduced corporate loans relative to non-stress tested banks. The results may posit that the exercises meet their expected objective of prudentially examining banks against an adverse stress scenario. However, one inadvertent effect is a reduction in loans, which may instigate knock-on-effects for the economy, such as reduced investment, thus inhibiting economic growth. At the expense of reduced lending, the regulator's objective is to ensure that banks hold sufficient capital levels to absorb future losses, which ultimately upholds financial stability, a key objective of the stress tests.

The thesis chapter addresses the effect of stress testing on credit risk issues because the literature states that the central reason banks cut back on lending is to manage credit risk issues. On the contrary, this is not the case, where stress-tested banks face greater credit risk challenges, as shown with the set of EU banks that I consider. The key recommendation is that while the stress tests are important in prudentially monitoring banks, I find that the banks face greater credit risk problems, which may indirectly affect the exercises. Thus, regulators must ensure that credit risk problems are maintained (Risk Management Hypothesis).

I hypothesise that there are heterogeneities across the spectrum of the stress-tested banks. I segregate the stress-tested banks into two different regions to test the hypothesis. Namely, those who are members of the GIIPS countries and non-GIIPS countries. When I control for this, I find statistical results showing that GIIPS stress-tested banks reduce more loans and face greater credit risk issues than their counterparts. This distinction is important, as I find that stress-tested banks behave differently due to differing characteristics. Intuitively, there are apparent differences in the effects of the stress testing framework for the banks. Stress testing practices can be open to revisions that may promote or even mitigate credit risk in certain regions like the GIIPS. Leniency in the stress testing exercises (removing hurdle rates) and not failing certain banks, especially in the GIIPS region, can support the stress-tested banks (Shapiro and Zeng, 2019).

4.8 Conclusions

The second empirical chapter continues to build the thesis by following the structure of the first empirical chapter. For the first chapter, I address the possible effects of stress testing on bank lending for the set of UK banks that participate in the BoE's supervisory stress testing. To contribute to the emerging literature that analyses the impact of stress testing on bank lending, for this specific chapter, I focus on a set of EU stress-tested banks that must undergo bi-annual stress tests that the EBA coordinates.

One component of the second empirical chapter included two different methodological approaches that the literature has recently used in isolation but not in conjunction. The methodological approach analyses the differences between similar banks (stress test exposure) and finds potential differences between stress-tested and non-stress tested banks (difference-in-difference specification).

Concerning the difference-in-difference specification, I report statistically significant results to suggest that stress-tested banks reduce corporate loans relative to non-stress tested banks. Furthermore, the results become more interesting as I conduct a dynamic analysis of stress-tested banks, examining bank lending behaviour for each year since the supervisory stress tests.

The second methodological approach isolates the total sample banks to only the stress-tested banks. The key motive behind this is to assess noticeable differences among stress-tested banks. I construct the stress test exposure variable to support the approach, which places banks into two groups. The first group is allocated to banks that are highly exposed to the stress (greater reduction in the capital ratio) and the alternative group that is less exposed to the stress. When applying the variable, I find that highly exposed stress-tested banks will seek to reduce consumer loans, thus showing the influential impact of stress testing on bank lending.

The literature identifies that a possible explanation for the banks' decisions to adjust lending may be linked to credit risk problems. Banks are cutting back on lending to improve credit risk. To validate if this claim is true, I conduct additional analysis to assess if this is the case. Contrary to prior beliefs, the stress-tested banks face greater credit risk problems.

Moreover, I conjecture that not all stress-tested banks in our sample will behave similarly, and there may be underlying factors that influence lending practices or credit risk difficulties. In particular, I divide the stress-tested banks into those originating from the GIIPS region and those in the non-GIIPS region. The results report significant findings which are robust throughout our results. Stress-tested GIIPS banks face a greater reduction in lending and growth in credit risk issues than their counterparts.

Ultimately, I find that a new strand of the literature on stress testing is beginning to analyse the effect of the exercises on bank lending decisions. Although the literature on this is limited, the literature solely focuses on the U.S. banking system. To contribute to the limited literature, in our first and second empirical chapters, I observe the effect of the exercises on lending for the UK and EU banks, respectively.

The primary reason I complete this is to understand better the effects of supervisory stress testing as an overall prudential tool and develop conclusions that may provide significant insight into these exercises' impact on lending. Understanding the general effect of these exercises may foster debate and provide policy recommendations to regulators to advise that there may be a trade-off between reduced bank lending (which can affect GDP growth) and financial stability.

Chapter 5

Bank Diversification, Profitability and Financial Stability: Comparisons Between the GFC and the COVID-19 Pandemic

5.1 Introduction

The COVID-19 pandemic that spread rapidly worldwide has shaped public life. One side of the pandemic relates heavily to the public health crisis, in which cases of rising infection rates have prompted governments to act swiftly. In order to tackle the COVID-19 virus, the first steps undertaken by governments across the world were to impose national lockdowns. In relation to lockdown measures, certain countries across the globe have developed varying lockdown strategies to curb the infection rates. In particular, lockdowns are considered the primary strategy to control the virus, prevent the loss of lives, and reduce pressure on health services.

On the other hand, the pandemic has markedly disrupted the economy, mainly due to national lockdowns. Small and large businesses have been facing the pressure of reduced cash flows as they are forced to remain shut. To ease financial pressure and alleviate businesses' burden. Governments and central banks have acted promptly by devising ad-hoc fiscal and monetary policy measures.

Motivated by the context of the COVID-19 pandemic, the third empirical chapter addresses the impact of bank diversification on bank performance during crisis periods. Specifically, I compare the influence of diversification on bank performance for two crisis periods; the COVID-19 pandemic and the GFC.

In a financial crisis, expansionary monetary policy influences the central bank's base rate. Intuitively, a shift in the base rate profoundly affects bank profitability. I hypothesise that bank diversification supports firm performance during such a crisis characterised by a low-interest-rate environment.

In a scenario where interest income gradually declines, banks that hold alternate assets that are not bound to movements in the interest rate may be comparatively advantageous relative to their peers that engage in traditional banking services. Banks that hold a diverse portfolio can absorb shocks and support businesses, consumers, and households in times of crisis.

The motive to examine diversification as a risk-mitigating tool, particularly during periods of financial crises, is grounded in the literature. In a recent paper, Doerr and Schaz (2021) discuss how bank diversification can support an economy throughout a financial downturn. Suppose banks are geographically diversified (defined by their loan portfolio via cross-border lending). In that case, non-financial firms can access credit from these diversified banks relative to a specialised bank, while a financial crisis persists in the background. Doerr and Schaz (2021) propose that diversified banks can raise a stable funding source that ultimately allows them to allocate their credit to firms in the economy freely.

In a similar vein, diversification benefits during a crisis period such as a recession, can help contain bank risk, shift bank operations to a less-affected region (due to geographical reach), and insulate banks from further shocks (DeLong, 2001). Sanya and Wolfe (2011) suggest that there are discernible benefits of diversification for emerging economies on bank performance. Bank managers choose to diversify their portfolios to shield themselves from macroeconomic shocks, which is followed by a contraction in the interest rates. This, in turn, incentivises banks to pursue other generating lines of revenues[25].

In the case of the Japanese economy, the low-interest-rate environment reduces banks' ability to generate interest income, prompting them to pursue non-interest income activities (Harimaya and Ozaki, 2021). Similarly, for a cluster of large Austrian banks, Rossi et al. (2009) find that diversification can alleviate shortcomings in bank performance when interest rate margins are constrained. Thus, relying on diversification as a risk management strategy in an economic environment characterised by low-interest rate margins.

During the COVID-19 pandemic, the bank's function is to maintain lending, especially for small businesses that require immediate funds. Yet, due to the deteriorating economic environment induced by the public health shock, a rising number of NPLs may materialise in the background. Park and Shin (2021) address the

[25] Although, Sanya and Wolfe (2011) find that a greater reliance on non-interest income for a long period can lead to increased risk. The chapter hypothesises that a reliance on non-interest income is desirable during a time of a financial crisis, predominately when a low-interest-rate environment emerges in the background.

phenomena and argue that the NPLs ratio will inevitably rise, affecting bank performance, such as financial stability. I hypothesise to reduce this risk of rising NPLs on the bank's balance sheet, there are strong motivations to diversify into non-traditional activities that can alleviate financial instability. More broadly, in view of the banks' interests, it may be cost-efficient to alter their business models away from loan origination during a crisis, as the customers' ability to repay loan instalments is impaired. Accordingly, Park and Shin (2021) emphasise the knock-on effect of rising NPLs. First, as the NPLs increase for the largest banks in their respective advanced countries, the large banks will also contract lending to the emerging countries, thus impacting global lending. To resolve the underlying issue, banks must ensure they are financially stable, and this chapter proposes that diversification can support bank performance.

In a similar case, for the EU, the origination and distribution of loans during the COVID-19 pandemic declined markedly. Albeit, the degree of the decline in loan origination differs for each bank. Banks with weaker capital positions decrease their lending but not to the extent of the stronger capitalised banks. The initial results of the pandemic suggest that weaker-capitalised banks continue to borrow to ensure that they do not report loan losses on their balance sheets, thus exacerbating their current capital position difficulties. Özlem Dursun-de Neef and Schandlbauer (2021) argue that weaker banks engage in zombie lending to mitigate financial problems in their balance sheets. In general, continuing traditional banking activities during a crisis can affect financial stability.

In regards to the methodology, I construct the Herherfindahl-Hirschman Index to measure the degree of bank diversification. The index is frequently applied to differentiate the degree of bank diversification by analysing their asset and income data. Furthermore, this chapter relates to the 'Portfolio Theory', which concerns the classic case of whether leaving 'all your eggs in one basket' is a suitable/profitable method for banks to maximise profits and/or minimise idiosyncratic risk. In other words, I hypothesise that during a crisis, it is beneficial to spread 'the eggs' into different baskets to mitigate bank risk.

In the first and second empirical chapters, I particularly focus on a sample of large systemic banks that must undergo routine stress tests by their national regulators. In the spirit of these chapters, I subsequently focus on a set of stress-tested banks that are part of the FED's stress testing framework. I focus on the set of stress-tested banks for two reasons.

First, macroprudential policies that have developed since the subprime crisis have created more robust and stringent regulations that promote financial stability and strengthen a bank's capital position over the last decade. In effect, the impact of the COVID-19 pandemic produces a natural environment to test for the effect of the pandemic on these specific banks, especially since this is a real shock as opposed to the hypothetical shocks that stress-tested banks are examined against. Second, I find that the function of diversification is to reduce the risk for the banks, but does being a participant in the stress tests help manage risk in conjunction with being diversified?

In the first step, I find that diversification supports bank performance (profitability and financial stability), as the empirical results reflect. In a second step, I segment our data to account for the effect of diversification during the GFC and COVID-19 pandemic. In the case of the GFC period, I find that diversification supports profitability and financial stability more significantly than the baseline results, as shown by the magnitudes of the coefficients. Concerning the COVID-19 pandemic, I also document significant results for the relationship between diversification and bank performance.

Interestingly, the results show that banks that are stress-tested and diversified fare better than banks that are not diversified and included in the stress testing frameworks. Hence, the analysis suggests that adopting stronger risk management strategies (diversification) and participating in the stress tests (prudential exercises) is beneficial and can support the economy during crises.

The remainder of the chapter is as follows. The following section outlines the research objectives of the study. Next, I describe the data and methodology of the chapter and discuss the construction of the diversification indicators. I then proceed to estimate our results and discuss the findings of the empirical regressions. The robustness section considers alternative diversification measures and econometric techniques. A brief overview of the policy implications is discussed. Finally, the last section concludes the chapter.

5.2 Research Questions and Objectives

To achieve the research objectives, I first identify the principal questions that the third empirical chapter addresses. The main research questions and objectives are summarised below in ascending order of relevance and focus:

- Does bank diversification improve bank performance?
  - The first research objective is central to the third chapter, in which I intend to assess how a diversified bank (banks' balance sheet) affects bank performance.
  - I define bank performance in two ways: bank profitability and financial stability, crucial metrics for any bank, hence their relevance in the related literature.

- Are there any differences between bank diversification and performance during the GFC and the current COVID-19 pandemic?
  - The second objective is to investigate the effect of bank diversification on performance in two different periods. In summary, I break down our empirical testing to isolate specific periods and focus on the impact of diversification on bank performance in those periods.
  - Was the effect of bank diversification on performance more pronounced during the GFC, as the crisis was financial sector-specific?
  - Does bank diversification play less of a role in the current COVID-19 pandemic due to the crisis being defined as a public health crisis episode rather than a crisis spurred by the financial sector?

- How are the stress-tested banks reacting to the current pandemic?
  - The stress-tested banks are now facing their first real crisis since the GFC. How are these banks performing concerning profitability and financial stability, especially during a period that strains their operational activity?
  - Are there benefits of being stress-tested and highly diversified relative to highly diversified banks but not included in the stress testing programme?
  - I examine if greater scrutiny (stress testing) and stronger risk management (diversification) are pivotal in ensuring bank profitability and financial stability.

5.3 Data

This chapter diverts from the previous empirical chapters and concentrates on the U.S. banking system relative to the subset of UK and EU banks. The previous chapters exclusively use Orbis Bank Focus as the primary database to collect banking data. One noticeable disadvantage of the database is that the data is recorded annually, resulting in limited data and analysis, especially since the WHO (World Health Organisation) formally announced the COVID-19 pandemic in Q1 2020.

To overcome this issue, I focus on U.S. banks that provide quarterly balance sheets reports. I collect information on BHCs (Bank Holding Companies) using the FR Y-9C reports[26], enabling the chapter to analyse more detailed disaggregated data than annual data.

The sample comprises BHCs that hold \$10BN or more in total assets[27]. Selecting the \$10BN threshold enables the chapter to analyse similar large banks. More precisely, the large banks can diversify into other areas, as opposed to smaller banks that may be restricted by regulations or the inability to diversify into non-traditional activities.

As this chapter evaluates the effect of the early stages of the COVID-19 pandemic on bank performance, I initially use the latest data available to me at the time of writing. Therefore, the data spans from 2005 Q1 – 2020 Q4. Overall, I have a total of 183 BHCs, including a subset of stress-tested banks that I analyse in the empirical regressions.

The data is deflated by using a GDP deflator to the reference quarter of 2005 Q1. In addition, to remove potential outliers, the data is winsorised at the 1% and 99% values. The macroeconomic data that I use in subsequent iterations of the econometric testing (not reported in the chapter) are available from the St Louis Federal Reserve website[28].

Table 5.1 provides summary statistics of the main variables, and this also includes the diversification measures, which are explained in further detail in the methodology section. Table 5.2 reports a correlation matrix of

26 Available from https://www.chicagofed.org/banking/financial-institution-reports/bhc-data.

27 The \$10BN threshold is similar to the thresholds that I have used in the previous chapters. In addition, to ensure that I have a similar pool of banks, I use the \$10BN or more threshold as a condition for the banks to be included in our econometric testing. In addition, Laeven and Levine (2007) consider a threshold of \$100MN and more.

28 See https://fred.stlouisfed.org/

the variables used in the chapter. The correlation matrix includes one of the dependent variables that I investigate. In sum, the correlation matrix does not exhibit high correlation values, thus ensuring that the variables do not suffer from multicollinearity.

Table 5.1: Summary Statistics

Variable	**Description**	**Observations**	**Mean**	**Std. Deviation**	**Min**	**Max**
Dependent Variables (Profitability)						
ROA	Net income (profit) / Total Assets. A proxy to measure the profitability of a bank.	5,533	.005025	.0062844	-.0249921	.0250457
ROE	Net income (profit) / Total Equity. An alternate proxy to measure the profitability of a bank.	5,533	.0458379	.0617578	-.2637424	.2062683
Dependent Variables (Financial Stability)						
Risk Adjusted ROA	ROA / Standard Deviation of ROA.	5,488	1.667203	1.450193	-3.203979	5.502575
Risk Adjusted ROE	ROE / Standard Deviation of ROE.	5,488	1.671093	1.472095	-3.342864	5.751921
Z Score	(ROA + Equity) / Standard Deviation of ROA. See the Equity variable below for definition.	5,488	45.66582	34.77271	3.711186	243.1217
Non-Performing Loans	Non-Performing Loans / Total Net Loans	5,533	.0185775	.0224809	.0000671	.1362188
Equity	Total Equity / Total Assets	5,533	.1102209	.0323158	.0125735	.2049682
Independent Variables (Diversification Measures)						
AHHI Main	See Methodology section for a detailed description.	5,533	.3698989	.1245621	-.0537198	.4999312
AHHI Asset	See Methodology section for a detailed description.	5,533	.4132731	.0881119	.09798	.4999313
AHHI Non-Interest	See Methodology section for a detailed description.	5,492	.5131882	.5657695	-3.945264	.819777
Non-Interest Share	See Methodology section for a detailed description.	5,533	.3767726	.2218489	.0050379	.9700041
Independent Variables (Explanatory Variables)						
Size	Natural Logarithm of Total Assets.	5,533	17.65543	1.343344	16.12957	21.40796
Liquidity	Liquid Assets / Total Assets	5,533	.2955821	.1594672	.0581955	.8075061
Equity	Total Equity / Total Assets	5,533	.1102209	.0323158	.0125735	.2049682
Deposits	Deposits / Total Assets	5,533	.6503596	.1999927	.005269	.8977372
GDP Growth	GDP Growth of the U.S. economy	5,533	1.481727	2.376954	-9.032775	4.147747
Subprime Crisis	Dummy variable designated as 1 during Q1 2020 – Q4 2020, and 0 otherwise	5,533	.072655	.2595928	0	1
COVID-19 Crisis	Dummy variable designated as 1 during Q3 2007 – Q4 2008, and 0 otherwise	5,533	.088921	.2846554	0	1

Table 5.2: Correlation Matrix – ROA (Dependent Variable)

	ROA	AHHI Main	Size	Liquidity	Equity	Deposits	GDP Growth	Subprime Crisis	COVID-19 Crisis
ROA	1.0000								
AHHI Main	0.0082	1.0000							
Size	-0.0155	0.2550	1.0000						
Liquidity	-0.0107	0.0441	0.2664	1.0000					
Equity	0.1881	-0.1740	-0.1232	-0.3063	1.0000				
Deposits	0.0288	0.1319	-0.4534	-0.1651	0.1204	1.0000			
GDP Growth	0.2364	0.0429	0.0118	-0.0117	0.0266	-0.0422	1.0000		
Subprime Crisis	-0.1065	0.0712	0.0227	-0.0701	-0.1408	-0.0589	-0.1005	1.0000	
COVID-19 Crisis	-0.0718	-0.0674	-0.0294	0.0449	0.0372	0.0879	-0.6707	-0.0874	1.0000

5.4 Methodology

The chapter examines the effects of bank diversification on bank performance. In general, I inspect bank profitability and financial stability as performance measures.

I employ similar econometric methods used in the related literature to achieve the research objective. Precisely, I implement the two-step System Generalised Method of Moments (GMM) (Arellano and Bond, 1991) using the ‘xtabond2’ command postulated by Roodman (2009), which corrects for endogeneity issues that may arise between the explanatory variables and the error term (Roodman, 2009). The adoption of the dynamic panel data model is used to address possible endogeneity issues that produce bias and inconsistent results. More specifically, the dynamic model includes a lagged dependent variable as an explanatory variable, whereby the econometrician assumes that the lagged dependent variable influences the dependent variable. Moreover, the econometric justification for employing the GMM estimation for the dynamic model is possible as the number of individuals must be larger than the period (N ¿ T).

Furthermore, for the GMM estimation, the steps taken to alleviate endogeneity concerns include using instrumental variables. Where the endogenous regressors are correlated with the error term, the instrumental variables, by nature, should not be correlated with the error term and the dependent variable but rather with the variables considered endogenous. The selection of the instrumental variables may be driven by intuition by the econometrician or influenced by the literature. Besides this, the econometrician conducts a test to ensure that the instrumental variables are valid and that instrumental variables are viable by performing supplementary estimations.

For instance, as I employ the GMM model to test for the effect of diversification on profitability (ROA) which is defined as a flow variable, the literature that similarly examines profitability assumes that the previous period of ROA also impacts the ROA in the current period. In addition, the lagged dependent variable is used as an internal instrumental variable to correct for endogeneity.

Several estimation techniques are also employed to test the validity of the regressors. The estimations examine if variables are endogenous or if the instrumental variables are over-identified, identified, or under-identified by examining the Hansen J and Sargan tests, which are also reported in the tables of the respective chapter.

If, for instance, the dynamic model is over-identified, this would suggest that the number of instrumental variables used within the model is greater than the number of endogenous regressors. In addition, to ensure that the number of instrumental variables is satisfactory, the dynamic model uses estimation techniques to ensure validity. For example, with the GMM estimation, the number of included instrumental variables in the models must be less than the number of individuals in the sample. To achieve this, the xtabond2 command benefits from the 'collapse' function, which ensures that the number of instruments is less than the number of firms (Roodman, 2009).

The economic motivation to include a dynamic panel model for this respective chapter is linked to the literature review, where several papers address the effect of diversification on bank performance measures by similarly using the two-step system GMM estimator. In fact, several papers assume that profitability in the current period is a function of profitability in the previous period by including an autoregressive model, where there is a lag of the dependent variable (Meslier et al., 2014; Lee et al., 2014; Abuzayed et al., 2018).

For stability measures such as risk-adjusted profitability, several papers assume that past values can affect the current or future period (Sissy et al., 2017; Chiorazzo et al., 2018). Given that these papers use such flow variables in their dynamic panel model, this respective chapter considers lagged dependent variables when testing for the effect of diversification on bank performance measures such as bank profitability and financial stability. Furthermore, an economic reason to adopt a similar model enables the chapter's findings to be as similar as possible to the related literature, allowing comparisons between results and ensuring that potential policy implications align.

The GMM estimation also corrects for possible heteroscedasticity and serial correlation issues in the model by using the dynamic panel estimation while accounting for the unobserved heterogeneity within individuals.

Furthermore, the literature on the impact of bank diversification on bank performance largely employs the GMM model (Abuzayed et al., 2018; Adesina, 2021; Moudud-Ul-Huq et al.,2018; Elsas et al., 2010; Sanya and Wolfe, 2011).

It is important to note that the literature does not limit itself to using GMM as the sole econometric model to test bank performance. In addition, alternative econometric techniques such as the FE (Fixed Effect) model and OLS (Ordinary Least Squares) are also proposed (Stiroh and Rumble, 2006). In line with these papers, I additionally use the FE and OLS estimations for the robustness tests. The results from the robustness tests are similar to the baseline results, which indicates that the GMM estimations are robust.

5.4.1 Diversification Measures

In the methodology, I employ several variables to measure bank diversification. These measures for bank diversification are necessary as they are generally employed in the banking literature and simultaneously serve as additional robustness variables. Within this stream of the literature, the Adjusted Herherfindahl-Hirschman Index (AHHI) is commonly accepted as the leading metric to test for how diversified a bank is (Elsas et al., 2010). To construct the AHHI indicator, I use three variations for the AHHI indicator that are included in the models.

The first AHHI indicator is the Income-based indicator (Guerry and Wallmeier, 2017), based on how bank income is generated (interest income or non-interest income). Generally, banks that are heavily dependent on interest income relative to activities that generate non-interest income are viewed as less diversified as their portfolios rely on traditional activities than banks that specialise in non-interest income assets.

I employ this indicator as our primary measure of the AHHI. Figures C1-C4 show the relationship between more diversified banks and those that are less diversified (above and below the median) using the AHHI measure (located in the Appendix section).

To explain how I construct the AHHI indicator, I first outline the steps needed to develop the indicator[29].

[29] Unlike net interest income, I do not produce net non-interest income. There are two reasons for this. First, a bank's non-interest expense is always greater than the non-interest income they generate, so this would result in negative values, which would distort the operating income variable. Secondly, for that sole reason, the literature subsequently uses the non-interest income variable.

$$Net\ Interest\ Income\ =\ Total\ Interest\ Income\ -\ Total\ Interest\ Expenses \tag{5.1}$$

$$Operating\ Income\ =\ Net\ Interest\ Income\ +\ Non\ Interest\ Income \tag{5.2}$$

The AHHI main indicator is calculated below. Higher values of the AHHI indicator suggest that banks are more diversified. Each AHHI main indicator is constructed by averaging the value over the sample period (2005Q1-2020Q4). This provides us with one AHHI value for each bank in our sample. Consequently, in the robustness section, I modify the value by assessing the most diversified banks in the GFC and COVID-19 pandemic.

$$AHHI_{Main}\ =\ 1\ -\ [\left(\frac{Net\ Interest\ Income}{Operating\ Income}\right)^2\ +\ \left(\frac{Non\ Interest\ Income}{Operating\ Income}\right)^2] \tag{5.3}$$

The second AHHI indicator that I construct is the Asset-based variation, which is commonly used in conjunction with the Income-based indicator discussed above. The AHHI Assets indicator takes the following form[30].

$$Total\ Assets\ =\ Total\ Net\ Loans\ +\ Other\ Assets \tag{5.4}$$

$$AHHI_{Asset}\ =\ 1\ -\ [\left(\frac{Other\ Assets}{Total\ Assets}\right)^2\ +\ \left(\frac{Total\ Net\ Loans}{Total\ Assets}\right)^2] \tag{5.5}$$

The final variation of the AHHI indicator is related to the non-interest income component reported in the banks' balance sheets. The variation of this indicator is presented by Abuzayed et al. (2018), although one

[30] The construction of these AHHI variables is highly similar to the variables employed by Laeven and Levine (2007).

benefit of using FR Y-9C reports is that I have access to more disaggregated data. I exploit this advantage and develop a variable that includes more disaggregated data. To my knowledge, this is the first study that provides a highly disaggregated AHHI indicator that is based solely on the net-interest income. Note the sum of all the numerators equals the denominator. The final AHHI indicator is:

$$
\begin{aligned}
AHHI_{Non-Interest} = 1 - [& \left(\frac{Income\ Fiduciary}{Non\ Interest\ Income}\right)^2 + \left(\frac{Services\ Deposit\ Domestic}{Non\ Interest\ Income}\right)^2 \\
& + \left(\frac{Trading\ Revenue}{Non\ Interest\ Income}\right)^2 + \left(\frac{Fees\ Commissions}{Non\ Interest\ Income}\right)^2 \\
& + \left(\frac{Venture\ Capital\ Revenue}{Non\ Interest\ Income}\right)^2 + \left(\frac{Net\ Servicing\ Fees}{Non\ Interest\ Income}\right)^2 \\
& + \left(\frac{Net\ Securitisation\ Income}{Non\ Interest\ Income}\right)^2 + \left(\frac{Net\ Gains\ Loans}{Non\ Interest\ Income}\right)^2 \\
& + \left(\frac{Net\ Gains\ Real\ Estate}{Non\ Interest\ Income}\right)^2 + \left(\frac{Net\ Gains\ Sales}{Non\ Interest\ Income}\right)^2 \\
& + \left(\frac{Other\ Non\ Interest\ Income}{Non\ Interest\ Income}\right)^2]
\end{aligned} \tag{5.6}
$$

Alternatively, I also use another proxy to measure bank diversification that has no link to the AHHI indicator. Consistent with the literature, I use a simple measure that calculates the share of non-interest income that a bank generates (Baele et al., 2007). I divide banks into groups using a median value as a threshold with this measure. Banks that generate higher non-interest income (conditional on being above the mean) are deemed to be more diversified than those below the threshold.

$$
Non\ Interest\ Share = \frac{Non\ Interest\ Income}{Operating\ Income} \tag{5.7}
$$

5.4.2 Econometric Models

In line with the baseline models, I divided the econometric testing into two sections investigating the two bank performance measures. The first section focuses on bank profitability as the first performance metric, and the second focuses on financial stability.

The first model which uses the GMM estimation is:

$$Bank\ Profitability_{i,t} = Bank\ Profitability_{i,t-1} + Diversification\ Measure_{i,t} + Explanatory\ Variables_{i,t} + \varepsilon_{i,t} \tag{5.8}$$

Where, i represent the individual bank, and t represents the period. The chapter employs the ROA and ROE variables to proxy bank profitability, which are frequently applied in empirical analyses. The time lag of the dependent variable is included to control for endogeneity as a requirement of GMM estimation.

As explained above, for the diversification measure, I use the three AHHI variations and the non-interest share (4 models). The explanatory variables are outlined in the data section, and their summary statistics are reported in table 5.1.

In the second part of the analysis, I turn my attention to the bank's financial stability. Likewise, the GMM estimation is implemented, and the diversification measure and explanatory variables remain unchanged.

$$Financial\ Stability_{i,t} = Financial\ Stability_{i,t-1} + Diversification\ Measure_{i,t} + Explanatory\ Variables_{i,t} + \varepsilon_{i,t} \tag{5.9}$$

In contrast to the bank profitability measure of the bank addressed in the first stage, I have the flexibility of using several metrics to gauge financial stability. Table 5.1 reports the variables that are employed to proxy financial stability. Each model included in the results section uses alternative financial stability measures.

5.4.3 Stress Testing Interactions

In the 2008-2009 financial crisis, the banking system vulnerabilities were apparent, and stringent regulations were needed. Hence, an influx of new policies has been implemented to strengthen the banking sector's resilience. Although stress tests were a common risk management tool used by banks before the crisis, these were carried out internally by the bank themselves. Supervisory stress tests conducted by central banks and regulators are a new toolkit introduced to assess the strength of the banking system if a crisis were to materialise.

Since the SCAP launch in 2009, the U.S. FED has conducted annual stress tests to assess the banking system as a whole. During the last decade, no significant real crisis has materialised to test the banks' solvency or performance. However, the effects of the COVID-19 pandemic have renewed interest in this area of macroprudential policy.

Abuzayed et al. (2018) examine how a specific type of bank can facilitate diversification strategies, thus making diversification effective. Abuzayed et al. (2018) document that well-diversified Islamic banks exhibit a positive relationship with financial stability versus traditional banks.

Moreover, Adesina (2021) finds that the relationship between diversification and bank performance differs across banks, as factors such as human capital efficiency can lead to a positive relationship and mitigate any negative relationship.

Intuitively, it is interesting to compare the behaviour of stress-tested banks bound by stringent regulations relative to non-stress tested banks and how stress-tested banks can facilitate the intended effects of diversification as a risk management strategy.

In the econometric tests, I shift my attention to the stress-tested banks in the sample and conduct econometric tests to measure the performance of these stress-tested banks[31]. As this study contributes to the literature on bank diversification, I add to the existing literature by addressing whether highly diversified banks and those subject to the stress testing regime yield significant results.

I present below the econometric models, which are akin to the baseline models discussed above. The models below include a new interaction term between diversification and participation in the stress testing program. Likewise, I also employ the GMM approach.

$$\begin{aligned} Bank\ Profitability_{i,t} = {} & Bank\ Profitability_{i,t-1} + Diversification\ Measure_{i,t} \\ & + Diversification\ Measure_{i,t} * Stress\ Tested_i + Explanatory\ Variables_{i,t} \\ & + \varepsilon_{i,t} \end{aligned} \tag{5.10}$$

[31] Since the SCAP 2009 stress test, there have annual stress tests conducted by the FED, with several banks that have been participating. To help select the banks that form our stress test treatment group, I select the banks that have participated in every stress test since its inception. Therefore, I use 11 stress-tested banks and the remaining banks in the sample are designated as the control group.

$$
\begin{aligned}
Financial\ Stability_{i,t} = \ & Financial\ Stability_{i,t-1} + Diversification\ Measure_{i,t} \\
& + Diversification\ Measure_{i,t} * Stress\ Tested_i + Explanatory\ Variables_{i,t} \\
& + \varepsilon_{i,t}
\end{aligned}
\tag{5.11}
$$

5.5 Empirical Results

The empirical results address the baseline results by assessing the influence of bank diversification on bank performance using the whole period (2005Q1 – 2020Q4). In the second step, I isolate the periods of interest by focusing specifically on the GFC and COVID-19 pandemic to assess the effectiveness of diversification. In addition, for the three periods, I discuss the influence of the stress-tested banks and ask if the participation of banks in the FED's programme facilitates the intended effects of diversification.

Notably, the theme of the chapter is to establish whether there are observable differences in diversification patterns during the two mentioned crisis periods.

5.5.1 Profitability

The first set of results below is associated with the baseline results, in which I study the whole period (2005-2020) to analyse if bank diversification affects bank performance. Table 5.3 reports the influence of bank diversification using four variations as shown throughout models (1) to (4). I include four variations that serve as robustness results. The dependent variables ROA and ROE are the bank performance measures that reflect the profitability of a bank, which is often used to assess the bank's performance.

As expected, during times of economic booms, bank profitability tends to increase as a result of economic growth, low unemployment levels, and consumer confidence. On the other side, in times of crisis, bank profitability is hampered due to economic turmoil. This was evident during the GFC. Lending levels, bank confidence and other important factors played a crucial role in dampening bank profitability.

Therefore, in light of the COVID-19 pandemic, bank profitability has received renewed interest as a proxy for performance. Furthermore, I ask if diversification is an important tool that banks could exploit to remain profitable?

Using the diversification measure, which is income-based (AHHI-Main), Table 5.3 finds a significantly positive association between bank diversification and profitability (ROA), where a 1% increase in diversification results in a 0.2% increase in profitability (Moudud-Ul-Huq et al., 2018). The magnitude of the result is seemingly negligible. However, it is significant, and in times of a crisis, bank managers may find that diversifying is beneficial and required to cushion against a shock[32].

The second diversification measure is asset-based (AHHI-Assets), surprisingly I find a negative result between diversification and profitability, although this result is statistically insignificant[33]. To reassure the robustness of the first result, I turn my attention to models (3) and (4) that report the AHHI – Non-Interest variation and Non-Interest share variables. In brief, I find positive correlations with the diversification measures which show a 1% increase in diversification lead to an increase in profitability by 0.06% and 0.2%, respectively. As expected, the increase in the share of non-interest income will positively affect bank performance (Baele et al., 2007).

The second profitability measure is ROE, analogous to the previously discussed ROA. Given that this measure is similar to the ROA variable, it is no surprise to find similar results. Even though the Asset-based diversification measure (AHHI-Assets) yields a negative result. Moving forward, I also find similar results for the remaining two diversification measures, which are positive and align with the results shown for the ROA variable.

In this chapter, I contribute to bank diversification literature by adding a new interaction term that examines the role of the stress-testing regime[34]. To my knowledge, this is the first chapter that attempts to analyse the interaction between being diversified and stressed by the FED's macroprudential program.

I find mixed results for the first bank profitability measure on the relationship. There is a benefit of being highly diversified while simultaneously being a part of the stress testing programme, as shown by the positive

32 The small magnitude of the result may be due to the methodology of calculating the profitability measure. Concerning our methodology, the numerator of the ROA and ROE variables include the quarterly observation of the bank's profit (net income). While the denominator includes the total assets of the bank which remains somewhat similar throughout the year. Regarding literature that uses Orbis Bank Focus, the structure of the database is recorded annually, which results in larger magnitudes.

33 See Moudud-Ul-Huq et al. (2018), who find similar results for Asset diversification.

34 The decision to understand the interaction is influenced by Adesina (2021), Deng et al. (2013) and Doan et al. (2018), who explain that other factors and can drive the intended success of diversification.

relationship by the AHHI – Assets measure.

Albeit, for the Non-Interest measure, there is a negative relationship. The evidence is somewhat mixed, suggesting that adopting a balance sheet that spreads the risk by diversifying or ‘keeping the eggs in different baskets’ (as explained by the Portfolio Theory) is an underlying factor in remaining profitable. However, since the GFC, the rollout of macroprudential policies may have played a vital role in disciplining bank behaviour.

To assess if these results are robust, I shift my focus to the alternative bank profitability measure, the ROE variable, and observe similar relationships. The AHHI-Assets measure of diversification is statistically significant and produces a positive association.

Table 5.3: Bank Diversification and Profitability (ROA and ROE) – Full Sample

The table reports the effect of bank diversification on bank performance, using system GMM estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	ROA				**ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Lagged dependent variable	0.5191774***	0.5243650***	0.5207640***	0.5197641***	0.5672213***	0.5721350***	0.5556063***	0.5672117***
	(0.0421013)	(0.0417094)	(0.0410023)	(0.0419700)	(0.0421980)	(0.0413581)	(0.0415960)	(0.0415012)
Diversification Measure	0.0023266*	-0.0029164	0.0006130**	0.0025230***	0.0241011**	-0.0200761	0.0077090**	0.0174669**
	(0.0011942)	(0.0019072)	(0.0002975)	(0.0008856)	(0.0118477)	(0.0142100)	(0.0034881)	(0.0083904)
Stressed * Diversification	0.0017776	0.0046235*	0.0005114	-0.0026125*	0.0008043	0.0173240	0.0083027**	-0.0033370
	(0.0022944)	(0.0027157)	(0.0003440)	(0.0014826)	(0.0250884)	(0.0197500)	(0.0036070)	(0.0136446)
Stressed	0.0009243	-0.0004120	0.0009446	0.0027275**	0.0130014	0.0040596	0.0059855	0.0115266
	(0.0009516)	(0.0009474)	(0.0005747)	(0.0010636)	(0.0111448)	(0.0083447)	(0.0054625)	(0.0088475)
Size	-0.0004428***	-0.0002956*	-0.0003052**	-0.0003611**	-0.0026160*	-0.0013124	-0.0018678	-0.0016783
	(0.0001663)	(0.0001628)	(0.0001528)	(0.0001564)	(0.0015030)	(0.0013990)	(0.0013604)	(0.0013063)
Liquidity	0.0012900	0.0015577*	0.0014318*	0.0004146	0.0063709	0.0084791	0.0108141	-0.0012346
	(0.0008086)	(0.0008756)	(0.0008185)	(0.0008172)	(0.0077343)	(0.0080448)	(0.0084672)	(0.0084654)
Equity	0.0225847***	0.0225482***	0.0203613***	0.0196272***	0.0395584	0.0398204	0.0175925	0.0108806
	(0.0048930)	(0.0051011)	(0.0047633)	(0.0043792)	(0.0442841)	(0.0421781)	(0.0432614)	(0.0376126)
Deposits / Total Assets	-0.0012033	-0.0000182	-0.0006623	0.0005416	-0.0005381	0.0086658	0.0015172	0.0140205*
	(0.0010404)	(0.0009708)	(0.0009647)	(0.0009647)	(0.0092329)	(0.0088771)	(0.0090763)	(0.0079984)
Constant	0.0083738***	0.0068505**	0.0062628**	0.0062546**	0.0617058**	0.0477690*	0.0524234*	0.0430089
	(0.0031935)	(0.0033031)	(0.0029651)	(0.0029810)	(0.0288723)	(0.0278408)	(0.0272509)	(0.0261710)
Observations	5,318	5,318	5,277	5,318	5,318	5,318	5,277	5,318
Banks	181	181	181	181	181	181	181	181
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR (2)	**0.539**	**0.526**	**0.544**	**0.515**	**0.433**	**0.422**	**0.357**	**0.410**
Sargan	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Hansen J	**0.120**	**0.111**	**0.158**	**0.109**	**0.015**	**0.013**	**0.012**	**0.016**

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

5.5.2 Financial Stability

Next, I consider bank performance by examining bank financial stability[35]. Unlike the previous section, I have the advantage of including several financial stability measures following the literature. Table 5.4 reports the association between diversification and financial stability. In summary, I ask if diversification is a necessary strategic tool that bank managers should adopt to maintain financial stability (also a key motivation of introducing stress testing practices).

Motivated by Adesina (2021) and Sanya and Wolfe (2011), I use the risk-adjusted measures of the previous profitability measures to proxy for financial stability. In line with the construction of the variables, Adesina (2021) explains that higher values of the financial stability measure are desirable, and lower values suggest greater volatility in bank profitability, which is undesirable for banks.

Similar to the previous section, I find positive results aligned with the bank profitability measure. The result is expected as the variables are highly collinear and transformed by dividing by the standard deviation of ROA and ROE, respectively. Table 5.4 first reports the risk-adjusted ROA measure and shows that a 1% increase in diversification based on the income type (AHHI-Main) increases financial stability by 48%. Surprisingly, I find a negative association with the Asset type (AHHI-Asset), where a 1% increase in diversification reduces financial stability by 36%.

According to the literature, there is evidence suggesting that banks that diversify in alternative asset classes will experience a reduction in bank performance. Banks prefer to deal with specific assets classes such as commercial real estate loans or industrial loans (Deng et al., 2013). The successive diversification measures show a positive relationship. A 1% increase in diversification via the AHHI – Non-Interest variation and Non-Interest share variable increase financial stability by 11% and 24%, respectively.

For the risk-adjusted ROE in table 5.4, I find analogous results which are anticipated. The results show a 1% increase in the Income-based diversification variable increases financial stability by 40%. For the remaining diversification measures, the AHHI – Non-Interest variation and Non-Interest share variable, a 1% increase

[35] In contrast to my hypothesis that predicts a positive relationship between diversification and financial stability. See Wager (2010), who explains that diversification can cause a systemic crisis, which harms financial stability in the long run. Similarly, the impact of diversification on systematic risk are also confirmed by the empirical evidence reported by Baele et al. (2007) for the European banking sector.

in these measures lead to an 11% and 26% increase in financial stability, respectively.

Following Li and Zhang (2013), the results suggest that diversification can benefit the banking system if they engage in non-interest income activities. The empirical results indicate a positive relationship. Nevertheless, Li and Zhang (2013) imply that there should be a certain degree to which banks rely on non-interest income instead of the traditional route of generating interest income. Briefly, as banks rely on the non-interest income component, Li and Zhang (2013) explain that volatility increases by focusing on non-interest income, producing financial instability.

In a similar vein, for a sample of banks located in South Asia, Nguyen et al. (2012) suggest that diversification benefits the region regarding financial stability. Akin to the chapter's approach, Nguyen et al. (2012) postulate that underlying factors can facilitate the effectiveness of diversification as a risk management strategy. In the South Asian region, the authors postulate that banks with the largest market power or market share tend to focus on the traditional function of the banking system by engaging in interest income activities. Subsequently, Nguyen et al. (2012) indicate that to enhance or increase the income avenues for the dominating banks, they should also diversify into alternate activities that are deemed non-traditional. This, in turn, allows banks to enjoy greater returns while also reducing idiosyncratic bank risk.

In contrast, for a sample of banks from the GCC (Gulf Cooperation Council), Abuzayed et al. (2018) show conflicting findings and suggest that diversification negatively affects bank performance. Initially, the authors' results explain that diversification does not improve financial stability. Yet, Abuzayed et al. (2018) suggest that this is dependent on the degree of diversification within the bank. A certain level of diversification may offset the negative impact, and once there is a high degree of diversification, this can improve financial stability. Moreover, Abuzayed et al. (2018) conclude that the type of bank is an important factor to scrutinise. That is, the authors argue that although diversification may negatively affect bank performance for Islamic and traditional banks, the financially instability effects are less pronounced for Islamic banks due to their business models. In relation to the results, it is interesting to examine the stress-tested banks, as I find that diversification positively affects financial stability, which may result from the stringent regulations imposed by the regulators.

In the stress testing and diversification interaction context, I find one significantly positive relationship in table 5.4 (ROA model). The result shows that stress-tested and highly diversified banks are more financially stable and perform stronger than non-stress tested highly diversified banks.

It is of interest that implementing stronger prudential regulations through supervisory stress tests has supported the banking system by becoming more robust to possible shocks, which inevitably means that these banks will be more financially stable. A combination of being cautiously prudent (via stress tests) and strategically mindful of banks' balance sheet risk (diversified portfolio) is advantageous, as shown in table 5.4.

For the risk-adjusted ROA measure, diversification using the AHHI – Non-Interest measure reveals that a 1% increase in diversification increases financial stability by 17% relative to non-stress tested banks. The second financial stability dependent variable (risk-adjusted ROE) also displays similar results, showing statistically positive associations relative to non-stress tested banks and highly diversified.

The Z-Score is the main financial stability measure employed to proxy bank stability with respect to the literature. Subsequently, I also include the Z-Score as the main measure of financial stability reported in table 5.5. For the Z-Score, positive values are desirable and suggest that a bank is more financially stable. On the other hand, negative values mean that banks are prone to financial instability, which banks focus on mitigating.

In table 5.5, I find that diversification negatively affects financial stability (Non-interest share). I turn my attention to stress-tested and diversified banks, where I find a positive relationship with the Z-Score, thus suggesting stress-tested banks are more financially stable.

Next, I use the NPL ratio as an alternative dependent variable to proxy financial stability. The inclusion of the NPL ratio is unduly important, as this metric is often used to assess credit risk and can be an influential indicator of understanding an economies health and consumers' ability to service their debts.

As presented in table 5.5, the results appear to be statistically insignificant for most of the models. Although for the Asset-type diversification variable, a 1% increase in diversification reduces the NPL ratio by 0.2%, thus suggesting that diversification can also affect financial stability by mitigating the NPL ratio.

Equally, I find a similar pattern emerging for the stress-tested banks. The Non-interest variation shows that an increase in diversification of 1% reduces the NPL ratio by 0.1% relative to the non-stress tested banks.

The final dependent variable I include to measure financial stability is equity. The banks' equity is often a metric used to evaluate a banks' solvency or loss-absorbing capacity. The equity variable is the central metric (not only limited to the equity ratio) used by regulators such as the FED to inform supervisors on a bank's solvency. Therefore, I include this measure as an auxiliary variable to proxy financial stability. Table 5.6 reports the banks' equity, and I find differing results. In model (1), the Income-type measure shows that a 1% increase in bank diversification improves a banks' equity by 0.2%[36]. Yet, there is a negative relationship between stress-tested and highly diversified banks.

5.5.3 Explanatory Variables

In this section, I briefly overview the results of the explanatory variables across tables 5.3-5.6. The first bank performance measure I account for is the bank's profitability. Using the ROA dependent variable reported in table 5.3, I find a negative correlation between bank size and profitability which is statistically significant in models (1) – (4). The liquidity levels of a financial institution are positively related to bank profitability, as expected.

As the previous section explains, the bank's equity is used as a loss-absorbing cushion against shocks. The equity of the bank serves as a buffer to mitigate impending risks. Table 5.3 reports that bank equity is positively correlated with profitability. I find no statistical results for having a stronger funding foundation concerning the deposit variable for the ROA performance measure. Regarding the stress-tested dummy variable, I find one significant result that shows that stress-tested banks are more profitable than non-stress tested banks.

Subsequently, I investigate the significance of the explanatory variables in terms of financial stability. Table 5.4 produces identical results, reflecting what I find in table 5.3. Nonetheless, this is expected as the dependent variables are highly correlated. With this in mind, I find that bank size is negatively correlated with financial stability, as shown by most models in table 5.4. Bank liquidity and equity are positively related to financial stability. Besides, in model (4) of the risk-adjusted ROA model, the bank's funding structure is positively related to financial stability.

Following this, I continue to analyse the explanatory variables of tables 5.5 and 5.6 that show a positive

[36] The result is similar to Khan et al. (2020) who document a positive relationship between diversification and bank efficiency.

relationship between bank equity and financial stability (Z-Score). In regards to the NPL ratio, there is a negative correlation between the funding structure and the NPL ratio. The result signifies that a stable funding structure composed of deposits will improve financial stability. In table 5.6, there is a positive association between liquidity and financial stability.

For brevity and space, I do not discuss the results of the explanatory variables for the remaining tables presented below.

Table 5.4: Bank Diversification and Financial Stability (Risk-Adjusted ROA and Risk-Adjusted ROE) – Full Sample

The table reports the effect of bank diversification on bank performance, using system GMM estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Risk Adjusted - ROA				**Risk Adjusted - ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Lagged dependent variable	0.6622162***	0.6648922***	0.6608983***	0.6626985***	0.6809866***	0.6825372***	0.6758409***	0.6805922***
	(0.0213581)	(0.0215091)	(0.0225449)	(0.0214941)	(0.0218800)	(0.0218348)	(0.0226532)	(0.0218114)
Diversification Measure	0.4838193***	-0.3639112*	0.1168478***	0.2430053***	0.4076937***	-0.2957966	0.1169551***	0.2616921***
	(0.1673943)	(0.2182948)	(0.0409564)	(0.0922135)	(0.1536255)	(0.2016534)	(0.0388077)	(0.0977184)
Stressed * Diversification	-0.0114669	0.2597704	0.1776878**	0.1626269	0.0091775	-0.0332969	0.2112512***	0.2418394
	(0.3886765)	(0.4750601)	(0.0734551)	(0.1939542)	(0.3460434)	(0.4459797)	(0.0609055)	(0.1881532)
Stressed	0.2643188	0.1198540	0.1129051	0.1184630	0.2422302	0.2189420	0.0823009	0.0636425
	(0.1812711)	(0.2092961)	(0.0773812)	(0.1133481)	(0.1649162)	(0.1969719)	(0.0760511)	(0.1130330)
Size	-0.0568842***	-0.0354480*	-0.0434988**	-0.0399496**	-0.0523217***	-0.0300983	-0.0412469**	-0.0366749**
	(0.0185661)	(0.0193511)	(0.0184933)	(0.0179004)	(0.0186531)	(0.0189983)	(0.0183878)	(0.0178457)
Liquidity	0.2182956**	0.2288988**	0.2192589**	0.1000694	0.1703359*	0.1684125*	0.1582600	0.0430281
	(0.0965644)	(0.0992525)	(0.1003257)	(0.1114885)	(0.0981867)	(0.0972631)	(0.1039925)	(0.1123278)
Equity	1.9574222***	1.8911065***	1.4272702**	1.5192236**	1.2105322*	1.2228743*	0.7698309	0.8104035
	(0.6855152)	(0.6326322)	(0.6330399)	(0.6126910)	(0.7006187)	(0.6520209)	(0.6588753)	(0.6329728)
Deposits / Total Assets	-0.0170030	0.1096162	-0.0197574	0.1822899*	-0.0856684	0.0446706	-0.0981433	0.1297773
	(0.0992960)	(0.1077227)	(0.0995627)	(0.1069783)	(0.0969950)	(0.1069245)	(0.0947441)	(0.1032969)
Constant	1.6215390***	1.4800295***	1.5617968***	1.3562378***	1.7083447***	1.4935883***	1.6634605***	1.4213670***
	(0.3726596)	(0.3827221)	(0.3814986)	(0.3635253)	(0.3718973)	(0.3730483)	(0.3733654)	(0.3544857)
Observations	5,286	5,286	5,245	5,286	5,286	5,286	5,245	5,286
Banks	180	180	180	180	180	180	180	180
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR (2)	**0.147**	**0.159**	**0.163**	**0.164**	**0.155**	**0.165**	**0.189**	**0.172**
Sargan	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Hansen J	**0.196**	**0.223**	**0.169**	**0.209**	**0.348**	**0.384**	**0.277**	**0.366**

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.5: Bank Diversification and Financial Stability (Z-Score and NPL Ratio) – Full Sample

The table reports the effect of bank diversification on bank performance, using system GMM estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Z-Score				**NPL Ratio**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Lagged dependent variable	0.7892341***	0.7892379***	0.7887856***	0.7890570***	1.0197659***	1.0217042***	1.0210070***	1.0185131***
	(0.0218071)	(0.0219050)	(0.0218697)	(0.0219584)	(0.0248536)	(0.0249364)	(0.0257009)	(0.0246392)
Diversification Measure	0.3079308	-0.1812696	0.8364024	-4.0458633*	0.0001053	-0.0022105**	0.0001045	-0.0004675
	(3.7572607)	(5.4677241)	(0.5872537)	(2.3581925)	(0.0011294)	(0.0010552)	(0.0002701)	(0.0007370)
Stressed * Diversification	-7.1590973	-5.1761272	1.0626844	7.0107621**	-0.0020793	0.0001280	-0.0010543***	-0.0002200
	(9.8334833)	(9.3568901)	(0.9417236)	(3.3007361)	(0.0024046)	(0.0024403)	(0.0003483)	(0.0010207)
Stressed	1.2681196	0.2866067	-2.0507068	-5.5745524**	0.0005559	-0.0004326	0.0003065	-0.0001278
	(4.1043501)	(3.6024007)	(1.5561757)	(2.4866209)	(0.0010414)	(0.0010216)	(0.0003012)	(0.0005957)
Size	0.3224311	0.3585278	0.1750636	0.4841215	-0.0000574	-0.0000446	-0.0000596	-0.0000504
	(0.4784242)	(0.4583156)	(0.4497616)	(0.4541192)	(0.0000867)	(0.0000864)	(0.0000922)	(0.0000868)
Liquidity	1.7417231	1.5653112	2.2530441	3.1228256	0.0002269	0.0003767	0.0003032	0.0005180
	(2.5260483)	(2.6529298)	(2.4613612)	(2.6426209)	(0.0007111)	(0.0007208)	(0.0007382)	(0.0008213)
Equity	56.8093961***	56.0315727***	54.8061703***	60.8567530***	-0.0048916	-0.0037337	-0.0048500	-0.0046544
	(15.4311521)	(16.6155906)	(15.5380676)	(15.7086014)	(0.0033541)	(0.0032663)	(0.0032481)	(0.0032845)
Deposits / Total Assets	-1.0142092	-0.9921430	-1.6426005	-2.6009948	-0.0006832	-0.0003338	-0.0008230*	-0.0009237
	(2.4652392)	(2.4834972)	(2.3337756)	(2.3591566)	(0.0004327)	(0.0004485)	(0.0004478)	(0.0005961)
Constant	-2.1093571	-2.4391954	0.6868907	-3.1889923	0.0019308	0.0022088	0.0020448	0.0020574
	(9.2854864)	(9.2790280)	(8.8212524)	(8.8434397)	(0.0014294)	(0.0014504)	(0.0015287)	(0.0015369)
Observations	5,286	5,286	5,245	5,286	5,318	5,318	5,277	5,318
Banks	180	180	180	180	181	181	181	181
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR (2)	**0.459**	**0.461**	**0.455**	**0.478**	**0.835**	**0.836**	**0.821**	**0.838**
Sargan	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Hansen J	**0.086**	**0.085**	**0.109**	**0.105**	**0.051**	**0.059**	**0.047**	**0.051**

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.6: Bank Diversification and Financial Stability (Equity Ratio) – Full Sample

The table reports the effect of bank diversification on bank performance, using system GMM estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Equity			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)
Lagged dependent variable	1.0381586***	1.0396653***	1.0370186***	1.0356851***
	(0.0071830)	(0.0078103)	(0.0071857)	(0.0069438)
Diversification Measure	0.0025624**	-0.0037641	0.0002997	0.0010381
	(0.0012961)	(0.0023921)	(0.0002274)	(0.0008588)
Stressed * Diversification	-0.0042747	0.0029726	-0.0011474**	-0.0022824
	(0.0038603)	(0.0034024)	(0.0005624)	(0.0022700)
Stressed	0.0020441	-0.0010078	0.0007915	0.0013515
	(0.0017203)	(0.0014057)	(0.0007384)	(0.0013146)
Size	-0.0001243	-0.0000347	-0.0000553	-0.0000921
	(0.0001627)	(0.0001673)	(0.0001556)	(0.0001589)
Liquidity	0.0013790	0.0015956*	0.0013366	0.0010716
	(0.0009035)	(0.0009596)	(0.0008811)	(0.0009136)
Deposits / Total Assets	-0.0012242	-0.0001118	-0.0011585	-0.0005982
	(0.0009760)	(0.0010144)	(0.0009703)	(0.0009660)
Constant	-0.0021081	-0.0022549	-0.0024510	-0.0021817
	(0.0032614)	(0.0034611)	(0.0031615)	(0.0032288)
Observations	5,318	5,318	5,277	5,318
Banks	181	181	181	181
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**
AR (2)	**0.134**	**0.139**	**0.148**	**0.137**
Sargan	**0.001**	**0.001**	**0.001**	**0.001**
Hansen J	**0.362**	**0.349**	**0.312**	**0.368**

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

5.5.4 GFC Period

In this stage, I consider two crisis periods. The chapter's main objective is to compare and find noticeable differences in being diversified between the GFC and the COVID-19 pandemic. In addition, I ask how important bank diversification is to mitigate risk and improve performance. I first analyse the GFC period by restricting the sample period from 2006-2010, including the GFC period; this ensures I study this period to address if bank diversification displays significant results.

Table 5.7 presents the first set of results for bank profitability during the GFC period. I find similar results to those outlined in the baseline models considering the whole sample period. To note, I find there are positive and significant results that suggest that during the subprime mortgage crisis, bank diversification is one determinant that supports bank profitability (Elsas et al., 2010). In model (4), I find that an increase in bank diversification by 1% leads to an increase in profitability by approximately 3% (ROA). The second profitability proxy I employ is the ROE. Likewise, a similar relationship emerges.

Interestingly, I focus on stress-tested banks and find no significant results. As a reminder, supervisory stress tests became apparent during the 2006-2010 period at the end of the period. Intuitively, I would not expect the stress-tested banks to show strong results, as the supervisory stress testing frameworks were in their early stages. Yet, as the baseline results show, being stress-tested and diversified is significant over a long period.

Next, I move on to the second bank performance and evaluate the financial stability of U.S. banks during the GFC period. Table 5.8 reports the effect of bank diversification on financial stability. In line with the base model presented in table 5.4, I observe the same relationship, positively correlating with bank diversification. In table 5.8, Model (1) finds that an increase in bank diversification by 1% increases financial stability by 204%. Model (3) and (4) also show that an increase in diversification by 1% leads to increased financial stability by 20% and 128%, respectively. The results are also larger in magnitude relative to the whole sample that was analysed in the baseline model.

Following this, I proceed by examining the risk-adjusted ROE and unsurprisingly find similar results. Model (1), (3), and (4) show that an increase in bank diversification by 1% results in a 143%, 14%, and 79% rise in financial stability. Yet again, I observe that the magnitude of the results is comparatively larger than the baseline model addressed in table 5.4.

Bank diversification is essential to support financial stability in times of crisis, especially the GFC. In relation to diversified banks and banks that participate in supervisory stress tests, I find significant results, as the financial stability indicators (Risk-adjusted ROA and ROE) show positive and significant results. Statistically significant results point towards these banks being more financially stable. However, the driving result may be due to being diversified during the bank crisis.

I address the Z-Score, NPL Ratio, and Equity for the remaining financial stability measures in tables 5.9 and

5.10. For the three dependent variables, I find no statistically significant results across all models.

Moving on, I study the interaction between diversified and stress-tested banks. In summary, there are no significant results for most of the results.

Table 5.7: Bank Diversification and Profitability (ROA and ROE) – GFC Period

The table reports the effect of bank diversification on bank performance during the GFC period (2007Q1 – 2010Q4), using system GMM estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	ROA				**ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Lagged dependent variable	0.5239622***	0.5569994***	0.5236504***	0.5293467***	0.5605933***	0.5800336***	0.5377188***	0.5567096***
	(0.0634849)	(0.0559962)	(0.0576463)	(0.0665732)	(0.0667611)	(0.0564196)	(0.0569179)	(0.0587663)
Diversification Measure	0.0118996***	0.0016595	0.0012259***	0.0063904**	0.1271154***	-0.0176264	0.0168829***	0.0769038***
	(0.0034282)	(0.0048947)	(0.0004529)	(0.0027296)	(0.0361668)	(0.0487184)	(0.0047215)	(0.0245795)
Stressed * Diversification	-0.0043785	0.0010579	-0.0001311	-0.0060915	-0.0383835	0.0238478	0.0003081	-0.0586016
	(0.0046366)	(0.0059088)	(0.0004527)	(0.0050854)	(0.0642922)	(0.0675030)	(0.0047699)	(0.0579328)
Stressed	0.0041447*	0.0013000	0.0019773	0.0046643	0.0366349	0.0061577	0.0157594	0.0441375
	(0.0023179)	(0.0022481)	(0.0012610)	(0.0030856)	(0.0301692)	(0.0283556)	(0.0130663)	(0.0337396)
Size	-0.0006309	-0.0002047	-0.0003281	-0.0003892	-0.0056600	-0.0009681	-0.0016881	-0.0032416
	(0.0003935)	(0.0004041)	(0.0003712)	(0.0003729)	(0.0042450)	(0.0040955)	(0.0038946)	(0.0036913)
Liquidity	0.0042791	0.0036538	0.0047173	0.0044406	0.0589119**	0.0550973**	0.0609894**	0.0473023*
	(0.0029817)	(0.0026565)	(0.0030066)	(0.0030208)	(0.0292727)	(0.0268439)	(0.0298766)	(0.0283839)
Equity	0.0293567***	0.0284890**	0.0246172**	0.0280119***	0.2528647**	0.3064674**	0.2173565*	0.2611695**
	(0.0098426)	(0.0119720)	(0.0104708)	(0.0101002)	(0.1109648)	(0.1263538)	(0.1120827)	(0.1110850)
Deposits / Total Assets	-0.0041541*	-0.0022271	-0.0026650	0.0000074	-0.0361928*	-0.0090269	-0.0185194	0.0144860
	(0.0021139)	(0.0017169)	(0.0016428)	(0.0020202)	(0.0217329)	(0.0191397)	(0.0171828)	(0.0198819)
Constant	0.0028996	-0.0016051	0.0012436	-0.0018669	0.0120688	-0.0359001	-0.0246848	-0.0419880
	(0.0078183)	(0.0090965)	(0.0078654)	(0.0079686)	(0.0874010)	(0.0932933)	(0.0855316)	(0.0821711)
Observations	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015
Banks	95	95	95	95	95	95	95	95
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR (2)	**0.949**	**0.806**	**0.928**	**0.921**	**0.674**	**0.706**	**0.426**	**0.577**
Sargan	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Hansen J	**0.020**	**0.042**	**0.023**	**0.032**	**0.307**	**0.303**	**0.368**	**0.418**

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.8: Bank Diversification and Financial Stability (Risk-Adjusted ROA and Risk-Adjusted ROE) – GFC Period

The table reports the effect of bank diversification on bank performance during the GFC period (2007Q1 – 2010Q4), using system GMM estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Risk Adjusted - ROA				**Risk Adjusted - ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Lagged dependent variable	0.6992804***	0.7220070***	0.6975564***	0.6988178***	0.7219732***	0.7337543***	0.7211669***	0.7162284***
	(0.0461852)	(0.0404075)	(0.0476460)	(0.0447398)	(0.0412065)	(0.0380288)	(0.0412649)	(0.0402522)
Diversification Measure	2.0489173***	-0.1511570	0.2028100***	1.2850180***	1.4390213***	-0.2683894	0.1441400**	0.7906450**
	(0.4801405)	(0.8850674)	(0.0709965)	(0.4253304)	(0.4528001)	(0.7893874)	(0.0674614)	(0.3790418)
Stressed * Diversification	-1.9955438	0.1765623	0.1131616*	-0.3878825	-1.8986666	-0.1246786	0.2085428***	-0.0649414
	(1.2558132)	(1.0278658)	(0.0599483)	(0.7031881)	(1.2958792)	(0.9588734)	(0.0682630)	(0.7265526)
Stressed	1.3963912**	0.3586060	0.3690009*	0.5732181	1.3069210**	0.4775936	0.2852505	0.4111557
	(0.5764041)	(0.4510783)	(0.2029604)	(0.4338547)	(0.5707554)	(0.4182384)	(0.1839626)	(0.4452676)
Size	-0.1283589*	-0.0398415	-0.0578188	-0.0890780	-0.0771984	-0.0248410	-0.0367858	-0.0507743
	(0.0704692)	(0.0674005)	(0.0655612)	(0.0689998)	(0.0661848)	(0.0640048)	(0.0605031)	(0.0597816)
Liquidity	0.7365293	0.6790358*	0.7868033*	0.4385990	0.9373041**	0.7967322**	1.0135457**	0.8086258*
	(0.4449277)	(0.4056343)	(0.4331123)	(0.4951889)	(0.4138632)	(0.3674844)	(0.4139454)	(0.4645384)
Equity	1.9597000	3.2688363	1.8331945	2.0146929	2.1693617	3.0050850	2.1248062	1.9378363
	(1.8560990)	(2.1309271)	(2.0364089)	(1.8595634)	(1.8076430)	(1.9894274)	(1.9255322)	(1.8070067)
Deposits / Total Assets	-0.3556712	0.0475404	-0.0920126	0.4303310	-0.2152179	0.0691855	-0.0796586	0.3252041
	(0.4016882)	(0.3622886)	(0.3284742)	(0.3387213)	(0.3795629)	(0.3623924)	(0.3145753)	(0.2935206)
Constant	1.2571349	0.1544754	0.5530284	0.4208898	0.4034143	-0.0973266	0.0822201	-0.1304223
	(1.4455134)	(1.4975897)	(1.4087511)	(1.4212967)	(1.3468403)	(1.3909832)	(1.2860590)	(1.1855394)
Observations	1,008	1,008	1,008	1,008	1,008	1,008	1,008	1,008
Banks	94	94	94	94	94	94	94	94
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR (2)	**0.094**	**0.102**	**0.139**	**0.177**	**0.153**	**0.168**	**0.241**	**0.238**
Sargan	**0.051**	**0.038**	**0.037**	**0.048**	**0.295**	**0.240**	**0.230**	**0.304**
Hansen J	**0.062**	**0.072**	**0.073**	**0.061**	**0.213**	**0.250**	**0.222**	**0.242**

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.9: Bank Diversification and Financial Stability (Z-Score and NPL Ratio) – GFC Period

The table reports the effect of bank diversification on bank performance during the GFC period (2007Q1 – 2010Q4), using system GMM estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Z-Score				**NPL Ratio**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Lagged dependent variable	0.8744241***	0.8812117***	0.8784856***	0.8754114***	1.0578703***	1.0512087***	1.0557489***	1.0501206***
	(0.0517934)	(0.0499120)	(0.0498639)	(0.0509126)	(0.0355802)	(0.0356519)	(0.0340527)	(0.0348165)
Diversification Measure	8.4516235	-5.3390722	0.4468925	4.7901467	0.0039220	-0.0009558	0.0002675	-0.0011260
	(5.2280223)	(13.2043885)	(0.6304009)	(4.0565411)	(0.0045740)	(0.0059764)	(0.0004536)	(0.0028498)
Stressed * Diversification	1.2717107	7.1586816	0.9029589	5.4898116	-0.0075862	-0.0008887	-0.0011059**	0.0007813
	(8.5346242)	(12.2161429)	(0.8276131)	(7.4899444)	(0.0084369)	(0.0067003)	(0.0005338)	(0.0028627)
Stressed	-1.0786037	-4.0851552	-1.8387803	-4.5360370	0.0037325	0.0006782	0.0009615	0.0000906
	(4.3147777)	(3.3022649)	(3.0230131)	(5.5387223)	(0.0038619)	(0.0031202)	(0.0007672)	(0.0015475)
Size	0.0687703	0.4382161	0.5289604	0.3722195	-0.0001872	-0.0000916	-0.0000957	-0.0000397
	(0.9518568)	(1.0136780)	(0.9289004)	(1.0475556)	(0.0002662)	(0.0002759)	(0.0002735)	(0.0002906)
Liquidity	-1.5985184	-0.9626403	-1.8344196	-4.1004810	-0.0042352**	-0.0041835**	-0.0039502**	-0.0037038**
	(5.8438646)	(6.3181913)	(5.6143483)	(6.1624507)	(0.0016981)	(0.0019573)	(0.0016050)	(0.0016847)
Equity	57.5237389*	66.8222118**	58.5253742*	56.2455807*	-0.0217997**	-0.0209730**	-0.0217091**	-0.0218572**
	(31.9402185)	(29.8065219)	(32.0925701)	(29.7099124)	(0.0091684)	(0.0097538)	(0.0089834)	(0.0092328)
Deposits / Total Assets	-2.6919219	-0.2669713	-0.4908247	1.1051722	0.0007451	0.0011129	0.0009867	0.0010944
	(4.1744910)	(3.8829428)	(3.9978749)	(4.5118831)	(0.0018266)	(0.0025320)	(0.0019246)	(0.0024599)
Constant	-2.6306789	-6.4736506	-9.1620269	-8.2025859	0.0085596*	0.0086761	0.0081553	0.0077529
	(19.7835888)	(23.9215681)	(19.7577403)	(20.8891167)	(0.0047823)	(0.0055170)	(0.0053471)	(0.0060936)
Observations	1,008	1,008	1,008	1,008	1,015	1,015	1,015	1,015
Banks	94	94	94	94	95	95	95	95
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.001**	**0.001**
AR (2)	**0.295**	**0.282**	**0.289**	**0.277**	**0.541**	**0.542**	**0.520**	**0.531**
Sargan	**0.002**	**0.002**	**0.002**	**0.002**	**0.008**	**0.009**	**0.007**	**0.008**
Hansen J	**0.096**	**0.116**	**0.105**	**0.107**	**0.119**	**0.085**	**0.110**	**0.093**

Robust Standard errors in parentheses. $^{***} p < 0.01$, $^{**} p < 0.05$, $^{*} p < 0.1$

Table 5.10: Bank Diversification and Financial Stability (Equity Ratio) – GFC Period

The table reports the effect of bank diversification on bank performance during the GFC period (2007Q1 – 2010Q4), using system GMM estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Equity			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)
Lagged dependent variable	1.0894629***	1.0918156***	1.0897154***	1.0920277***
	(0.0175737)	(0.0182629)	(0.0176061)	(0.0179170)
Diversification Measure	0.0051740	-0.0013719	0.0002972	0.0007425
	(0.0036882)	(0.0060141)	(0.0004935)	(0.0023890)
Stressed * Diversification	-0.0106392	0.0066205	-0.0015730***	-0.0099870
	(0.0114653)	(0.0068103)	(0.0005608)	(0.0078513)
Stressed	0.0045276	-0.0024637	0.0006143	0.0053045
	(0.0054576)	(0.0023076)	(0.0017746)	(0.0050488)
Size	-0.0002489	-0.0002021	-0.0001297	-0.0002761
	(0.0005048)	(0.0005062)	(0.0004787)	(0.0005210)
Liquidity	0.0043825	0.0054407	0.0046749	0.0049176
	(0.0035222)	(0.0034416)	(0.0035586)	(0.0034515)
Deposits / Total Assets	-0.0066838**	-0.0062032*	-0.0062886**	-0.0069810**
	(0.0033461)	(0.0036463)	(0.0030877)	(0.0030776)
Constant	-0.0015857	-0.0006169	-0.0020510	0.0004544
	(0.0103204)	(0.0104680)	(0.0098957)	(0.0104106)
Observations	1,015	1,015	1,015	1,015
Banks	95	95	95	95
AR (1)	**0.000**	**0.000**	**0.000**	**0.000**
AR (2)	**0.827**	**0.817**	**0.829**	**0.811**
Sargan	**0.000**	**0.000**	**0.000**	**0.000**
Hansen J	**0.076**	**0.077**	**0.072**	**0.073**

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

5.5.5 COVID-19 Pandemic Period

This section investigates the impact of diversification on bank performance during the first four quarters of the COVID-19 pandemic. Since the pandemic is ongoing, I am limited by data availability. Therefore, examining the crisis's long-term impact and its effect on the banking system's resilience is not feasible. Consequently, I employ the OLS model instead of the GMM estimation for this stage of econometric testing due to the short-term data.

Table 5.11 reports the effect of diversification on bank profitability using two proxies (ROA and ROE). The results find that diversification may be equally important during this pandemic to a slight extent. As table 5.11 shows, there are signs of a positive relationship shown in Model (4) for the ROA and ROE dependent variable. To some extent, I find that diversification as a risk-mitigating tool is also beneficial for the COVID-19 pandemic. Although, I cannot confirm the strength of the findings as the COVID-19 pandemic persists, and the long-term effect has not been considered.

Following this, I analyse the interaction between being highly diversified and stress-tested. Surprisingly, I find strong statistically significant results across all the model variations shown in table 5.11. The evidence suggests that the role of supervisory stress tests to examine if banks can weather financial shocks proves to be successful. Banks that are participants of the FED's supervisory stress tests are in stronger positions to remain profitable, given that they are also highly diversified. In sum, a mixture of adopting risk management strategies and remaining financially prudent has its advantages.

Next, I address whether diversification affects financial stability, specifically the onset of the COVID-19 pandemic. Table 5.12 reports the effect of diversification on financial stability using both the risk-adjusted ROA and ROE measures. The majority of the models yield unexpected negative signs, implying that diversification can lead to financial instability. Yet, when I investigate the interaction between stress-tested banks and diversification, I find an overwhelmingly positive relationship across all models, thus indicating that being prudent and cautious (stress tests and choosing to be diversified) is beneficial.

Tables 5.13 and 5.14 reports the results of the remaining financial stability indicators. I find statistically significant results concerning the Z-Score, implying that the interaction between stress testing and diversification positively affects financial stability, especially during the COVID-19 crisis. With respect to the auxiliary financial measures, there is a positive relation between diversification and capital for the majority of the models.

In line with the economic rationale proposed by the results, the COVID-19 pandemic is structurally in contrast with the GFC in one essential method. The GFC resulted from the banking activity that ensued within the U.S financial system by the mismanagement of the subprime mortgages. In other words, the crisis can be determined as an endogenous shock that was predominantly caused by the financial system and inevitably spilt into the real economy. Berger and Demirgüç-Kunt (2021) argue that the COVID-19 pandemic is viewed as an exogenous shock, primarily a public health crisis. In general, Berger and Demirgüç-Kunt (2021) address the current COVID-19 pandemic as a shock that is more significant due to the widespread impact relative to the GFC. Besides, the authors describe that the COVID-19 pandemic has resulted in a very short recession and a more extensive bailout programme directed towards small businesses instead of the banking industry during the GFC. Still, the strength of the financial system has ensured that institutions have diverted a banking or financial crisis. The results show the impact of diversification on bank performance, especially during the pandemic, exhibit a positive effect. Following Berger and Demirgüç-Kunt (2021), the implementation of enhanced prudential regulations post-GFC, such as improved capital adequacy and supervisory stress tests, have mitigated bank risk and supported bank performance. Indeed, the results posit that during the COVID-19 period, stress-tested and highly diversified banks experience greater levels of financial stability and profit. The magnitudes of the effect of diversification on bank performance are smaller than the magnitudes shown in the GFC results. There are perhaps two reasons for this, the role of bank diversification during the GFC was more relevant due to bank activities in the subprime mortgage market. Secondly, the magnitude of the COVID-19 pandemic results is connected to the limited data I utilise. Intuitively, as Berger and Demirgüç-Kunt (2021) explain, the long-term impact of the pandemic will require more bank-level data, which should be considered for future research.

In a recent paper, Simoens and Vennet (2022) discuss the effects of diversification on bank performance. In the European banking system context, the authors document that diversification is an essential strategy used by banks to withstand an exogenous shock. More precisely, Simoens and Vennet (2022) posit that during the onset of the COVID-19 pandemic, diversified banks, with respect to their income stream, experienced a smaller decline in their stock market valuations than banks that specialise in traditional activities (interest-income). Notably, the authors explain that during a shock, investors prefer banks to rely on non-interest income sources due to the low-interest environment induced by the exogenous shock. Nonetheless, there are various methods to define diversification. Simoens and Vennet (2022) find that for the COVID-19 pandemic, geographical diversification does not mitigate the decline in the bank's stock valuations. Intuitively, as the COVID-19 pandemic is a global public health crisis, other regions' banking activity restrictions may be similar; therefore, minimising the impact of the shocks is not possible by focusing on alternate financial jurisdictions. In line with the empirical results, Simoens and Vennet (2022) corroborate the findings of the results and conclude that diversification can positively affect bank performance but suggest that the type of diversification is vital to consider.

Table 5.11: Bank Diversification and Profitability (ROA and ROE) – COVID-19 Period

The table reports the effect of bank diversification on bank performance during the COVID-19 period (2019Q4 – 2020Q4), using OLS estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	ROA				**ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	-0.0023444	-0.0029581	-0.0011118*	0.0039437**	-0.0240676	-0.0656131*	-0.0092605	0.0355740**
	(0.0023427)	(0.0035998)	(0.0005841)	(0.0017150)	(0.0222510)	(0.0350325)	(0.0064069)	(0.0156710)
Stressed * Diversification	0.0139729***	0.0088483*	0.0090312***	-0.0025044	0.1293500***	0.1291575**	0.0760746***	-0.0361748
	(0.0043606)	(0.0053612)	(0.0029165)	(0.0026617)	(0.0389118)	(0.0500124)	(0.0221094)	(0.0229057)
Stressed	-0.0024744	-0.0004179	-0.0018525	0.0043461**	-0.0254819	-0.0254442	-0.0154802	0.0453588***
	(0.0018024)	(0.0019750)	(0.0017148)	(0.0019834)	(0.0156605)	(0.0193959)	(0.0121767)	(0.0164662)
Size	-0.0009985***	-0.0010301***	-0.0010584***	-0.0010799***	-0.0094212***	-0.0096542***	-0.0100342***	-0.0105032***
	(0.0002665)	(0.0002650)	(0.0002568)	(0.0002645)	(0.0024148)	(0.0024218)	(0.0023385)	(0.0024165)
Liquidity	0.0043272***	0.0045322***	0.0045582***	0.0023272	0.0404436***	0.0454985***	0.0419762***	0.0237662
	(0.0014794)	(0.0015692)	(0.0013958)	(0.0017385)	(0.0144398)	(0.0151236)	(0.0135560)	(0.0173494)
Equity	0.0241993***	0.0270993***	0.0299480***	0.0223285**	-0.2834981***	-0.2291408***	-0.2331973***	-0.3034908***
	(0.0082358)	(0.0084102)	(0.0084532)	(0.0087338)	(0.0872171)	(0.0807217)	(0.0870245)	(0.0932818)
Deposits / Total Assets	-0.0040156***	-0.0034570**	-0.0034548**	-0.0010352	-0.0553083***	-0.0431083***	-0.0509481***	-0.0301187*
	(0.0014697)	(0.0015156)	(0.0014651)	(0.0017878)	(0.0155176)	(0.0150028)	(0.0158839)	(0.0178738)
Constant	0.0278401***	0.0279954***	0.0275260***	0.0259051***	0.3268989***	0.3329352***	0.3247343***	0.3156079***
	(0.0050929)	(0.0051884)	(0.0049573)	(0.0050738)	(0.0489965)	(0.0503518)	(0.0478452)	(0.0495181)
Observations	606	606	606	606	606	606	606	606
R-Squared	0.3326152	0.3300082	0.3354948	0.3349333	0.2863964	0.2872758	0.2877772	0.2883895

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.12: Bank Diversification and Financial Stability (Risk-Adjusted ROA and Risk-Adjusted ROE) – COVID-19 Period

The table reports the effect of bank diversification on bank performance during the COVID-19 period (2019Q4 – 2020Q4), using OLS estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Risk Adjusted - ROA				**Risk Adjusted - ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	-1.3778450***	-2.8348296***	0.0606656	-0.3154467	-1.5590797***	-3.6935865***	0.0601585	-0.2740969
	(0.5182964)	(0.8343737)	(0.1205692)	(0.2851224)	(0.5374834)	(0.9096706)	(0.1252707)	(0.2948649)
Stressed * Diversification	3.8020305***	2.9272515**	1.6780112***	0.5197568	4.0223830***	3.5493616**	1.5576850***	0.3908681
	(1.0254705)	(1.3194091)	(0.5835682)	(0.6119855)	(1.0511029)	(1.3988031)	(0.5822535)	(0.6498506)
Stressed	-0.6881232	-0.3419051	-0.0522957	0.5761389	-0.8574715*	-0.6799412	-0.0569618	0.5788898
	(0.4600068)	(0.5404853)	(0.3779034)	(0.4251761)	(0.4786429)	(0.5896577)	(0.3849285)	(0.4375363)
Size	-0.2999378***	-0.3135084***	-0.3529754***	-0.3203367***	-0.2848587***	-0.2963740***	-0.3436547***	-0.3150905***
	(0.0544595)	(0.0566659)	(0.0571740)	(0.0572603)	(0.0567763)	(0.0587708)	(0.0595180)	(0.0598538)
Liquidity	1.3094030***	1.3717493***	1.2471194***	1.2722113***	1.3186494***	1.4095744***	1.2426733***	1.2681847***
	(0.3457990)	(0.3718289)	(0.3384651)	(0.3992963)	(0.3670672)	(0.3889422)	(0.3632427)	(0.4270557)
Equity	-0.4457171	2.3046546	0.2268034	0.6518617	-1.7179916	1.7637386	-0.9690113	-0.6045026
	(1.8773092)	(2.0244434)	(1.9901125)	(2.0893258)	(2.1768796)	(2.2081247)	(2.2879125)	(2.4095664)
Deposits / Total Assets	-0.7411023**	-0.2557098	-0.9146241**	-1.0274251**	-1.0153723**	-0.3692348	-1.2105333***	-1.3073323***
	(0.3730618)	(0.3323089)	(0.4069230)	(0.4365529)	(0.4214406)	(0.3697403)	(0.4631780)	(0.4810975)
Constant	8.8389208***	9.0686323***	9.3041519***	8.9009245***	8.9854552***	9.2586229***	9.4986125***	9.1478391***
	(1.0915228)	(1.1533305)	(1.1254397)	(1.1564574)	(1.1722164)	(1.2324836)	(1.2134172)	(1.2545519)
Observations	601	601	601	601	601	601	601	601
R-Squared	0.4196172	0.4207380	0.4113582	0.4088400	0.3995889	0.4065822	0.3888282	0.3865814

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.13: Bank Diversification and Financial Stability (Z-Score and NPL Ratio) – COVID-19 Period

The table reports the effect of bank diversification on bank performance during the COVID-19 period (2019Q4 – 2020Q4), using OLS estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Z-Score				**NPL Ratio**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	-24.6441071	-11.7023062	2.9710587	-16.8296333**	0.0038628	0.0203575**	-0.0088507*	-0.0052355
	(17.1751134)	(21.0511969)	(8.6429582)	(8.2180180)	(0.0029978)	(0.0092090)	(0.0046389)	(0.0035045)
Stressed * Diversification	75.7774503***	47.6653737*	23.2598171	-7.4383243	-0.0373336**	-0.0217130	0.0123099**	0.0075973
	(25.0056037)	(28.6591136)	(14.8053868)	(11.2693003)	(0.0152548)	(0.0155180)	(0.0060537)	(0.0078589)
Stressed	-46.3344897***	-33.8304208***	-28.4605258***	-10.8777249	0.0132355*	0.0077488	-0.0073217**	-0.0054341
	(10.1669696)	(12.1988973)	(7.4861402)	(8.0631550)	(0.0067482)	(0.0071802)	(0.0036253)	(0.0039499)
Size	2.6931567**	1.8351752	1.8503834	2.2662113*	0.0012275*	0.0009321	0.0011134**	0.0012682**
	(1.1667311)	(1.4451136)	(1.3622924)	(1.3324243)	(0.0006904)	(0.0006975)	(0.0005599)	(0.0006127)
Liquidity	15.0030007*	16.0405299*	12.9069001	21.1363226**	-0.0127423***	-0.0130025***	-0.0089897**	-0.0099794**
	(8.5048239)	(9.3059873)	(8.6915102)	(10.4873072)	(0.0042376)	(0.0045733)	(0.0040005)	(0.0042800)
Equity	115.0459959*	132.3094546*	120.8122978*	136.6941122**	-0.0794539**	-0.0969469**	-0.0533170*	-0.0765610**
	(60.1484169)	(69.9522405)	(62.5755829)	(59.7095376)	(0.0380284)	(0.0416841)	(0.0287117)	(0.0368918)
Deposits / Total Assets	-6.5690445	-6.9327912	-10.1774803	-21.4881616**	-0.0070855*	-0.0121954**	-0.0034599	-0.0113676*
	(7.7646715)	(7.7625570)	(9.6781580)	(10.2973413)	(0.0041687)	(0.0048504)	(0.0035252)	(0.0058915)
Constant	-8.1853932	0.8609649	-1.3350740	2.2399115	0.0048207	0.0086810	0.0062736	0.0089474
	(22.4972059)	(27.1147816)	(25.2507283)	(27.4456143)	(0.0189314)	(0.0185197)	(0.0155846)	(0.0193267)
Observations	601	601	601	601	606	606	606	606
R-Squared	0.0428852	0.0343926	0.0355890	0.0395006	0.0605367	0.0622663	0.1116173	0.0572688

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.14: Bank Diversification and Financial Stability (Equity Ratio) – COVID-19 Period

The table reports the effect of bank diversification on bank performance during the COVID-19 period (2019Q4 – 2020Q4), using OLS estimation. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Equity			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)
Diversification Measure	-0.0285542**	0.1256606***	0.0157606***	0.0281542***
	(0.0122043)	(0.0176335)	(0.0030181)	(0.0079974)
Stressed * Diversification	0.0482519*	-0.0318367	-0.0374193**	-0.0761810***
	(0.0287814)	(0.0301551)	(0.0181105)	(0.0107782)
Stressed	-0.0247268*	0.0134244	0.0154865	0.0392025***
	(0.0140083)	(0.0134920)	(0.0119562)	(0.0067765)
Size	-0.0038049***	-0.0063725***	-0.0045035***	-0.0063218***
	(0.0013726)	(0.0012363)	(0.0012271)	(0.0012216)
Liquidity	-0.0113530	-0.0127569	-0.0178646**	-0.0173904*
	(0.0087818)	(0.0090483)	(0.0086164)	(0.0096076)
Deposits / Total Assets	-0.0197358**	-0.0506765***	-0.0299375***	-0.0079628
	(0.0098194)	(0.0090172)	(0.0100457)	(0.0113186)
Constant	0.2169371***	0.2219244***	0.2193112***	0.2349930***
	(0.0249658)	(0.0246536)	(0.0235769)	(0.0252858)
Observations	606	606	606	606
R-Squared	0.1030128	0.1835679	0.1389427	0.1297489

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

5.6 Robustness Tests

To validate the above empirical results and scrutinise the robustness of the econometric approach. The following section constructs alternative econometric models to assess if the results are robust.

5.6.1 OLS Estimation

In line with Stiroh and Rumble (2006), I likewise adopt an OLS specification for the robustness tests[37]. Besides, the decision to adopt a similar approach to Stiroh and Rumble (2006) is driven by the authors using the FR Y-9C data in their paper.

Briefly, table 5.15 addresses the effect of diversification on bank profitability using OLS. In line with the GMM approach, I find similar results, which exhibit positive relationships between diversification and profitability (ROA and ROE). A similar theme emerges for the interaction between the stress-tested banks and diversification. Overall, I find that stress-tested banks that are diversified are more profitable than non-stress tested banks that are diversified.

Table 5.16 reports the OLS specification of the financial stability performance measures (risk-adjusted ROA and ROE), which similarly produces a positive relationship as observed by the GMM specification. Also, a few models yield positive results between the interaction of being stress-tested and diversified.

Finally, tables 5.17 and 5.18 provide significant results, unlike the baseline GMM model used in the main empirical results. I find mixed results, where diversification affects the Z-Score positively and negatively. Regarding the majority of the NPL loans, there is a negative relationship, thus suggesting that diversification helps reduce the NPL ratio, which in retrospect, mitigates credit risk problems.

In contrast to the baseline models, stress-tested diversified banks are less financially stable than non-stress tested banks; this is evident by the Z-Score and NPL ratio sign. Table 5.18 presents the equity ratio and shows that most models are positively correlated to bank diversification.

I repeat the econometric testing of the previous models above but add two more variables (interactions). I continue to use the OLS specification for this part of the econometric testing. In addition, I include dummy variables to represent the effect of bank diversification during the GFC period and the current COVID-19 pandemic.

Table 5.19-5.22 present these variations and examine the impact of diversification during these two crisis

[37] Moreover, I also conduct the same econometric tests using the FE model. The results produce similar findings as the OLS and GMM models. For brevity, I do not report the results, but are available on request.

periods. Table 5.19 reports the effect of being diversified during the subprime mortgage crisis and how this affects bank profitability. There is a positive and significant relationship for a select few model specifications, which shows that bank diversification as a strategy was influential.

Unexpectedly, bank diversification during the COVID-19 pandemic produces negative relationships. The result may provide evidence that diversification is less influential during this COVID-19 pandemic. However, I advise that the results be considered with caution due to data limitations and not account for the long-term effects of the pandemic.

Table 20 also finds positive relationships for both dependent variables for the GFC crisis regarding financial performance indicators. Notably, the results find that bank diversification is an underlying factor that supports financial stability. Likewise, I observe that diversification during the onset of the COVID-19 pandemic shows a negative relationship, meaning that diversification may not be as crucial as it was in the GFC period. Table 5.21 and 5.22 finds that diversification during the subprime mortgage crisis improved the Z-Score. The NPL ratio shows mixed results, finding positive and negative values. The results of the COVID-19 pandemic are insignificant for the Z-Score value, although half of the NPL ratio models find that diversification leads to an increase in the NPL ratio. Lastly, diversification during the GFC period increases equity, suggesting diversified banks improve their capital position, thus their resilience.

Table 5.15: Bank Diversification and Profitability (ROA and ROE) – OLS Estimation

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	ROA				**ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	0.0026348***	-0.0049802***	0.0004395**	0.0053982***	0.0475348***	-0.0506336***	0.0119843***	0.0563591***
	(0.0008434)	(0.0012955)	(0.0002035)	(0.0005051)	(0.0097887)	(0.0135543)	(0.0029325)	(0.0056056)
Stressed * Diversification	0.0059903***	0.0101338***	0.0015265***	-0.0060848***	0.0300176*	0.0749639***	0.0156607***	-0.0429674***
	(0.0014669)	(0.0018396)	(0.0004070)	(0.0008529)	(0.0167722)	(0.0193284)	(0.0053770)	(0.0088055)
Stressed	0.0007232	-0.0010997	0.0019320***	0.0061141***	0.0183492**	-0.0036637	0.0164568***	0.0482952***
	(0.0006398)	(0.0007425)	(0.0003518)	(0.0005622)	(0.0077240)	(0.0086118)	(0.0043032)	(0.0055934)
Size	-0.0006479***	-0.0004932***	-0.0004895***	-0.0006592***	-0.0059622***	-0.0032955***	-0.0040149***	-0.0050662***
	(0.0000867)	(0.0000841)	(0.0000831)	(0.0000847)	(0.0009024)	(0.0008582)	(0.0008304)	(0.0008341)
Liquidity	0.0012475***	0.0016759***	0.0010908**	-0.0007760	0.0145995***	0.0173661***	0.0156985***	-0.0078275
	(0.0004777)	(0.0005055)	(0.0004767)	(0.0005158)	(0.0048450)	(0.0050611)	(0.0048370)	(0.0056506)
Equity	0.0337490***	0.0352888***	0.0319097***	0.0268663***	-0.0200813	-0.0140822	-0.0612462**	-0.1008717***
	(0.0031264)	(0.0032597)	(0.0031237)	(0.0029896)	(0.0341496)	(0.0327236)	(0.0311789)	(0.0316043)
Deposits / Total Assets	-0.0014121***	0.0000297	-0.0007759	0.0015461***	-0.0040363	0.0151600***	0.0007831	0.0313907***
	(0.0005402)	(0.0005423)	(0.0005462)	(0.0005200)	(0.0055255)	(0.0056394)	(0.0054825)	(0.0060449)
Constant	0.0104916***	0.0098809***	0.0084293***	0.0091863***	0.1172322***	0.0989969***	0.0969216***	0.0923582***
	(0.0015840)	(0.0016571)	(0.0015542)	(0.0015709)	(0.0162480)	(0.0166079)	(0.0158713)	(0.0161921)
Observations	5,533	5,533	5,492	5,533	5,533	5,533	5,492	5,533
R-Squared	0.3438173	0.3435750	0.3415851	0.3591232	0.3134073	0.3083521	0.3184022	0.3265588

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.16: Bank Diversification and Financial Stability (Risk-Adjusted ROA and Risk-Adjusted ROE) – OLS Estimation

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Risk Adjusted - ROA				**Risk Adjusted - ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	0.8326503***	-0.0329657	0.2678088***	0.4949184***	0.7716710***	-0.2495727	0.2700488***	0.4954420***
	(0.1771839)	(0.2604660)	(0.0438066)	(0.1060978)	(0.1781819)	(0.2800132)	(0.0440226)	(0.1106190)
Stressed * Diversification	-0.3590370	-0.2799541	0.3489248***	0.2046351	-0.2665992	-0.1334575	0.3965713***	0.1584418
	(0.4283397)	(0.4217417)	(0.1031727)	(0.2183804)	(0.4437987)	(0.4482101)	(0.1023298)	(0.2232427)
Stressed	0.9118073***	0.8059648***	0.4908836***	0.5586816***	0.8490594***	0.7198125***	0.4382982***	0.5639096***
	(0.1893822)	(0.1837271)	(0.0866036)	(0.1312854)	(0.1960855)	(0.1979683)	(0.0887333)	(0.1357414)
Size	-0.1566575***	-0.1137775***	-0.1362558***	-0.1253111***	-0.1501300***	-0.1077674***	-0.1316980***	-0.1217138***
	(0.0184591)	(0.0186659)	(0.0178775)	(0.0182676)	(0.0186888)	(0.0187733)	(0.0181427)	(0.0185954)
Liquidity	0.2852996***	0.2587496**	0.3647161***	0.0418087	0.2742998***	0.2498162**	0.3468057***	0.0330237
	(0.1001360)	(0.1071156)	(0.0981644)	(0.1162648)	(0.1036601)	(0.1107208)	(0.1008177)	(0.1210501)
Equity	2.1690042***	1.7981104***	1.3394012**	1.2879410**	1.3366727**	1.1205114*	0.5102193	0.4831327
	(0.6443304)	(0.6525668)	(0.6349311)	(0.6333018)	(0.6751488)	(0.6702935)	(0.6649946)	(0.6637282)
Deposits / Total Assets	0.1670940	0.3637661***	0.1619677	0.5887738***	0.0711897	0.2943602**	0.0490779	0.4802566***
	(0.1152036)	(0.1176285)	(0.1128676)	(0.1223999)	(0.1217573)	(0.1199261)	(0.1194697)	(0.1287353)
Constant	2.8916938***	2.4213959***	2.7823483***	2.3928224***	2.9006874***	2.4774733***	2.8115635***	2.4328054***
	(0.3655558)	(0.3727715)	(0.3624558)	(0.3700574)	(0.3648941)	(0.3710683)	(0.3609688)	(0.3677096)
Observations	5,488	5,488	5,447	5,488	5,488	5,488	5,447	5,488
R-Squared	0.3958290	0.3921817	0.4047572	0.3957156	0.3814537	0.3785484	0.3909529	0.3817357

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.17: Bank Diversification and Financial Stability (Z-Score and NPL Ratio) – OLS Estimation

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Z-Score				**NPL Ratio**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	1.4177675	23.1872302***	5.9852167***	-24.4683478***	-0.0102474***	0.0229582***	-0.0053260***	-0.0102576***
	(5.1914302)	(7.0360087)	(1.1580797)	(3.0066863)	(0.0029798)	(0.0047885)	(0.0008432)	(0.0018337)
Stressed * Diversification	-23.5968543*	-22.1543545*	1.0670387	32.7503009***	0.0405111***	0.0285933***	0.0094511***	-0.0078966**
	(12.7153494)	(11.3769255)	(1.6996018)	(5.7057823)	(0.0064625)	(0.0070121)	(0.0021866)	(0.0035547)
Stressed	-3.7470856	-3.8341720	-14.0088307***	-30.8872787***	-0.0138207***	-0.0064420**	-0.0026647*	0.0080382***
	(5.5221526)	(4.6429628)	(1.9262938)	(3.5907235)	(0.0029807)	(0.0031079)	(0.0015698)	(0.0019491)
Size	2.3538113***	2.0975650***	1.8254819***	3.1979135***	0.0005673*	-0.0002741	0.0006833**	0.0005165*
	(0.5997060)	(0.5735622)	(0.5622070)	(0.5846411)	(0.0002944)	(0.0002827)	(0.0002727)	(0.0002788)
Liquidity	14.9532564***	14.8152569***	17.5446580***	23.1066770***	-0.0216176***	-0.0197112***	-0.0241727***	-0.0176588***
	(3.0028267)	(3.2085808)	(2.9233536)	(3.3680415)	(0.0020271)	(0.0020929)	(0.0020027)	(0.0023593)
Equity	269.1696276***	254.8273548***	256.6861562***	294.5572147***	-0.0845375***	-0.0932351***	-0.0722265***	-0.0687980***
	(19.6449967)	(20.7562645)	(19.9362399)	(19.8155846)	(0.0116629)	(0.0109365)	(0.0108447)	(0.0113929)
Deposits / Total Assets	-4.1020749	-8.6152011**	-8.9717011***	-13.7086678***	-0.0065468***	-0.0126625***	-0.0040859**	-0.0120052***
	(3.4104100)	(3.3452023)	(3.3584617)	(3.3128051)	(0.0017284)	(0.0016671)	(0.0016741)	(0.0017827)
Constant	-33.9614391***	-34.9423316***	-24.2212584**	-37.8173828***	0.0192025***	0.0237766***	0.0141127**	0.0207898***
	(12.0458151)	(12.1783478)	(11.6750311)	(11.7376456)	(0.0060607)	(0.0059987)	(0.0058426)	(0.0060022)
Observations	5,488	5,488	5,447	5,488	5,533	5,533	5,492	5,533
R-Squared	0.1021682	0.1034316	0.1099445	0.1152837	0.3077800	0.3155659	0.3216862	0.3095031

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.18: Bank Diversification and Financial Stability (Equity Ratio) – OLS Estimation

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Equity			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)
Diversification Measure	-0.0352776***	0.0991632***	0.0052242***	0.0318340***
	(0.0045435)	(0.0076943)	(0.0007952)	(0.0029523)
Stressed * Diversification	0.0429380***	-0.0736683***	-0.0050462*	-0.0337974***
	(0.0089521)	(0.0113957)	(0.0026006)	(0.0047122)
Stressed	-0.0170589***	0.0344262***	0.0046431**	0.0204979***
	(0.0040058)	(0.0045186)	(0.0022250)	(0.0029721)
Size	0.0004446	-0.0016909***	-0.0011100**	-0.0021033***
	(0.0004761)	(0.0005044)	(0.0004570)	(0.0004635)
Liquidity	-0.0609106***	-0.0625761***	-0.0621331***	-0.0714830***
	(0.0027249)	(0.0029034)	(0.0026529)	(0.0028739)
Deposits / Total Assets	0.0066305**	-0.0152188***	-0.0031145	0.0127049***
	(0.0032567)	(0.0034779)	(0.0034063)	(0.0032250)
Constant	0.1096775***	0.1039798***	0.1262270***	0.1272687***
	(0.0096919)	(0.0114578)	(0.0097194)	(0.0095596)
Observations	5,533	5,533	5,492	5,533
R-Squared	0.2347314	0.2647370	0.2293498	0.2474518

*Robust Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1*

Table 5.19: Bank Diversification and Profitability (ROA and ROE) – OLS Estimation with Interactions

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Diversification * Subprime and Diversification * COVID are two additional variables that assess the impact of being diversified during these two crisis periods. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	ROA				**ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	0.0024323***	-0.0045168***	0.0004334*	0.0048193***	0.0451856***	-0.0477882***	0.0101513***	0.0495584***
	(0.0009187)	(0.0013753)	(0.0002353)	(0.0005390)	(0.0094424)	(0.0132602)	(0.0027488)	(0.0054671)
Stressed * Diversification	0.0056826***	0.0099365***	0.0011636**	-0.0061921***	0.0256309	0.0727435***	0.0025872	-0.0440457***
	(0.0014511)	(0.0018633)	(0.0004834)	(0.0008318)	(0.0160885)	(0.0192628)	(0.0099070)	(0.0085320)
Stressed	0.0008007	-0.0010186	0.0021182***	0.0061421***	0.0194742***	-0.0034298	0.0231726***	0.0485691***
	(0.0006352)	(0.0007553)	(0.0003736)	(0.0005486)	(0.0073871)	(0.0084498)	(0.0063506)	(0.0053569)
Size	-0.0006383***	-0.0004925***	-0.0004780***	-0.0006680***	-0.0058300***	-0.0031416***	-0.0035433***	-0.0051644***
	(0.0000870)	(0.0000843)	(0.0000844)	(0.0000846)	(0.0008848)	(0.0008491)	(0.0008343)	(0.0008286)
Liquidity	0.0014088***	0.0016904***	0.0011408**	-0.0006760	0.0168440***	0.0180894***	0.0162330***	-0.0067363
	(0.0004777)	(0.0005055)	(0.0004765)	(0.0005156)	(0.0047864)	(0.0049864)	(0.0048106)	(0.0055946)
Equity	0.0329696***	0.0353155***	0.0317651***	0.0269444***	-0.0307986	-0.0167841	-0.0719021**	-0.1001662***
	(0.0031166)	(0.0032596)	(0.0031362)	(0.0029972)	(0.0329268)	(0.0323397)	(0.0307365)	(0.0316586)
Deposits / Total Assets	-0.0013681**	0.0000443	-0.0007682	0.0013371**	-0.0034324	0.0156369***	0.0008285	0.0291090***
	(0.0005407)	(0.0005423)	(0.0005454)	(0.0005221)	(0.0055493)	(0.0056340)	(0.0054629)	(0.0059615)
Diversification * Subprime	0.0107487***	-0.0006160	0.0004939	0.0073288***	0.1476913**	0.0909438	0.0193866*	0.0816457**
	(0.0029030)	(0.0038284)	(0.0004341)	(0.0017950)	(0.0632898)	(0.0850133)	(0.0107901)	(0.0332312)
Diversification * COVID	-0.0048787**	-0.0046726*	-0.0012283**	0.0019219*	-0.0717275***	-0.0935769***	-0.0202504***	0.0249397**
	(0.0022761)	(0.0028242)	(0.0005916)	(0.0011132)	(0.0229894)	(0.0359699)	(0.0072330)	(0.0116156)
Constant	0.0104043***	0.0096574***	0.0082291***	0.0096664***	0.1158374***	0.0948796***	0.0905931***	0.0978505***
	(0.0015871)	(0.0016685)	(0.0015603)	(0.0015600)	(0.0161753)	(0.0165217)	(0.0158988)	(0.0159636)
Observations	5,533	5,533	5,492	5,533	5,533	5,533	5,492	5,533
R-Squared	0.3470644	0.3438879	0.3425440	0.3620148	0.3199892	0.3107425	0.3247849	0.3304356

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.20: Bank Diversification and Financial Stability (Risk-Adjusted ROA and Risk-Adjusted ROE) – OLS Estimation with Interactions

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Diversification * Subprime and Diversification * COVID are two additional variables that assess the impact of being diversified during these two crisis periods. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Risk Adjusted - ROA				**Risk Adjusted - ROE**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	0.9540740***	0.3818763	0.2349202***	0.3104634***	0.9270768***	0.3814636	0.2653347***	0.3011510***
	(0.1805070)	(0.2589815)	(0.0460700)	(0.1044002)	(0.1827367)	(0.2647957)	(0.0459608)	(0.1072435)
Stressed * Diversification	-0.4926732	-0.4566420	0.1565423	0.1616203	-0.4017000	-0.3849709	0.2998944**	0.1248543
	(0.4097838)	(0.4165163)	(0.1348555)	(0.2049085)	(0.4253920)	(0.4354445)	(0.1425881)	(0.2120695)
Stressed	0.9537385***	0.8803122***	0.5896220***	0.5701188***	0.8927548***	0.8371374***	0.4878118***	0.5723512***
	(0.1825693)	(0.1809429)	(0.0992939)	(0.1241883)	(0.1894636)	(0.1901613)	(0.1048573)	(0.1289773)
Size	-0.1542117***	-0.1135058***	-0.1290972***	-0.1282315***	-0.1479108***	-0.1098452***	-0.1284777***	-0.1244688***
	(0.0184446)	(0.0186992)	(0.0179426)	(0.0181965)	(0.0187071)	(0.0187235)	(0.0181709)	(0.0185392)
Liquidity	0.3341095***	0.2699564**	0.3680394***	0.0785212	0.3201246***	0.2558647**	0.3578599***	0.0662743
	(0.0990571)	(0.1051134)	(0.0977656)	(0.1149819)	(0.1029929)	(0.1068777)	(0.1003953)	(0.1201989)
Equity	1.9822636***	1.8243788***	1.1630077*	1.3194202**	1.1719078*	1.2064408*	0.4611184	0.5028080
	(0.6368966)	(0.6482845)	(0.6376662)	(0.6290227)	(0.6686649)	(0.6599078)	(0.6668471)	(0.6602481)
Deposits / Total Assets	0.1770818	0.3762941***	0.1618370	0.5127992***	0.0799677	0.3075287***	0.0507550	0.4114298***
	(0.1140894)	(0.1165038)	(0.1123439)	(0.1201559)	(0.1203135)	(0.1181239)	(0.1189065)	(0.1265825)
Diversification * Subprime	2.4915743***	-0.7775445	0.2913117**	2.5506303***	2.1757005**	-2.7560026*	0.1347084	2.4043096***
	(0.9160584)	(1.1321573)	(0.1136015)	(0.5913687)	(0.9059017)	(1.4510433)	(0.1346357)	(0.5957913)
Diversification * COVID	-2.9244296***	-3.9857472***	-0.2130052*	0.4863410*	-3.0827030***	-5.0093530***	-0.2813287**	0.6609711**
	(0.5112441)	(0.7297505)	(0.1286808)	(0.2571873)	(0.5435745)	(0.8622589)	(0.1323684)	(0.2881608)
Constant	2.7961948***	2.2274640***	2.6920769***	2.5516148***	2.7949000***	2.2280552***	2.7592417***	2.5904364***
	(0.3636098)	(0.3706388)	(0.3607082)	(0.3674323)	(0.3629386)	(0.3661659)	(0.3598449)	(0.3654971)
Observations	5,488	5,488	5,447	5,488	5,488	5,488	5,447	5,488
R-Squared	0.4036625	0.3965104	0.4069518	0.4019349	0.3890140	0.3861662	0.3919945	0.3874779

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.21: Bank Diversification and Financial Stability (Z-Score and NPL Ratio) – OLS Estimation with Interactions

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Diversification * Subprime and Diversification * COVID are two additional variables that assess the impact of being diversified during these two crisis periods. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Z-Score				**NPL Ratio**			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**	**AHHI – Main**	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Diversification Measure	4.4046791	23.0878870***	6.0365412***	-25.0464617***	-0.0098242***	0.0224446***	-0.0056129***	-0.0104443***
	(5.4500352)	(7.4932210)	(1.2344028)	(3.1558139)	(0.0033087)	(0.0051884)	(0.0009527)	(0.0019504)
Stressed * Diversification	-23.6818127*	-22.4787476**	-0.3800584	32.4851659***	0.0411886***	0.0285248***	0.0077006***	-0.0072520**
	(12.9380015)	(11.4347442)	(1.7029733)	(5.6705705)	(0.0064771)	(0.0070782)	(0.0023946)	(0.0035610)
Stressed	-3.6041577	-3.9419010	-13.2687753***	-30.8113458***	-0.0139920***	-0.0066071**	-0.0017653	0.0078409***
	(5.6169003)	(4.6702848)	(1.9056952)	(3.5837839)	(0.0029917)	(0.0031357)	(0.0016884)	(0.0019525)
Size	2.3327706***	2.1504414***	1.8697944***	3.1851912***	0.0005464*	-0.0002322	0.0007479***	0.0005321*
	(0.6019959)	(0.5767764)	(0.5656865)	(0.5844261)	(0.0002953)	(0.0002802)	(0.0002717)	(0.0002782)
Liquidity	14.6706026***	15.0463174***	17.8069470***	23.2819977***	-0.0219704***	-0.0195470***	-0.0241337***	-0.0179396***
	(3.0037850)	(3.2204331)	(2.9461772)	(3.3654140)	(0.0020224)	(0.0020930)	(0.0019928)	(0.0023489)
Equity	271.1916647***	253.8440844***	256.3591763***	294.8057790***	-0.0828380***	-0.0940797***	-0.0737930***	-0.0695627***
	(19.7302232)	(20.7786807)	(20.1768222)	(19.8144951)	(0.0117093)	(0.0110131)	(0.0109740)	(0.0113655)
Deposits / Total Assets	-4.2132867	-8.4930612**	-8.9286160***	-14.0712993***	-0.0066425***	-0.0125684***	-0.0040858**	-0.0114241***
	(3.4062886)	(3.3493699)	(3.3601461)	(3.3195070)	(0.0017341)	(0.0016661)	(0.0016808)	(0.0017945)
Diversification * Subprime	-28.9986055	33.6207004*	1.8958240	11.1331854	-0.0234324**	0.0276211**	0.0026367*	-0.0142534**
	(23.9961415)	(19.0240622)	(1.7048173)	(14.2096087)	(0.0107162)	(0.0130265)	(0.0015627)	(0.0057383)
Diversification * COVID	-13.1073631	-21.4357697	-6.0093251	-0.1289810	0.0108335**	-0.0132740	-0.0020956	0.0094068***
	(16.8525549)	(14.0216223)	(7.9415031)	(6.8387486)	(0.0042391)	(0.0091195)	(0.0047667)	(0.0029276)
Constant	-34.8457374***	-35.8645798***	-25.0762249**	-37.2126428***	0.0194010***	0.0232438***	0.0132880**	0.0203913***
	(12.0469959)	(12.3247947)	(11.6774653)	(11.6917595)	(0.0060775)	(0.0060423)	(0.0057870)	(0.0059895)
Observations	5,488	5,488	5,447	5,488	5,533	5,533	5,492	5,533
R-Squared	0.1028490	0.1040868	0.1106063	0.1154812	0.3089974	0.3164577	0.3224552	0.3111470

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 5.22: Bank Diversification and Financial Stability (Equity Ratio) – OLS Estimation with Interactions

The table reports the effect of bank diversification on bank performance, using OLS estimation from 2005Q1-2020Q4. Four alternative diversification measures are used across each model. The performance measures (dependent variables) are segmented into bank profitability and financial stability. The bank profitability measures are proxied by ROA and ROE. The financial stability measures are proxied by the Risk-Adjusted ROA, Risk-Adjusted ROE, Z-Score, NPL Ratio and Equity Ratio. The explanatory variables include Size, Liquidity, Equity, and Deposits. The Diversification * Subprime and Diversification * COVID are two additional variables that assess the impact of being diversified during these two crisis periods. The Stressed variable is a dummy variable that accounts for U.S. banks that are included in all of the Fed's stress testing programmes since 2009 (11 banks). The Stressed and Diversification variables are interacted together to understand the effects of being a part of the stress testing programme and being diversified. Model (1) includes all controls and the AHHI - Main Diversification measure. Model (2) includes all controls and the AHHI - Assets Diversification measure. Model (3) includes all control variables and the AHHI - Non-Interest Diversification measure. Model (4) includes all controls and the Non-interest share measure which is not based on the AHHI construction technique. I also use year effects for each model but do not report the results. All models include robust standard errors which are reported in parentheses. The AR (2) value and Hansen value are also presented below. For further detail, Table 5.1 reports the description, and summary statistics for all variables. The methodology section outlines the construction estimation for the main AHHI Diversification measures.

	Equity			
	AHHI – Main	**AHHI - Assets**	**AHHI - Non - Interest**	**Non-interest share**
	(1)	(2)	(3)	(4)
Diversification Measure	-0.0397678***	0.0948821***	0.0021793***	0.0314764***
	(0.0047550)	(0.0082870)	(0.0008249)	(0.0031175)
Stressed * Diversification	0.0418644***	-0.0723413***	-0.0139722***	-0.0333148***
	(0.0088233)	(0.0115498)	(0.0018709)	(0.0047421)
Stressed	-0.0169191***	0.0335011***	0.0092073***	0.0203428***
	(0.0039514)	(0.0046117)	(0.0018723)	(0.0030004)
Size	0.0005017	-0.0016118***	-0.0007125	-0.0020930***
	(0.0004690)	(0.0005024)	(0.0004551)	(0.0004647)
Liquidity	-0.0597317***	-0.0622455***	-0.0622983***	-0.0716265***
	(0.0027041)	(0.0028986)	(0.0026403)	(0.0028788)
Deposits / Total Assets	0.0068892**	-0.0151080***	-0.0032890	0.0130777***
	(0.0032359)	(0.0034657)	(0.0034065)	(0.0032422)
Diversification * Subprime	0.0721247***	0.0572313***	0.0150267***	-0.0085808
	(0.0160198)	(0.0208363)	(0.0013449)	(0.0104515)
Diversification * COVID	0.0031293	0.0058958	0.0115628***	0.0079375
	(0.0134952)	(0.0216692)	(0.0029414)	(0.0078223)
Constant	0.1100193***	0.1042709***	0.1211581***	0.1270494***
	(0.0096711)	(0.0115488)	(0.0096572)	(0.0095976)
Observations	5,533	5,533	5,492	5,533
R-Squared	0.2386853	0.2660626	0.2394563	0.2478780

*Robust Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

5.6.2 Diversification Scores During Two Crisis Periods

The results of the diversification score may be susceptible to weaknesses as I average the diversification score for each bank using 64 quarters. One issue that may persist is that some banks may have been less diversified during a specific period and more diversified in an alternative period. To alleviate this issue, I develop a diversification score of each bank using the two crisis periods to average scores for each bank. For the GFC period (2007-2010), I construct the diversification score of each bank for 16 quarters to account for the subprime mortgage crisis. I then proceeded to average across the 16 quarters to evaluate which banks were more diversified during the GFC crisis; this, in turn, provides different diversification scores for each bank.

Subsequently, I also produced similar results to the baseline models that use an average score across the 64 quarters. Following this, I also develop alternative diversification scores for each bank during the current COVID-19 pandemic. I produce a diversification score of each bank for 5 quarters (2019Q4 – 2020Q4) and the average across each score, giving each firm one diversification score. The results of bank diversification on performance during the pandemic are similar to the baseline models, but are not reported for brevity.

5.7 Policy Recommendations

The policy recommendations for future research should mainly focus on two issues that arise from the results. First, the function of diversification for maximising revenue or minimising cost is analysed. Diversification helps alleviate bank risk, although I revisit the strategy and highlight its effectiveness during crisis periods for the chapter's objectives. While the empirical results find evidence of a diversification premium in times of crisis, bank managers should consider the intensity of diversification and their portfolio mix.

Importantly, Wagner (2010) suggests that diversification can help reduce individual risk, but there are possibilities of systemic risk crystallising in the background. Wagner (2010) proposes that bank diversification adopt sustainable levels as too much diversification can harm bank performance. I propose that diversification practices should be therefore carefully selected. However, the theme of the chapter hypothesises that diversification during a crisis should be a desirable strategy to support bank performance, especially when the central bank's base rate is low.

Second, a limitation of the chapter concerns the COVID-19 analysis. I attempt to understand the role of diversification on bank performance for two crisis periods (GFC and COVID-19). For the GFC period, I find significant results in which I can draw strong conclusions concerning the influence of diversification on bank performance. However, due to data availability, I am restricted to only analysing the first four quarters of the COVID-19 pandemic. Therefore, although the results show a positive relationship between diversification and bank performance, I cannot provide strong evidence to determine the long-term relationship. Future lines of research should consider the long-term effects when the data becomes available.

Regarding the stress testing section of our chapter, I hypothesise that underlying factors can ensure that diversification is effective enough to improve bank performance. Stress-tested and diversified banks perform better with respect to their profitability and financial stability levels. The result may inform policymakers on the effectiveness of the stress testing exercises and their impact on financial stability. However, the first and second empirical chapters show a trade-off between stress testing and improving bank performance. The stress-tested banks may be more financially stable, but the exercise negatively affects bank lending and could warrant further inadvertent effects.

5.8 Conclusions

Motivated by the current COVID-19 pandemic that has debilitated public health and consequently affected economic activity due to national lockdowns. The chapter aims to re-evaluate the function of bank diversification on a bank's financial performance. I build on the diversification literature by investigating the effect of diversification during two crisis periods. Namely, the beginning of the COVID-19 pandemic and the GFC of 2008-09. To this end, I empirically investigate the role of diversification on bank performance during these two crisis periods and compare the results. Importantly, I ask if there are visible differences in the relationship between diversification and bank performance during these periods.

I document positive relationships between diversification and bank performance for the baseline models, where diversification improves bank profitability and financial stability. In sum, the results indicate that diversification as a decision by bank managers to reduce risk by accumulating a diverse bank portfolio is a significant determinant in influencing bank performance.

In the second stage, I divide the period and compare the relationship during the GFC and COVID-19 pandemic. The results suggest that the effect of diversification on bank performance is positive. Nevertheless, the relationships are much stronger for the GFC, as shown by the larger magnitudes of the coefficient.

Second, I examine the relationship during the COVID-19 pandemic. Surprisingly, I find that the relationship exhibits significant results which is akin to the results shown for the GFC period. Therefore, the role of diversification continues to persist during the COVID-19 pandemic. However, I conclude that the results be interpreted with caution due to the data that only includes the first four quarters of 2020. Different results may become apparent if future research considers a long-term time horizon.

The literature explains that diversification should not be isolated, and underlying factors can facilitate its effectiveness. Among others, Adesina (2021) states that human efficiency is influential in facilitating diversification strategies. Deng et al. (2013) document that institutional shareholders can influence diversification strategy that supports financial stability. In sum, these papers generally suggest that bank diversification as a strategy can be beneficial if underlying conditions are met and either supported by specific factors. For this reason, I contribute to the diversification literature by assessing a sample of U.S. banks that participate in the FED's stress testing exercises.

The stress testing exercises are a prudential tool that gauges the impact of a hypothetical adverse shock on a bank's balance sheet and provides information to regulators on the bank's ability to withstand a shock and remain solvent. Analysing a set of stress-tested banks is equally important to practitioners, academics, and regulators alike in times of a crisis. This is vital as the function of the stress testing framework is to simulate a hypothetical shock. Given that a real crisis has now emerged, it is of interest to examine the resilience of the stress-tested banks.

In sum, I assess if being stress-tested (greater scrutiny) and being diversified (reduced risk) exhibits a significant relationship. Overall, the results find a positive significant correlation between being stress-tested and highly diversified. This particular sample of banks outperforms non-stress tested banks that are diversified especially during the COVID-19 pandemic, thus proving that the main objective of the stress testing frameworks is met.

The implication of this finding shows that stress-tested banks that are diversified are more profitable and financial stable, which is the key goal of the stress-testing regime and can fundamentally alleviate any risk management concerns. Policymakers can question and decide on the mix between being stress-tested and highly diversified and if this combination of reducing risk can replace regulations or reduce Moral Hazard issues.

Chapter 6

Conclusions

In this thesis, I attempt to examine the impact of supervisory stress testing on three bank performance indicators. The GFC exploited the weaknesses in the banking system and the system's inability to weather a financial shock. As expected, the magnitude of this shock affected economic activity and caused a global crisis. New regulations were implemented to safeguard the financial system to overcome such issues and reinforce the banking system's capability to absorb shocks and remain resilient.

The stress testing exercises that were an internal risk management practice before the crisis received renewed attention, and regulators improved the supervisory stress tests, which targeted the most significant systemic banks. Importantly, the exercises were overhauled to inform policymakers on the ability of the banks to withstand a shock and simultaneously ensure that the banking system can support an economy, especially in times of a downturn. Given that the stress test practices are now an established form of the risk management toolkit, I have the advantage of studying how the stress testing exercises affect bank performance.

In regards to the first and second empirical chapters, I assess if the stress test exercises inadvertently affect bank lending decisions. The recent literature review finds that bank lending is negatively affected by the stress tests. Although, I contribute to the subject by examining alternative jurisdictions relative to the U.S. banking system. First, I test the effect of the stress testing exercises on lending for the UK banking system. To my knowledge, I find that this relationship has not been examined for the UK. The empirical results for the UK find that banks that fail the stress testing exercise reduce lending relative to banks that pass. Concerning the contribution for the first stage, I provide incentives for future research to include and exploit the heterogeneities, as bank failure (negative outcome) can distort bank lending. In contrast to the literature, the effect of stress testing on bank lending does not lose its effectiveness in the most recent exercises. However, regulators should closely monitor the effectiveness of the exercises as they may follow the patterns that are noticeable for the U.S. banking system.

In the second empirical chapter, I follow the previous theme by assessing the effect of stress testing on bank lending for the EU system. An advantage of exploring an alternative jurisdiction is that the EBA stress testing framework differs from the UK and the U.S. stress tests regarding their structure and methodology. I diverge from the first empirical chapter and further contribute to the literature by employing two methodologies. Simply said, I include two methodologies that test the effect of stress testing on bank performance indicators. First, I analyse the impact of the exercises between two groups of banks (stress-tested and non-stress tested banks). Second, I examine the stress-tested banks in isolation and draw out heterogeneities among these banks. For the difference-in-difference specification, stress-tested banks reduce corporate loans relative to non-stress tested banks. The possible reasoning behind this result is that corporate loans may be deemed riskier than other loan types, hence why stress-tested banks reduce corporate loans. Moving forward, when I isolate the 39 stress-tested EU banks, I attempt to draw heterogeneities and assess if these significantly affect bank lending. I find that banks highly exposed to the stress tests reduce consumer loans relative to those less exposed to the stress test.

An alternative contribution of the second empirical chapter is to analyse credit risk, as the literature briefly posits that stress-tested banks reduce loans to manage credit risk. This thesis, therefore, contributes to the literature by studying how stress testing affects credit risk. The results show that stress-tested banks have higher credit risk levels than the non-stress tested banks. The chapter also hypothesises that stress-tested banks across the EU do not behave similarly. As a further contribution, I show that stress-tested GIIPS banks are weaker than non-GIIPS banks. GIIPS bank exhibit behaviour of reduced lending and higher credit risk levels.

The third chapter deviates from the main theme of the thesis. I contribute to the diversification literature and hypothesise that diversification supports bank performance during periods of financial crises. Additionally, I examine the role of diversification during the GFC and the recent COVID-19 pandemic. The results report that diversification improves profitability and financial stability and is an important determinant, specifically in times of crisis. In addition, I analyse a set of stress-tested banks and question if being stress-tested and diversified produces a comparative advantage. The results suggest a positive and significant relationship with being stress-tested and diversified, as these sets of banks are more profitable and financially stable than non-stress tested banks that are also diversified.

Overall, my thesis attempts to examine the impact of supervisory stress testing. The recent crisis exposed the vulnerabilities of the banking system. As a result of the crisis, the stress testing exercise was heavily improved. The literature section highlights the initial effects of the supervisory stress testing, such as public disclosure, criticisms of the structure, and market reactions. The recent literature now assesses how the stress testing exercises impact lending. My thesis documents evidence of reduced lending and increases in financial stability, as addressed in the third empirical chapter.

I find that the supervisory stress tests impact bank performance positively. While the stress tests reduce bank lending, this relation is only apparent for weaker banks. The weakest banks (failed/highly exposed) reduce lending to improve their balance sheets and capital ratios. This course of action may restrict bank lending but allows banks to build their resilience, which is a key objective of the stress testing exercises. Furthermore, the stress tests may affect banks differently, as GIIPS banks are riskier, which can be attributed to their macroeconomic environment.

I contribute to the growing literature on stress testing and provide incentives on the methodological structure for future research. Identifying heterogeneities, such as capturing failed banks, highly exposed banks, GIIPS banks, and dynamic analysis, are important components that future research must consider. Additionally, the impact of the exercises should be monitored closely by the regulators to ensure there is no repeat event such as the GFC, which harms the banking system and spills over into the real economy.

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Appendix

Appendix A

Chapter 3 - Supplementary Material

Table A.1: Loan Share of Each Bank

The table reports the loan share of each bank for all 19 banks in the sample. The top 7 banks provide 80% of lending to the real UK economy (BoE, 2015).

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
HSBC Holdings Plc	27.64	27.09	22.51	23.69	20.45	22.45	22.39	22.92	23.03	24.33	24.69	26.17	26.53	28.31
Barclays Plc	16.48	15.83	14.30	16.19	14.23	14.76	15.39	15.43	16.16	16.39	15.88	14.81	13.66	11.20
Lloyds Banking Group Plc	11.35	11.57	9.07	8.93	20.43	19.73	19.20	18.27	17.82	17.57	17.31	16.19	16.31	16.85
Royal Bank of Scotland Group Plc (The)	26.80	27.76	38.86	32.19	25.30	20.78	19.23	18.74	16.94	14.72	13.14	12.98	12.94	12.75
Standard Chartered Plc	4.26	4.09	3.50	4.81	4.74	5.97	6.84	7.14	7.75	8.25	7.83	8.96	9.08	8.54
Santander UK Plc	5.27	5.32	4.29	6.23	6.05	6.30	6.60	6.46	6.40	6.65	7.27	6.93	6.90	7.00
Nationwide Building Society	5.14	5.19	4.35	4.63	4.95	4.89	4.93	5.22	5.55	5.88	6.27	6.20	6.47	6.69
Coventry Building Society	N/A	N/A	N/A	0.43	0.44	0.56	0.63	0.74	0.83	0.95	1.07	1.12	1.23	1.36
Cybg Plc	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.00	1.02	1.11	1.15
Yorkshire Building Society	0.69	0.68	0.60	0.54	0.49	0.77	0.89	0.94	1.03	1.15	1.23	1.18	1.21	1.27
Tsb Banking Group Plc	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.83	0.76	0.96	1.02	1.06	1.04
Bank of Ireland (UK) Plc	N/A	N/A	N/A	N/A	N/A	0.99	1.22	1.50	1.05	0.86	0.84	0.79	0.77	0.76
Skipton Building Society	0.40	0.42	0.36	0.34	0.35	0.32	0.34	0.36	0.41	0.46	0.53	0.55	0.59	0.64
Co-operative Bank Plc (The)	0.50	0.48	0.38	0.37	1.11	1.18	1.15	1.17	1.09	0.95	0.74	0.68	0.59	0.63
Metro Bank PLC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.03	0.06	0.13	0.20	0.33	0.49
Leeds Building Society	N/A	N/A	0.29	0.25	0.23	0.23	0.25	0.28	0.32	0.36	0.42	0.46	0.52	0.56
Icbc Standard Bank Plc	0.23	0.28	0.30	0.39	0.32	0.32	0.27	0.13	0.12	0.05	0.05	0.07	0.07	0.06
Tesco Personal Finance Group Limited	0.40	0.36	0.28	0.17	0.14	0.16	0.15	0.19	0.24	0.27	0.31	0.34	0.39	0.44
AIB Group (UK) plc	0.84	0.94	0.92	0.84	0.77	0.59	0.54	0.52	0.41	0.34	0.34	0.31	0.25	0.26

Table A.2: t-test between banks who failed the stress test banks and banks who passed the stress test based on the BoE's stress testing frameworks

The table reports the t-test between two different groups. The difference in means between the stress-tested banks who failed the stress test and those who passed the stress test with respect to the BoE's stress tests framework. Only the 7 stress-tested banks by the BoE are analysed. The full sample is observed (2005-2018). The sample is then broken down into two parts. Pre-stress test and post-stress test.

	Full Sample			**2005-2013**			**2014-2018**		
	Failed Stress Tested Banks	Passed Stress Tested Banks	Difference	Failed Stress Tested Banks	Passed Stress Tested Banks	Difference	Failed Stress Tested Banks	Passed Stress Tested Banks	Difference
Total Loans Growth	3.56	3.78	-0.22	8.48	5.14	3.33	-4.31	1.59	-5.90**
Net Loans to Customers Growth	3.77	3.90	-0.13	8.72	5.18	3.55	-4.15	1.86	-6.01***
Net Loans to Banks Growth	1.77	5.26	-3.50	6.18	6.46	-0.27	-5.30	3.51	-8.81
Mortgage Loans Growth	6.17	3.26	2.91	9.64	3.94	5.70	0.33	2.21	-1.88
Consumer Loans Growth	1.57	2.21	-0.65	3.00	1.92	1.08	-0.85	2.69	-3.54
Corporate Loans Growth	5.13	12.45	-7.32	10.22	24.07	-13.85	-3.18	-3.82	0.64
CET1 Ratio	10.47	11.72	-1.25	8.73	9.39	-0.67	13.27	15.92	-2.65*

Table A.3: t-test between banks with a high CET1 ratio (above the median) and low CET1 ratio (below the median)

The table reports the t-test between two different groups. The difference in means between banks that have a High CET1 ratio (above the median) and Low CET1 ratio banks (below the median). All 19 banks are used within the sample for the t-test. The full sample is observed (2005-2018). The sample is then broken down into two parts. Pre-stress test and post-stress test.

	Full Sample			**2005-2013**			**2014-2018**		
	High CET1 Banks	Low CET1 Banks	Difference	High CET1 Banks	Low CET1 Banks	Difference	High CET1 Banks	Low CET1 Banks	Difference
Total Loans Growth	2.34	8.08	-5.74*	-0.02	7.69	-7.71	3.18	10.18	-7.00
Net Loans to Customers Growth	5.27	7.93	-2.66	2.20	7.58	-5.37	6.36	9.82	-3.46
Net Loans to Banks Growth	-4.85	7.04	-11.89**	-12.35	7.38	-19.73*	-2.17	5.31	-7.48
Mortgage Loans Growth	8.89	8.27	0.61	11.97	6.50	5.46	8.02	17.22	-9.20
Consumer Loans Growth	-5.66	6.24	-11.91**	-6.94	4.37	-11.32	-5.21	14.78	-20.00**
Corporate Loans Growth	-3.98	11.91	-15.89***	-11.88	10.10	-21.98**	-2.00	20.53	-22.53**
CET1 Ratio	17.36	9.48	7.88***	16.32	9.14	7.18***	17.75	11.49	6.26***

Table A.4: t-test between Globally Systemically Important Banks and non-Globally Systemically Important Banks

The table reports the t-test between two different groups. The difference in means between the stress-tested banks that are Globally Systemically Important Banks and non-Globally Systemically Important Banks. Only the 7 stress-tested banks by the BoE are analysed. The full sample is observed (2005-2018). The sample is then broken down into two parts. Pre-stress test and post-stress test.

	Full Sample			**2005-2013**			**2014-2018**		
	GSIB Bank	Non-GSIB Bank	Difference	GSIB Bank	Non-GSIB Bank	Difference	GSIB Bank	Non-GSIB Bank	Difference
Total Loans Growth	3.34	3.88	-0.54	6.50	7.46	-0.96	-1.70	-1.84	0.14
Net Loans to Customers Growth	3.62	3.98	-0.36	6.48	7.75	-1.26	-0.96	-2.04	1.09
Net Loans to Banks Growth	1.51	4.56	-3.05	7.21	5.57	1.64	-7.62	3.04	-10.66
Mortgage Loans Growth	3.44	6.09	-2.65	4.80	9.15	-4.36	1.26	1.08	0.17
Consumer Loans Growth	2.25	1.53	0.72	3.92	1.49	2.43	-0.61	1.59	-2.20
Corporate Loans Growth	5.60	10.24	-4.64	10.38	20.12	-9.74	-1.73	-4.83	3.09
CET1 Ratio	10.42	11.49	-1.07	9.07	9.01	0.06	12.67	15.71	-3.04**

Figure A.1: The change in Total Loans for the sample of banks

The figure shows the change in total loans for the sample of the 19 banks. Figure (a) is the change in total loans for the 19 banks. Figure (b) is the change in total loans for the BoE's stress-tested banks and the non-stress tested banks, the red vertical line shows the start of the BoE stress test in 2014. Figure (C) is the change in total loans for the EBA's stress-tested banks and the non-stress tested banks, the two red vertical lines show the 2009 and 2010 EBA's stress test exercises.

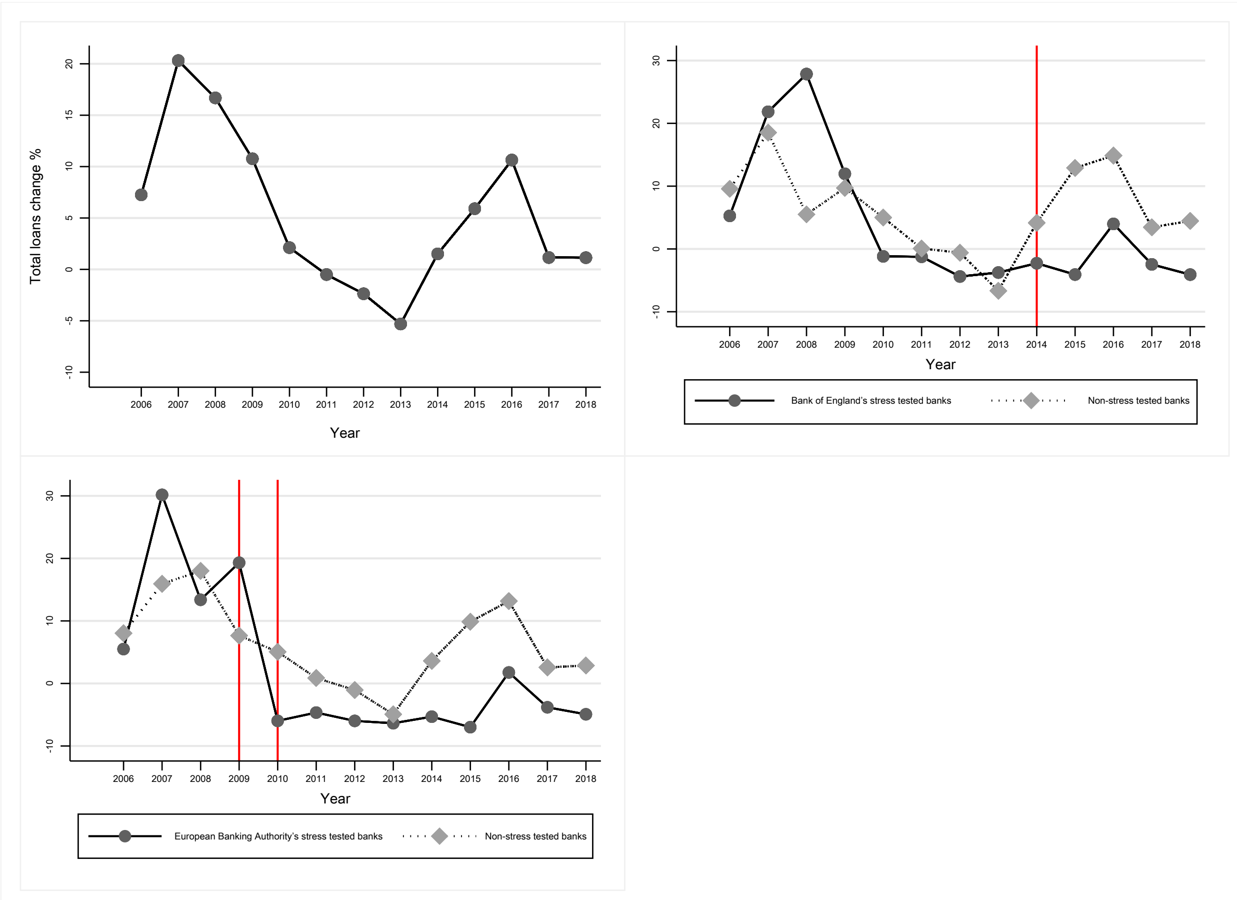


Figure A.2: The change in Net Loans to Customers for the sample of banks

The figure shows the change in net loans to customers for the sample of the 19 banks. Figure (a) is the change in net loans to customers for the 19 banks. Figure (b) is the change in net loans to customers for the BoE's stress-tested banks and the non-stress tested banks, the red vertical line shows the start of the BoE's stress test in 2014. Figure (C) is the change in net loans to customers for the EBA's stress-tested banks and the non-stress tested banks, the two red vertical lines show the 2009 and 2010 EBA's stress test exercises.

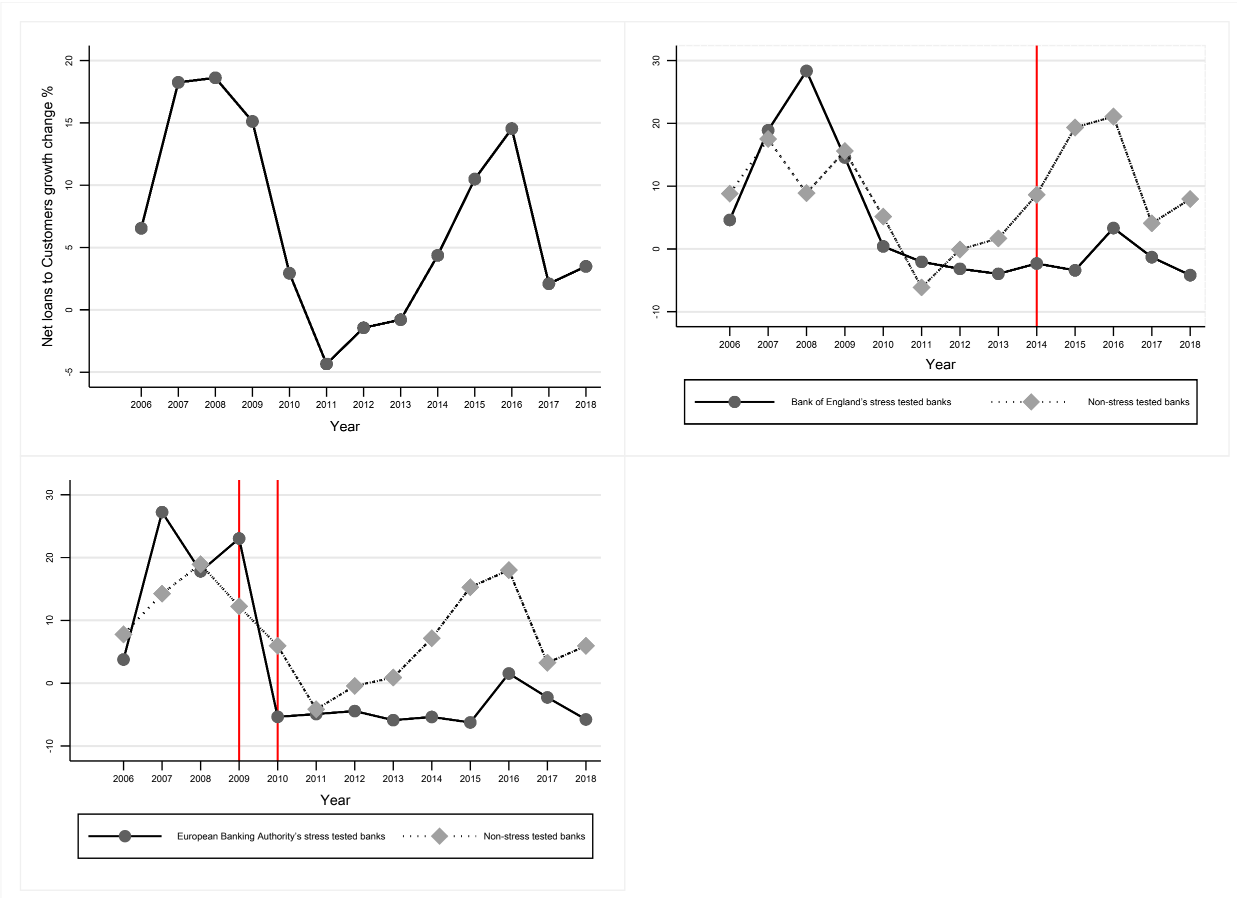


Figure A.3: The change in Net Loans to Banks for the sample of banks

The figure shows the change in net loans to banks for the sample of the 19 banks. Figure (a) is the change in net loans to banks for the 19 banks. Figure (b) is the change in net loans to banks for the BoE's stress-tested banks and the non-stress tested banks, the red vertical line shows the start of the BoE's stress test in 2014. Figure (C) is the change in net loans to banks for the EBA's stress-tested banks and the non-stress tested banks, the two red vertical lines show the 2009 and 2010 EBA's stress test exercises.

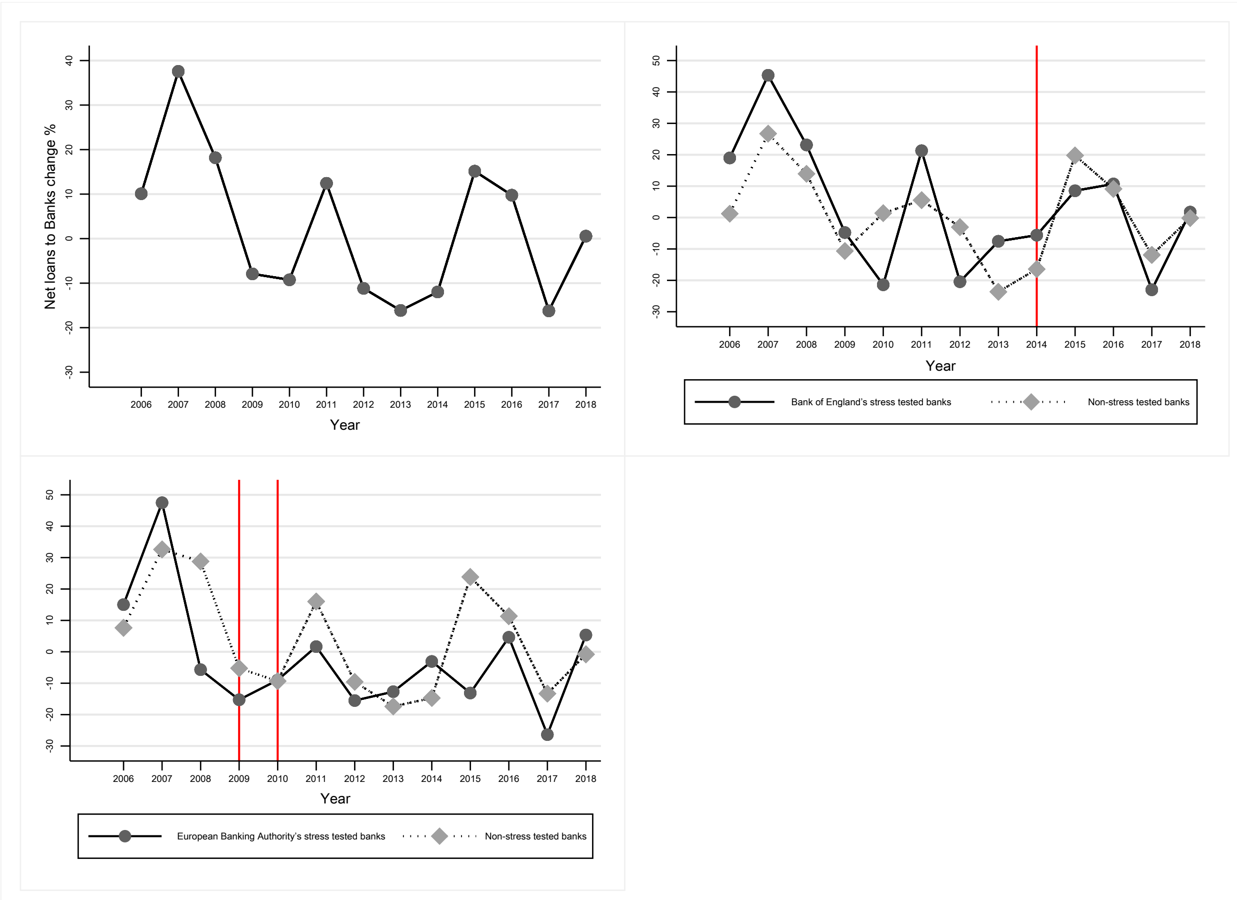


Figure A.4: The change in Mortgage Loans to banks for the sample of banks

The figure shows the change in mortgage loans for the sample of the 19 banks. Figure (a) is the change in mortgage loans for the 19 banks. Figure (b) is the change in mortgage loans for the BoE's stress-tested banks and the non-stress tested banks, the red vertical line shows the start of the BoE's stress test in 2014. Figure (C) is the change in mortgage loans to banks for the EBA's stress-tested banks and the non-stress tested banks, the two red vertical lines show the 2009 and 2010 EBA's stress test exercises.

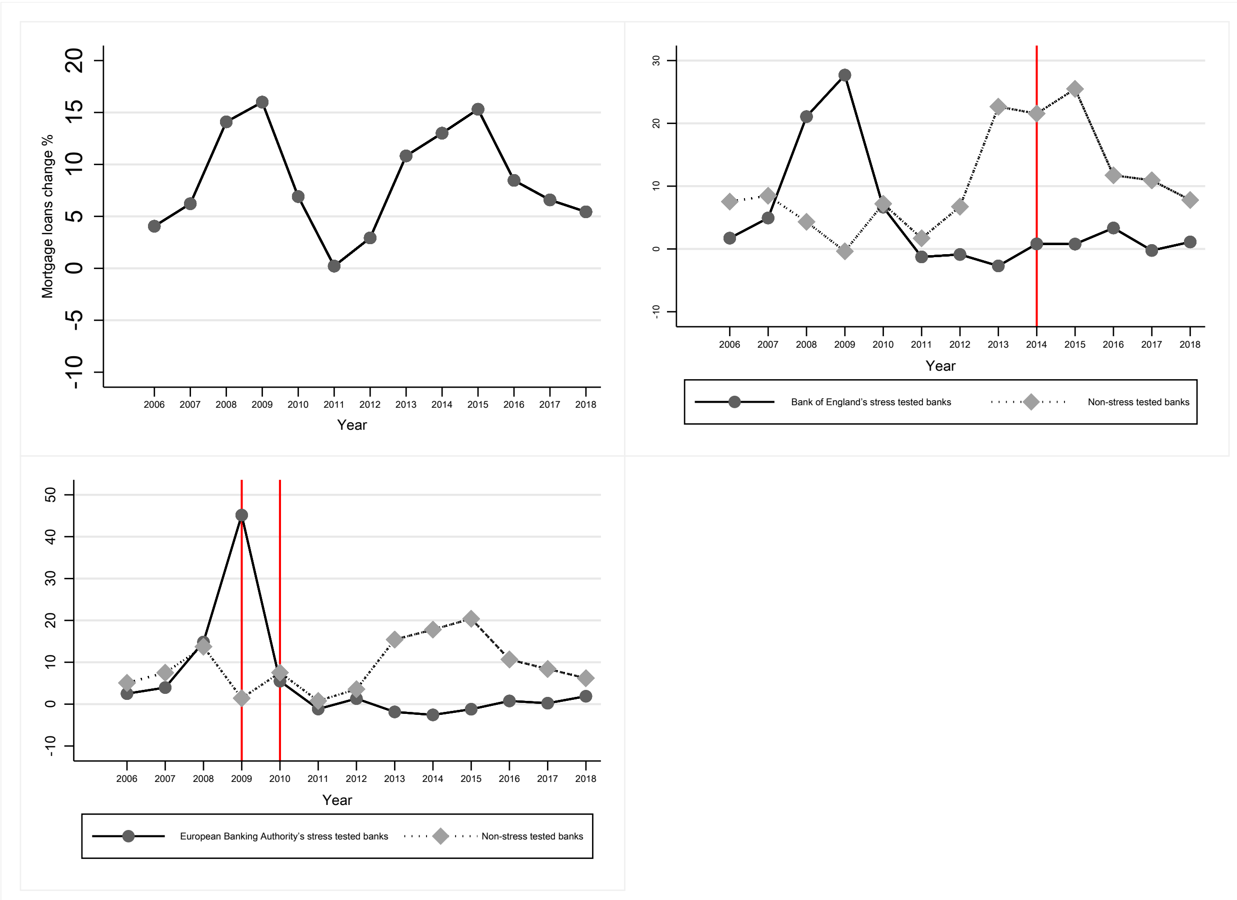


Figure A.5: The change in Consumer Loans to banks for the sample of banks

The figure shows the change in consumer loans for the sample of the 19 banks. Figure (a) is the change in consumer loans for the 19 banks. Figure (b) is the change in consumer loans for the BoE's stress-tested banks and the non-stress tested banks, the red vertical line shows the start of the BoE's stress test in 2014. Figure (C) is the change in consumer loans to banks for the EBA's stress-tested banks and the non-stress tested banks, the two red vertical lines show the 2009 and 2010 EBA's stress test exercises.

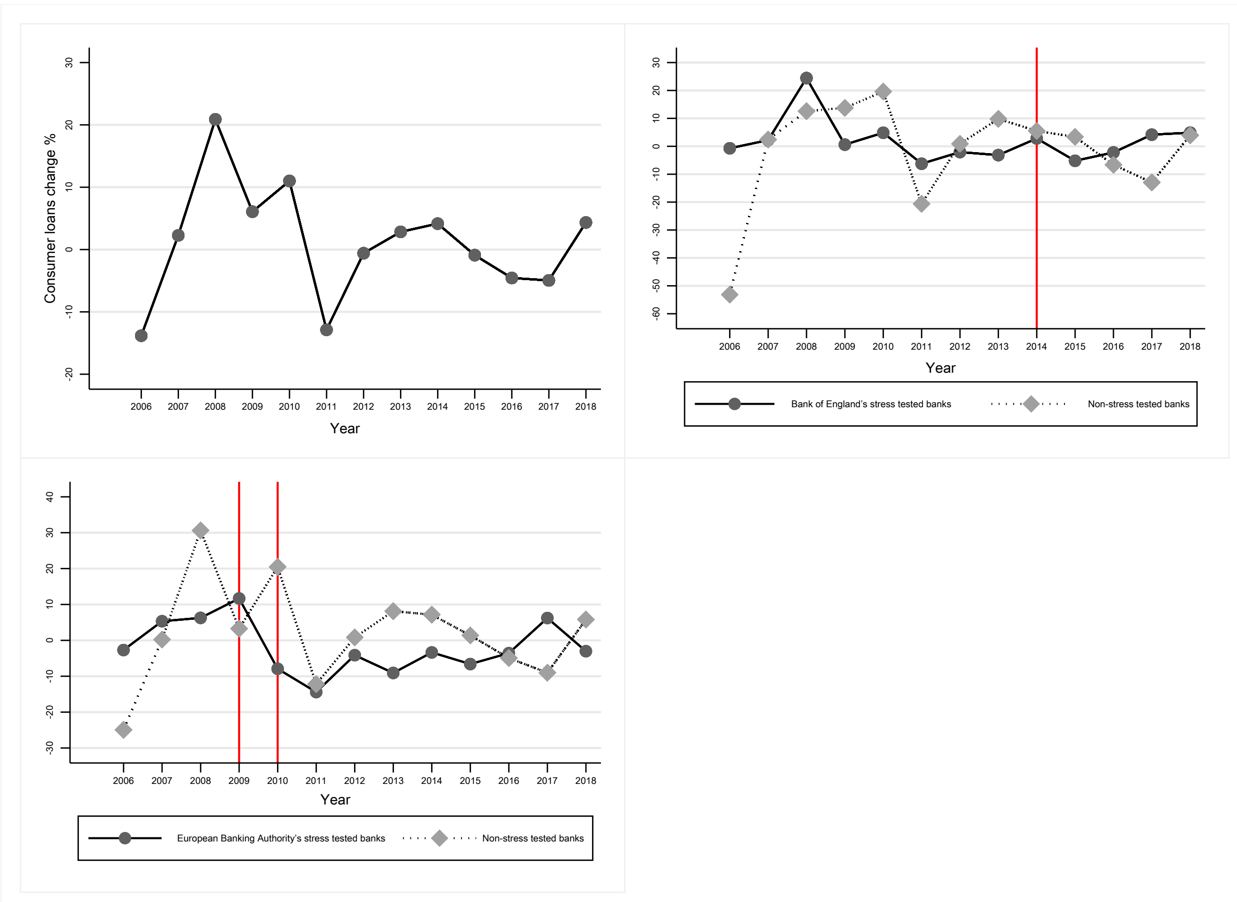


Figure A.6: The change in Corporate Loans to banks for the sample of banks

The figure shows the change in corporate loans for the sample of the 19 banks. Figure (a) is the change in corporate loans for the 19 banks. Figure (b) is the change in corporate loans for the BoE's stress tested banks and the non-stress tested banks, the red vertical line shows the start of the BoE's stress test in 2014. Figure (C) is the change in corporate loans to banks for the EBA's stress tested banks and the non-stress tested banks, the two red vertical lines show the 2009 and 2010 EBA's stress test exercises.

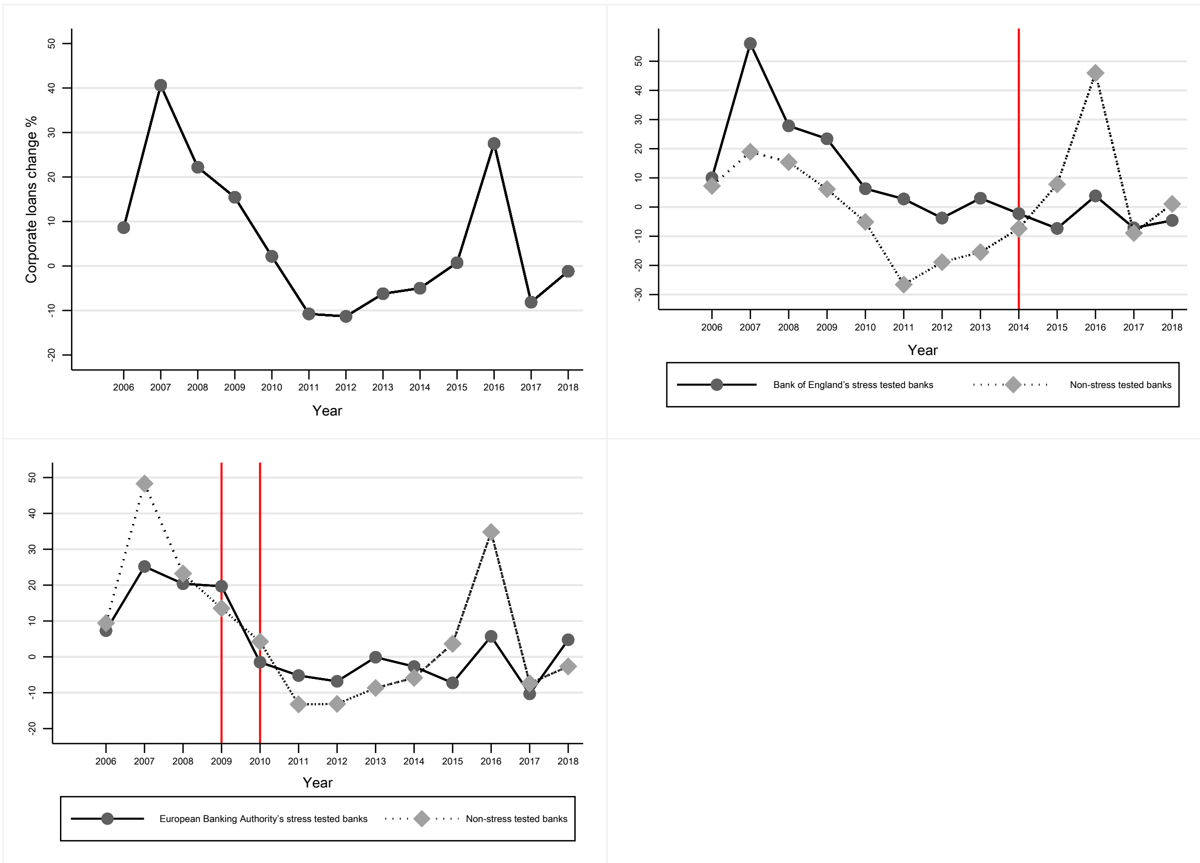


Figure A.7: The difference between failed banks and banks that have passed the BoE's stress tests

The figure shows the difference between banks that failed the BoE's stress tests and the banks that have passed the BoE's stress tests. Figure (a) shows the change in total loans, figure (b) shows the change in net loans to customers, and figure (c) shows the change in net loans to banks.

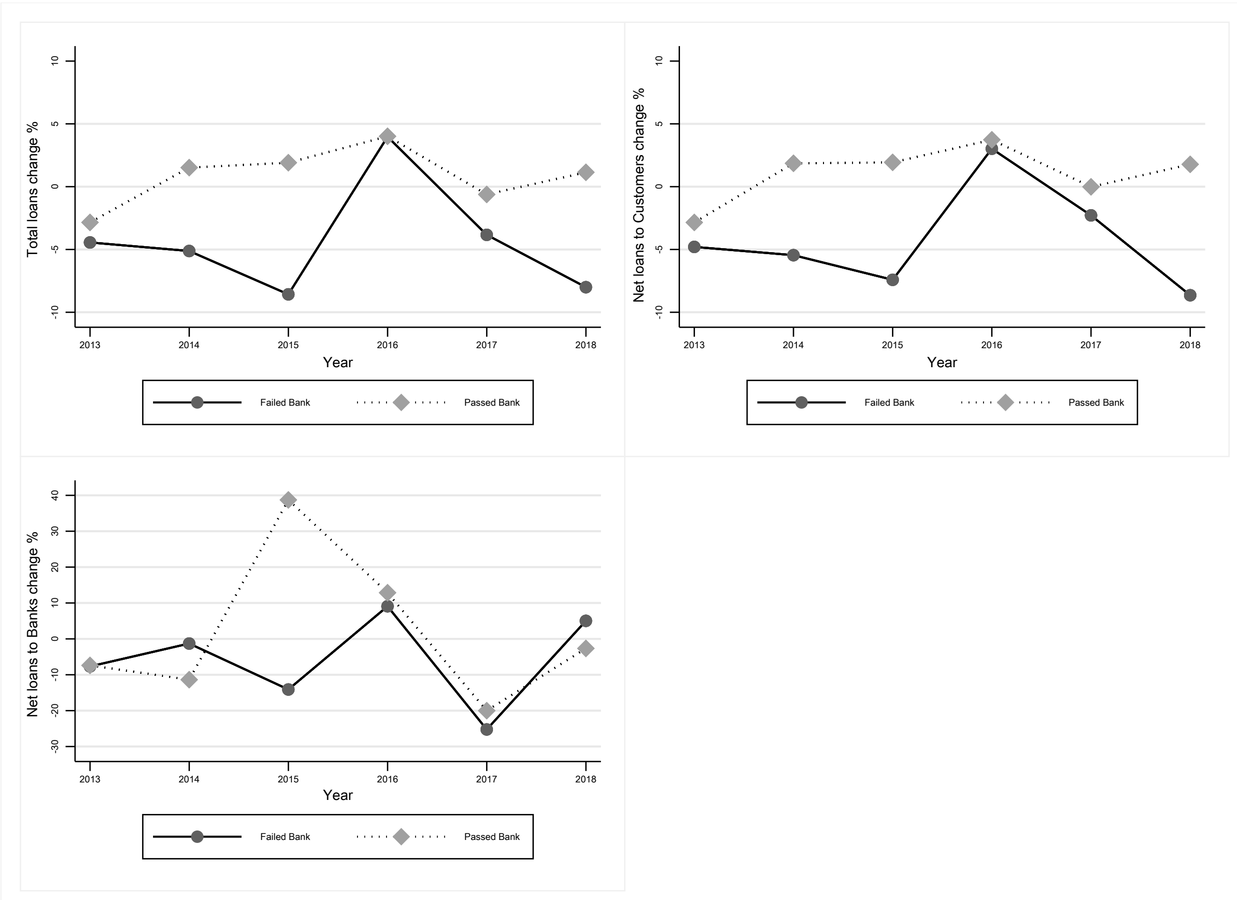


Figure A.8: The difference between failed banks and banks that have passed the BoE's stress tests (continued)

The figure shows the difference between banks that failed the BoE's stress tests and the banks that have passed the BoE's stress tests. Figure (a) shows the change in mortgage loans, figure (b) shows the change in consumer loans, and figure (c) shows the change in corporate loans.

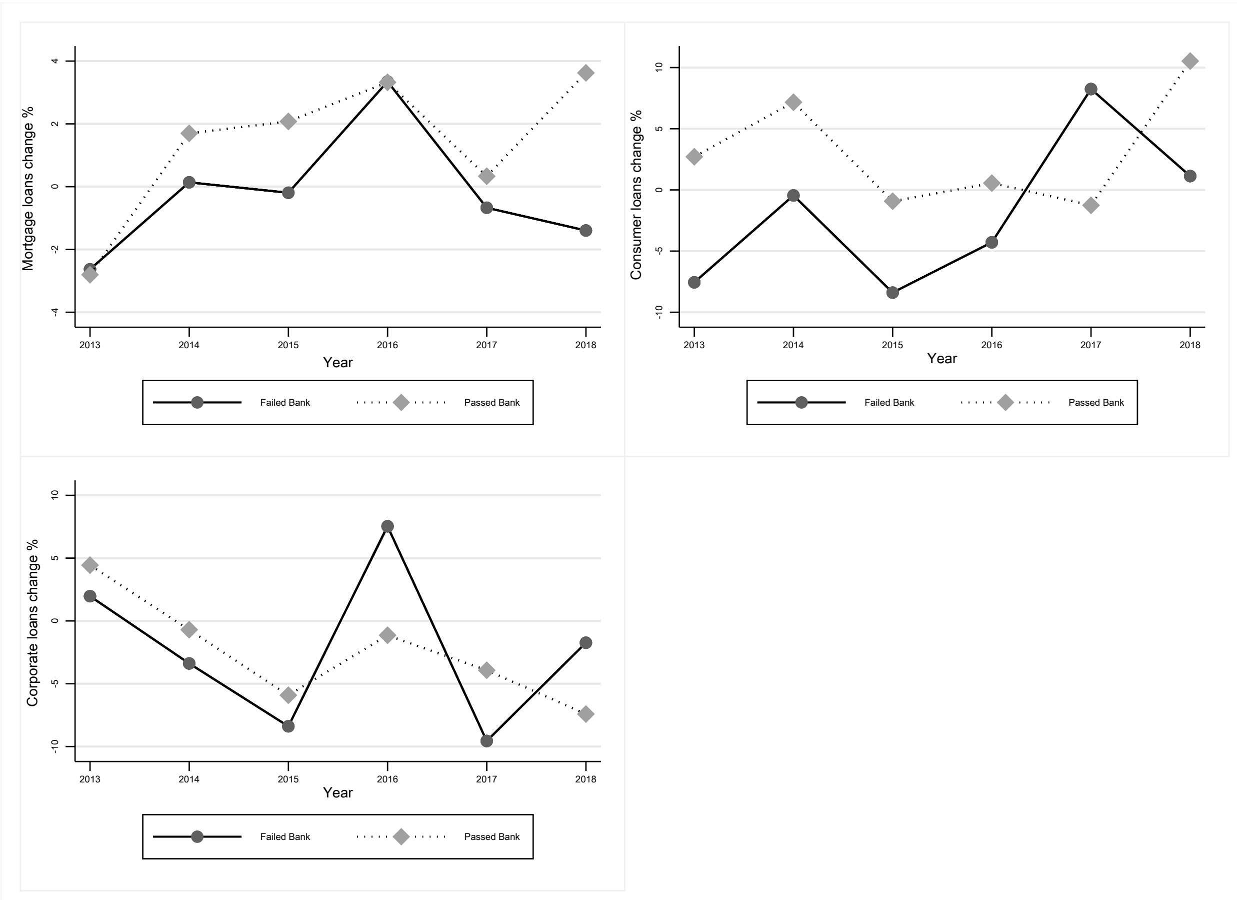


Figure A.9: The change in Total Loans for Barclays plc

The figure shows the change in total loans for Barclays plc. The BoE's stress test starts at 2014 and the vertical red line shows the year that Barclays plc failed the stress test.

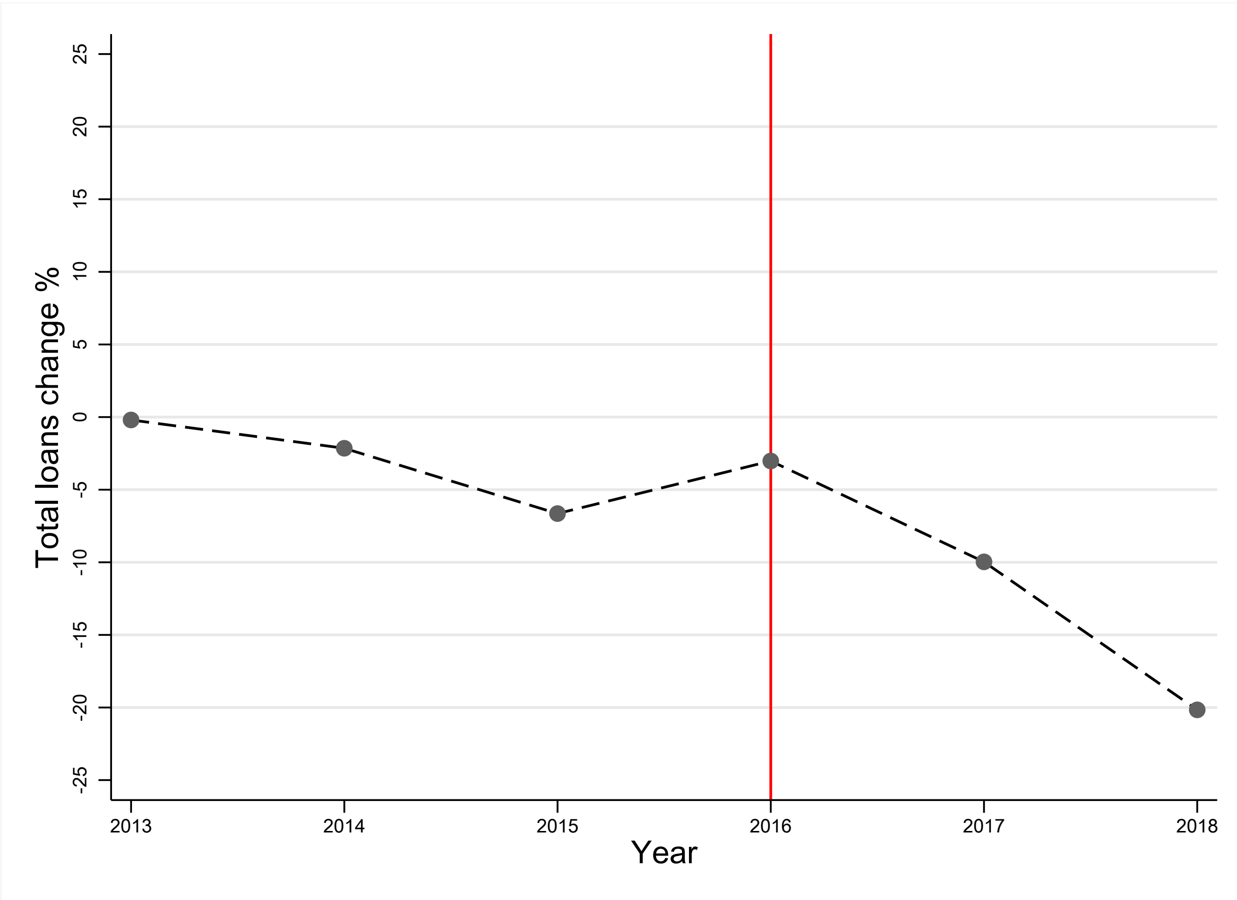


Figure A.10: The change in Total Loans for Lloyds Banking Group plc

The figure shows the change in total loans for Lloyds Banking Group plc. The BoE's stress test starts at 2014 and the vertical red line shows the year that Lloyds Banking Group plc failed the stress test.

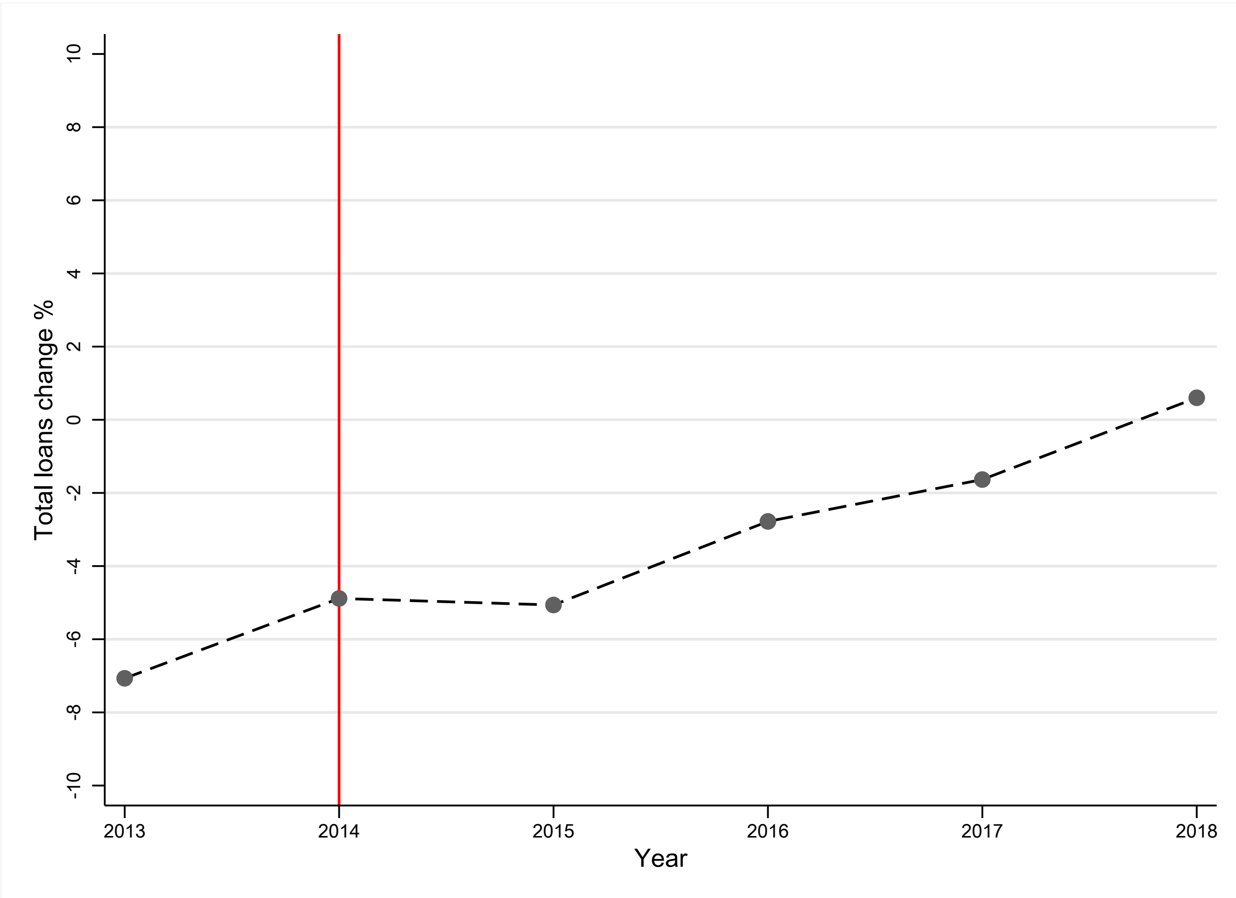


Figure A.11: The change in Total Loans for the Royal Bank of Scotland Group plc

The figure shows the change in total loans for the Royal Bank of Scotland Group plc. The BoE's stress test starts at 2014 and the vertical red lines show the years that the Royal Bank of Scotland Group plc failed the stress tests.

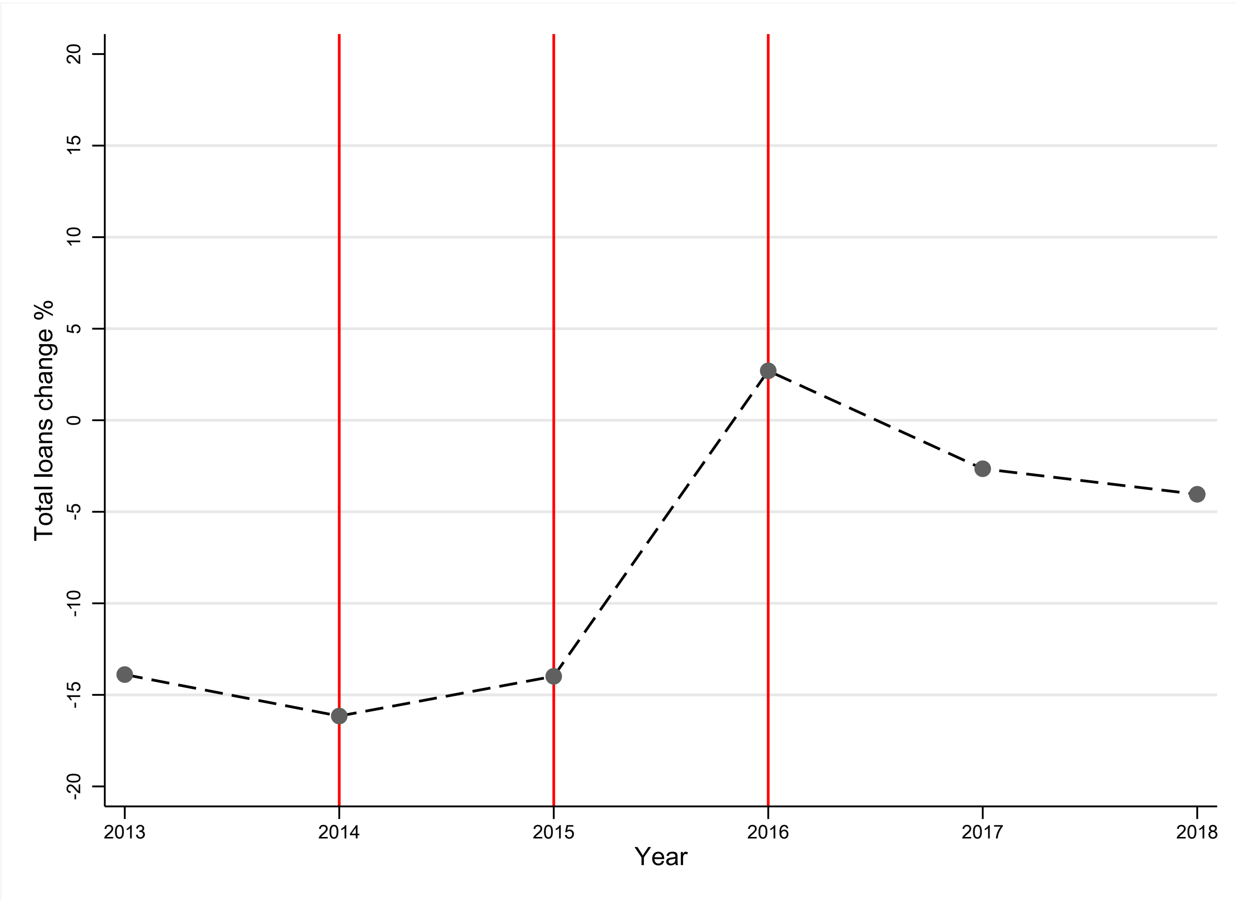
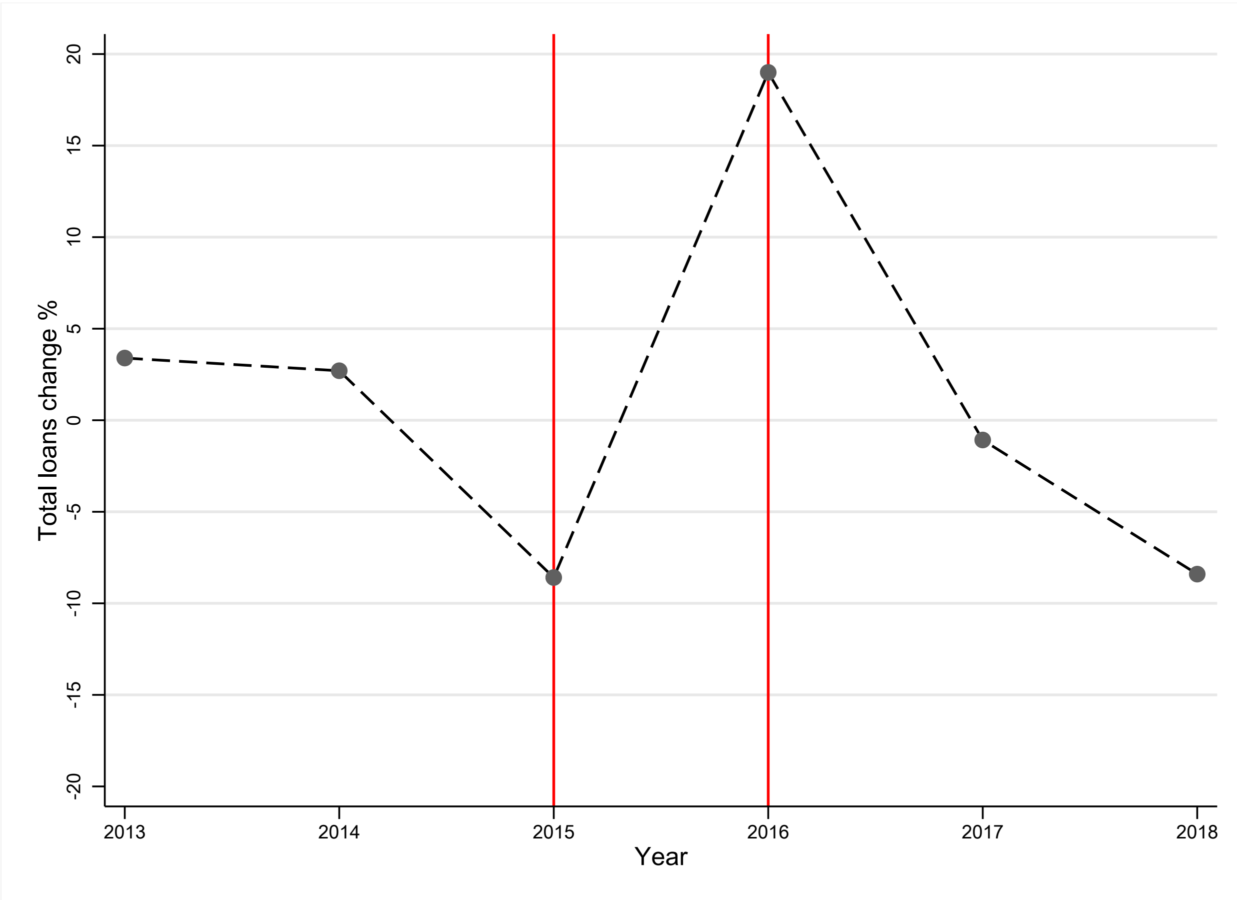


Figure A.12: The change in Total Loans for Standard Chartered plc

The figure shows the change in total loans for Standard Chartered plc. The BoE's stress test starts in 2014 and the vertical red lines show the years that Standard Chartered plc failed the stress tests.



Appendix B

Chapter 4 - Supplementary Material

Figure B.1: Change in Total Loans – All Banks

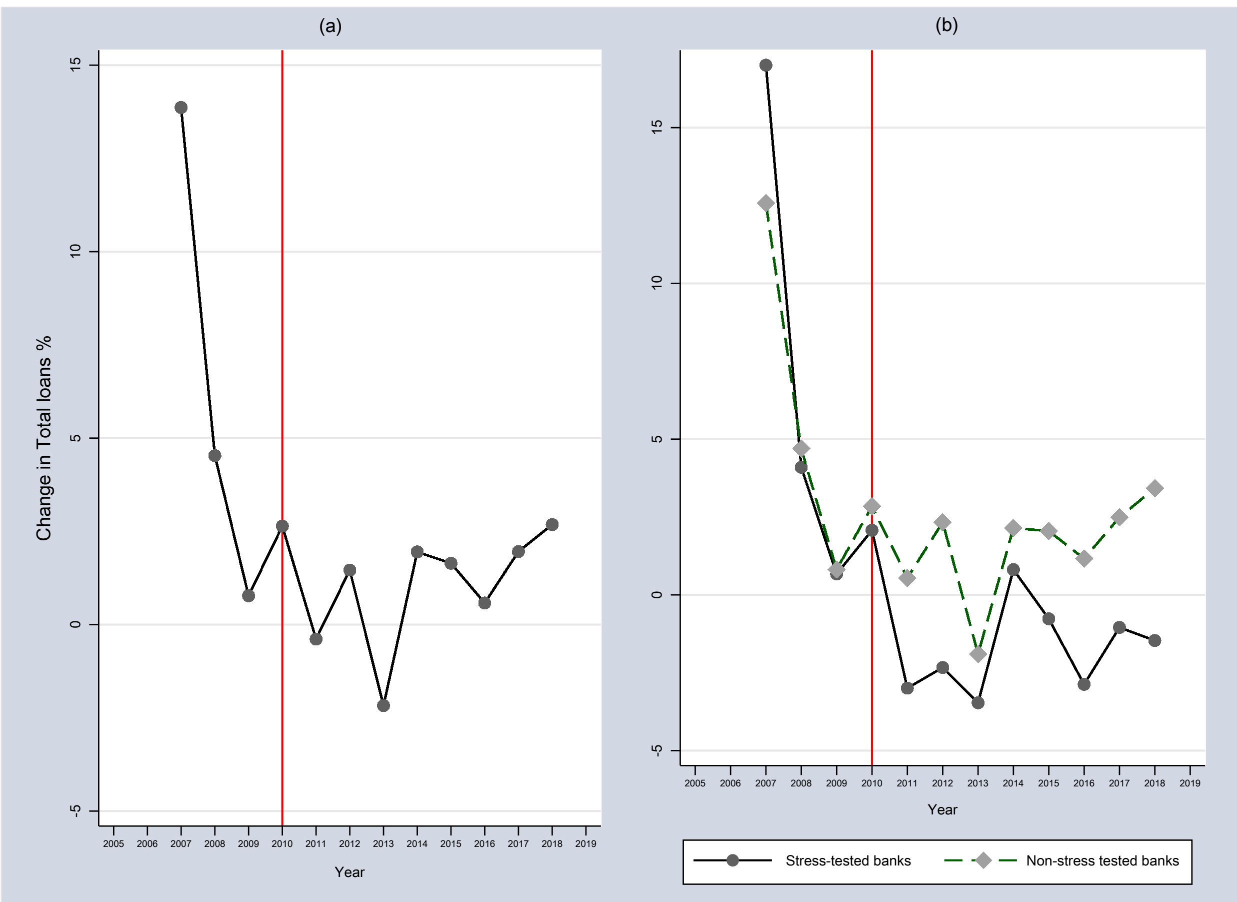


Figure B.2: Change in Total Loans – GIIPS Banks

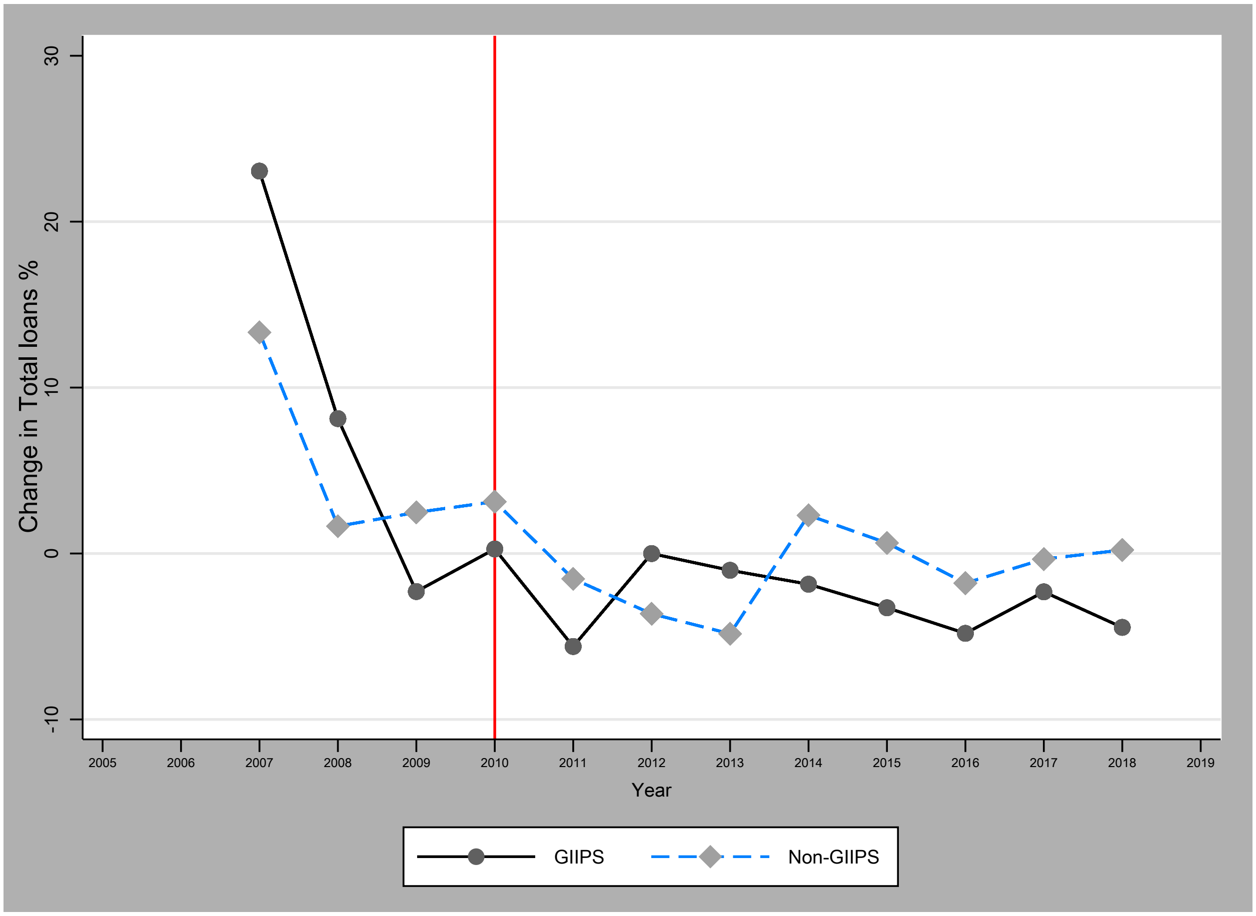


Figure B.3: Change in Mortgage Loans – All Banks

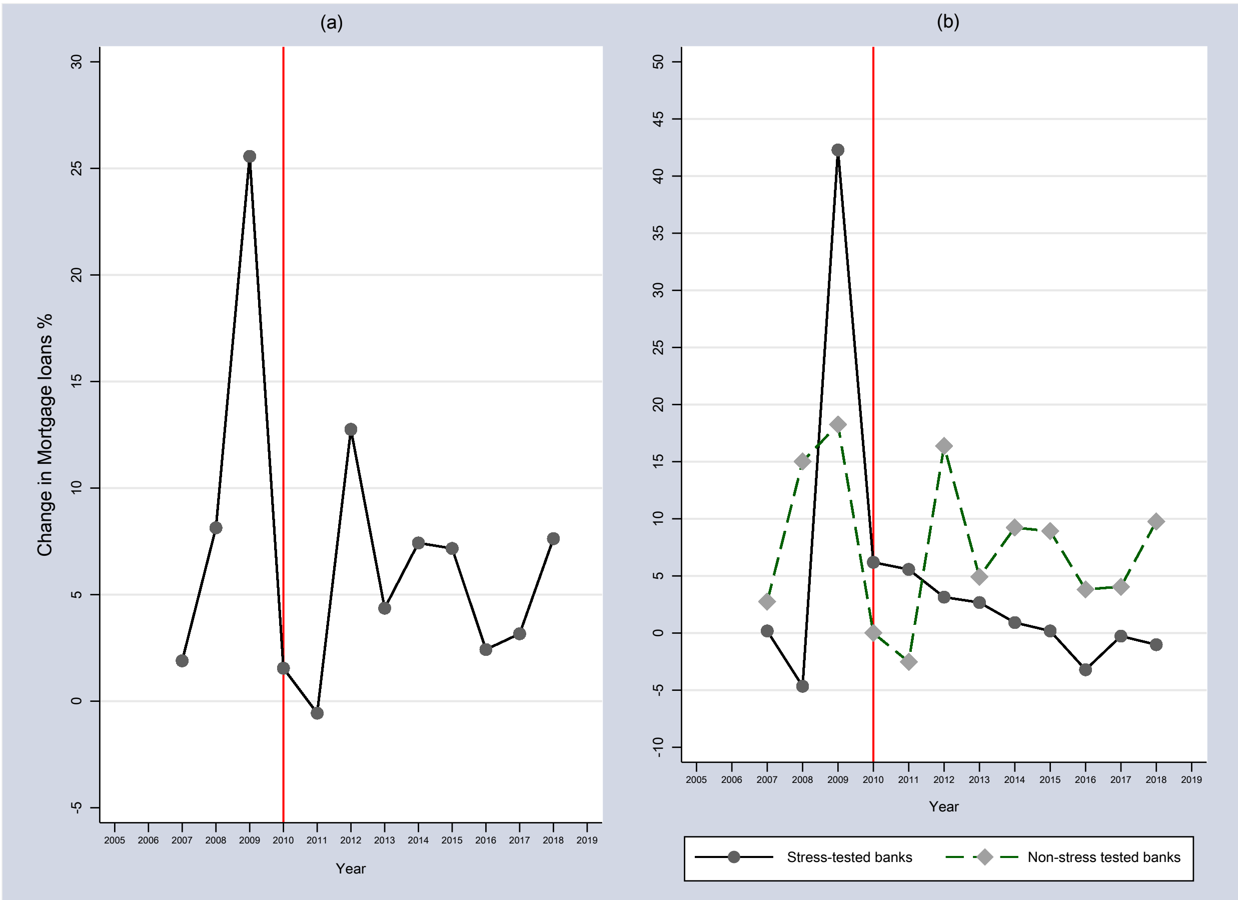


Figure B.4: Change in Mortgage Loans – GIIPS Banks

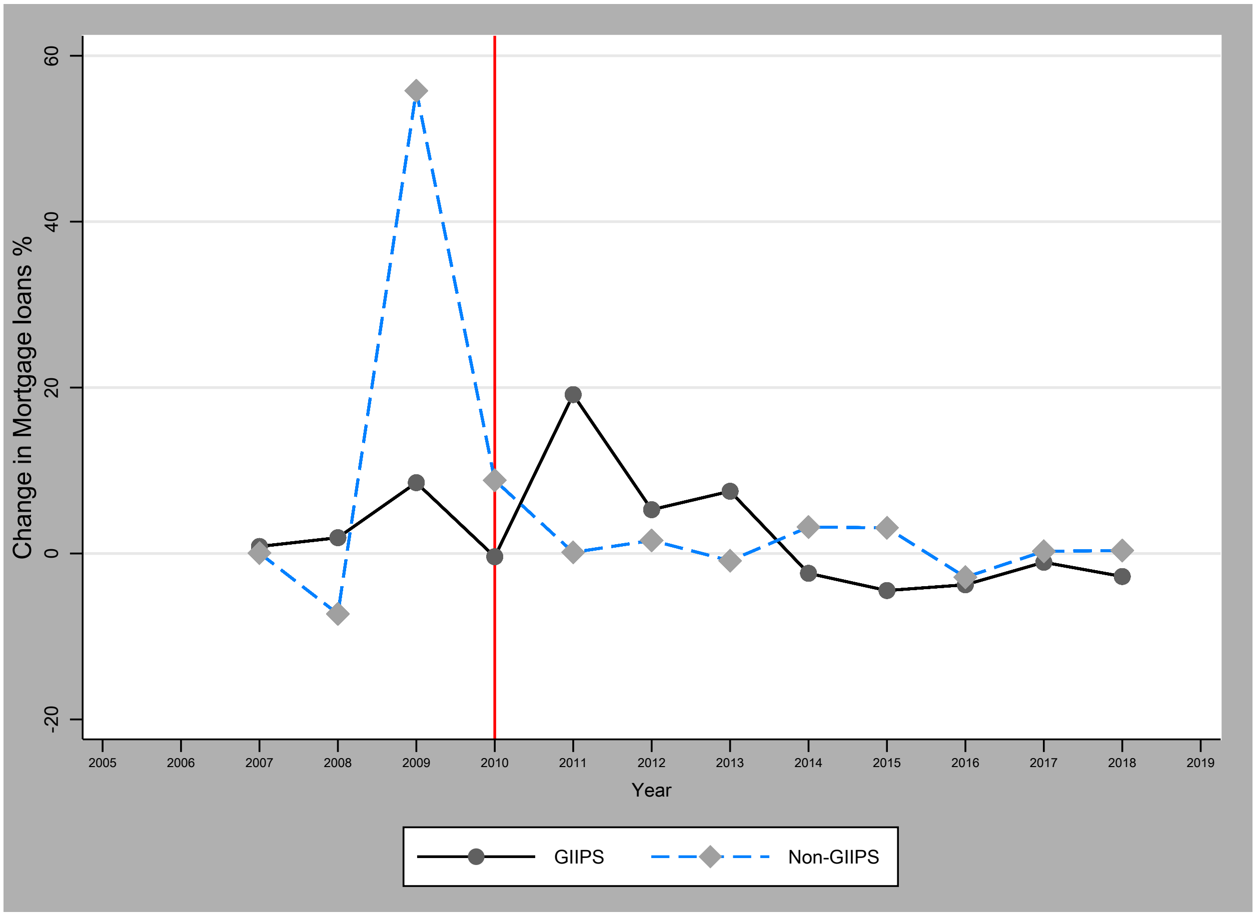


Figure B.5: Change in Corporate Loans – All Banks

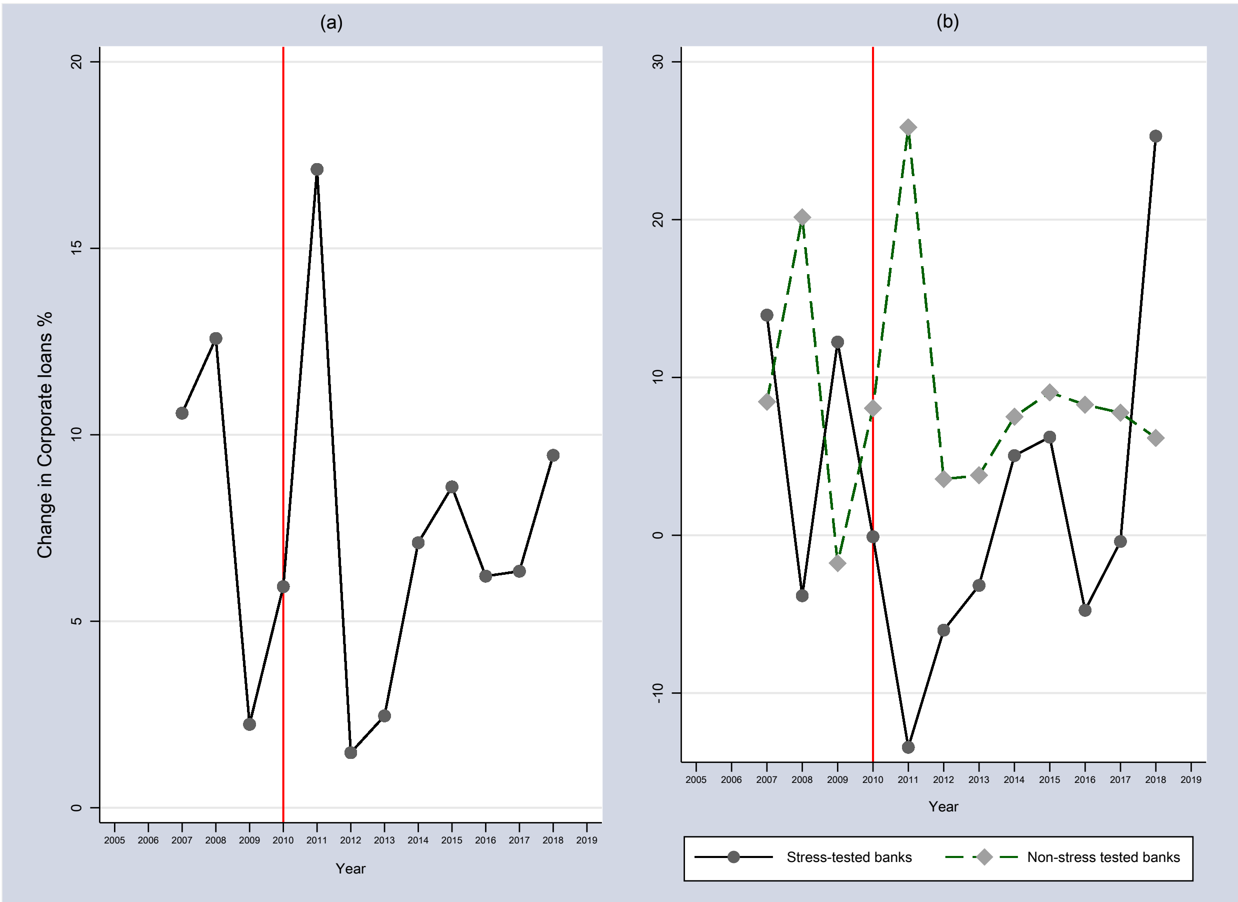


Figure B.6: Change in Corporate Loans – GIIPS Banks

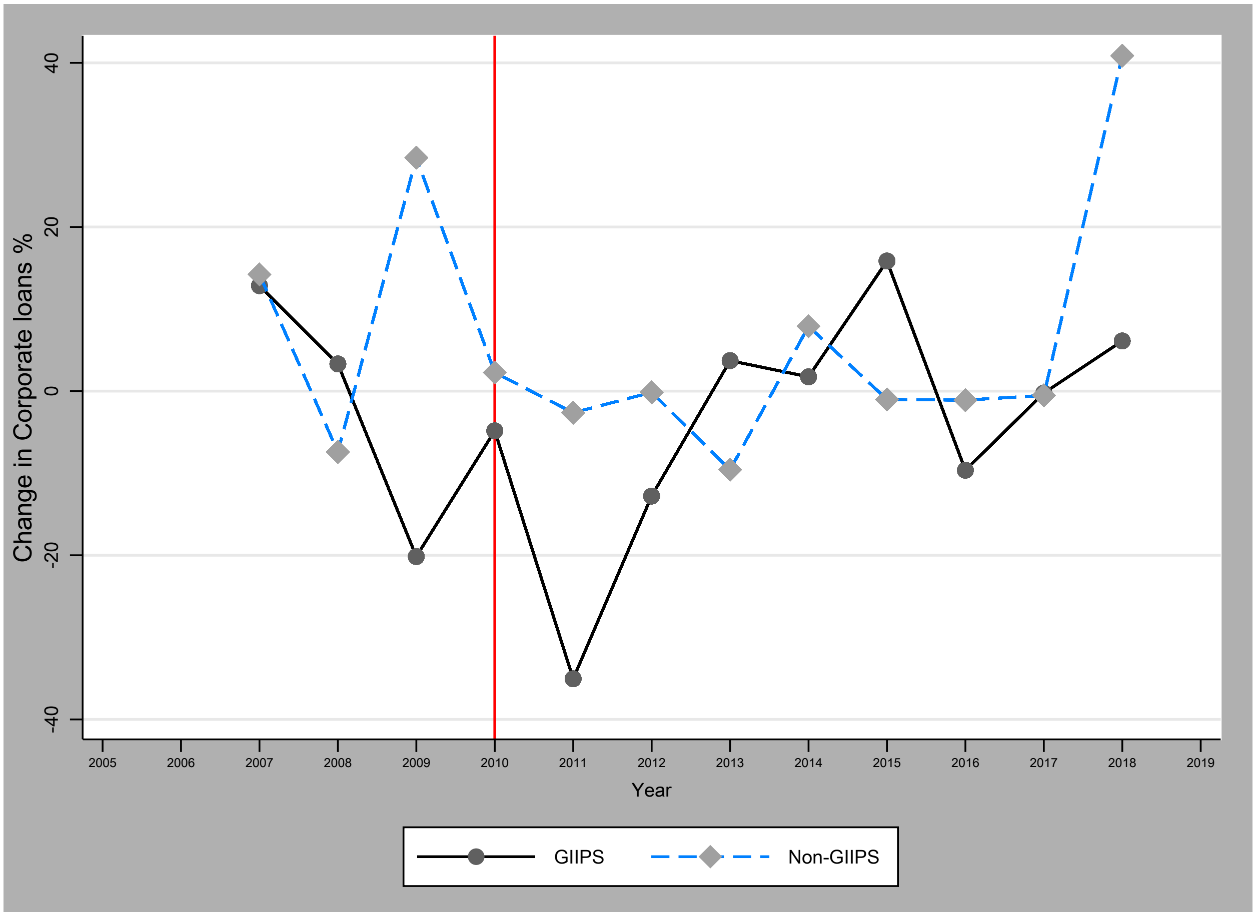


Figure B.7: Change in Consumer Loans – All Banks

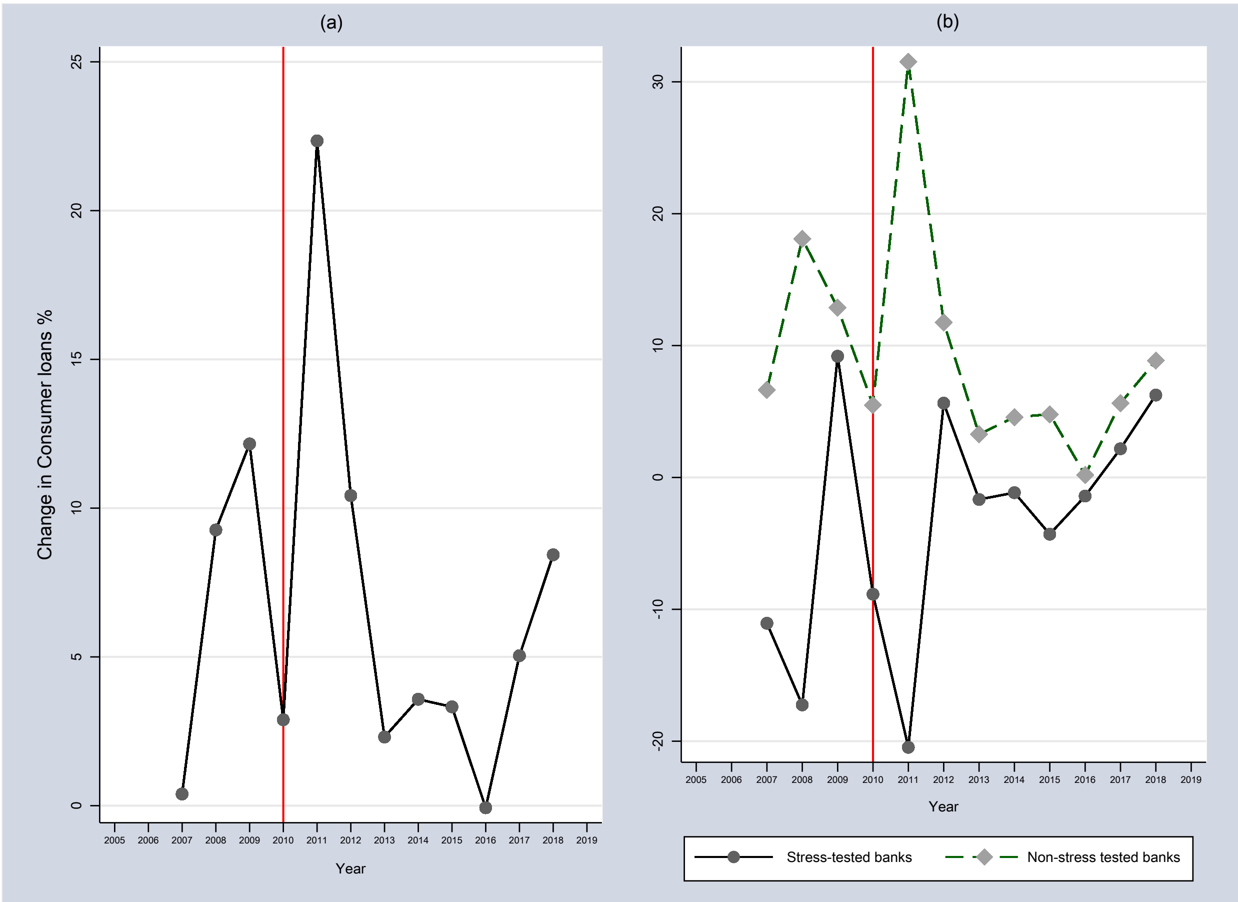


Figure B.8: Change in Consumer Loans – GIIPS Banks

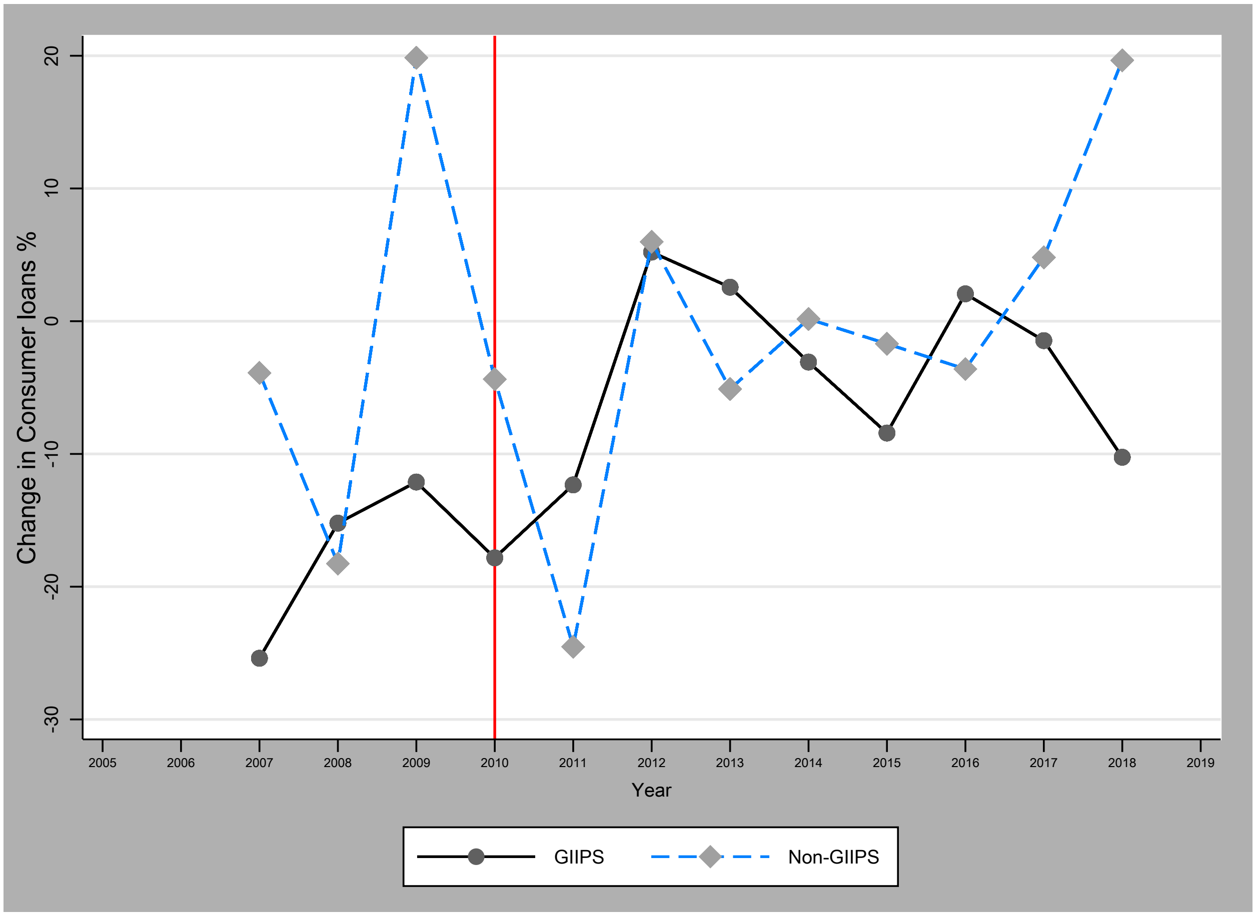


Figure B.9: Change in Bank Loans – All Banks

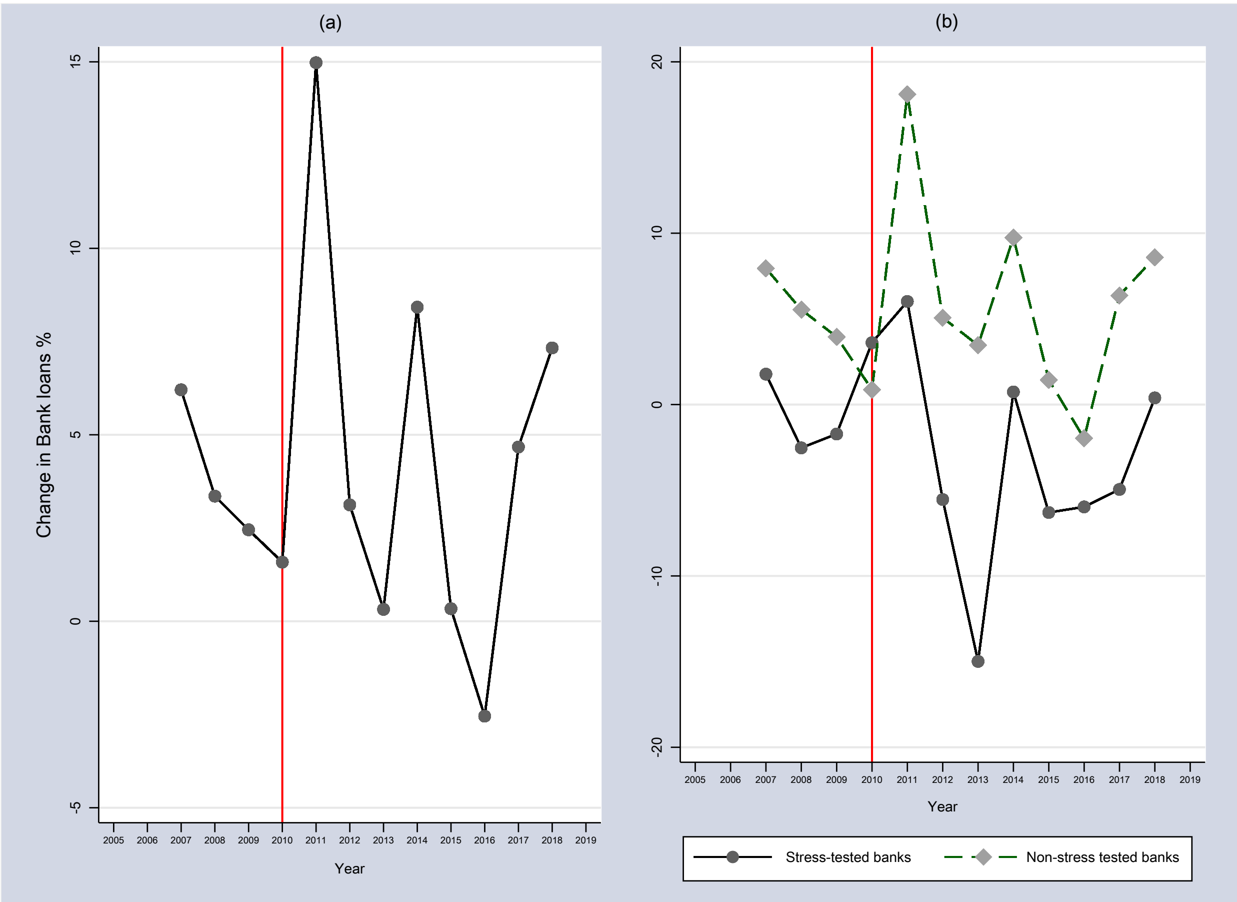


Figure B.10: Change in Bank Loans – GIIPS Banks

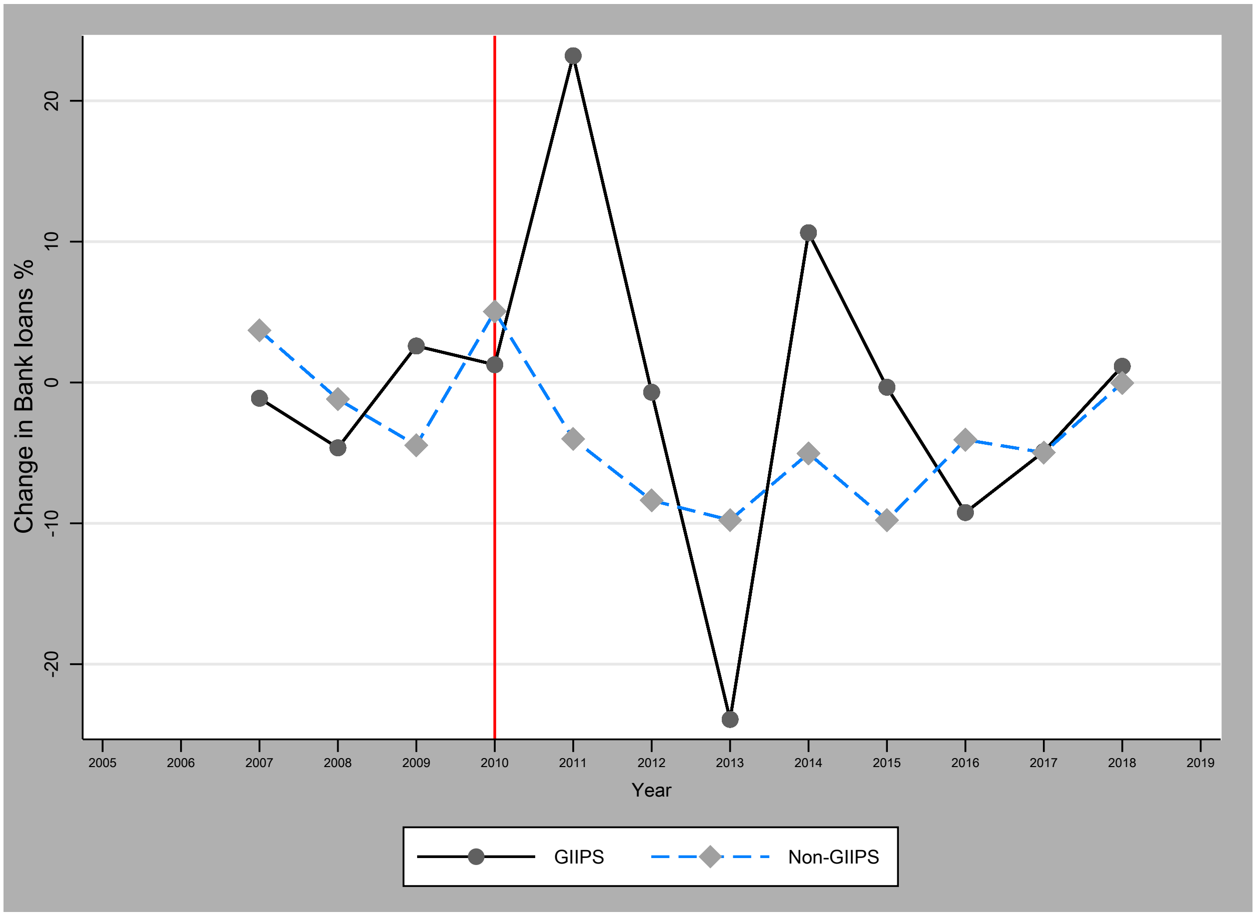


Figure B.11: Non-performing Loans Ratio – All Banks

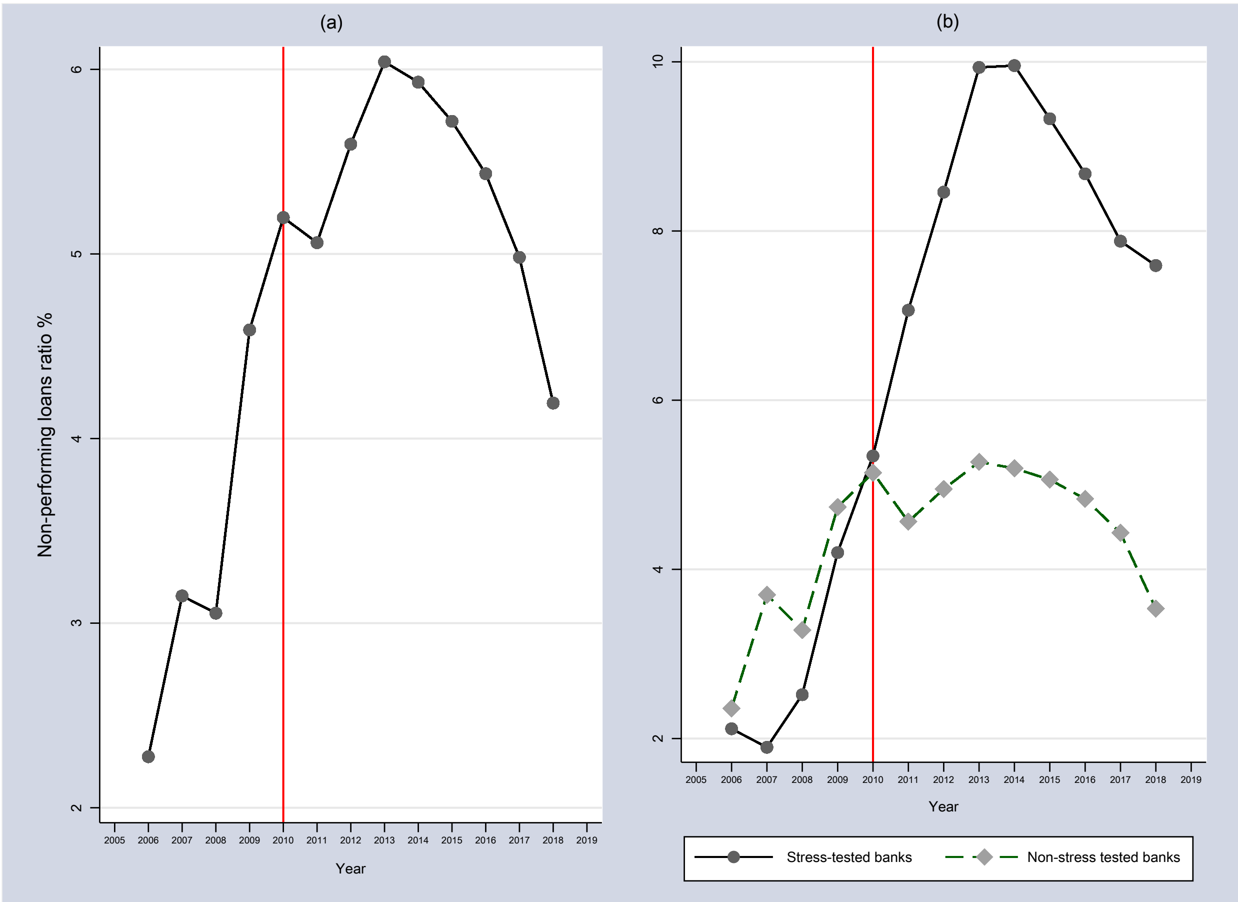


Figure B.12: Non-performing Loans Ratio – GIIPS Banks

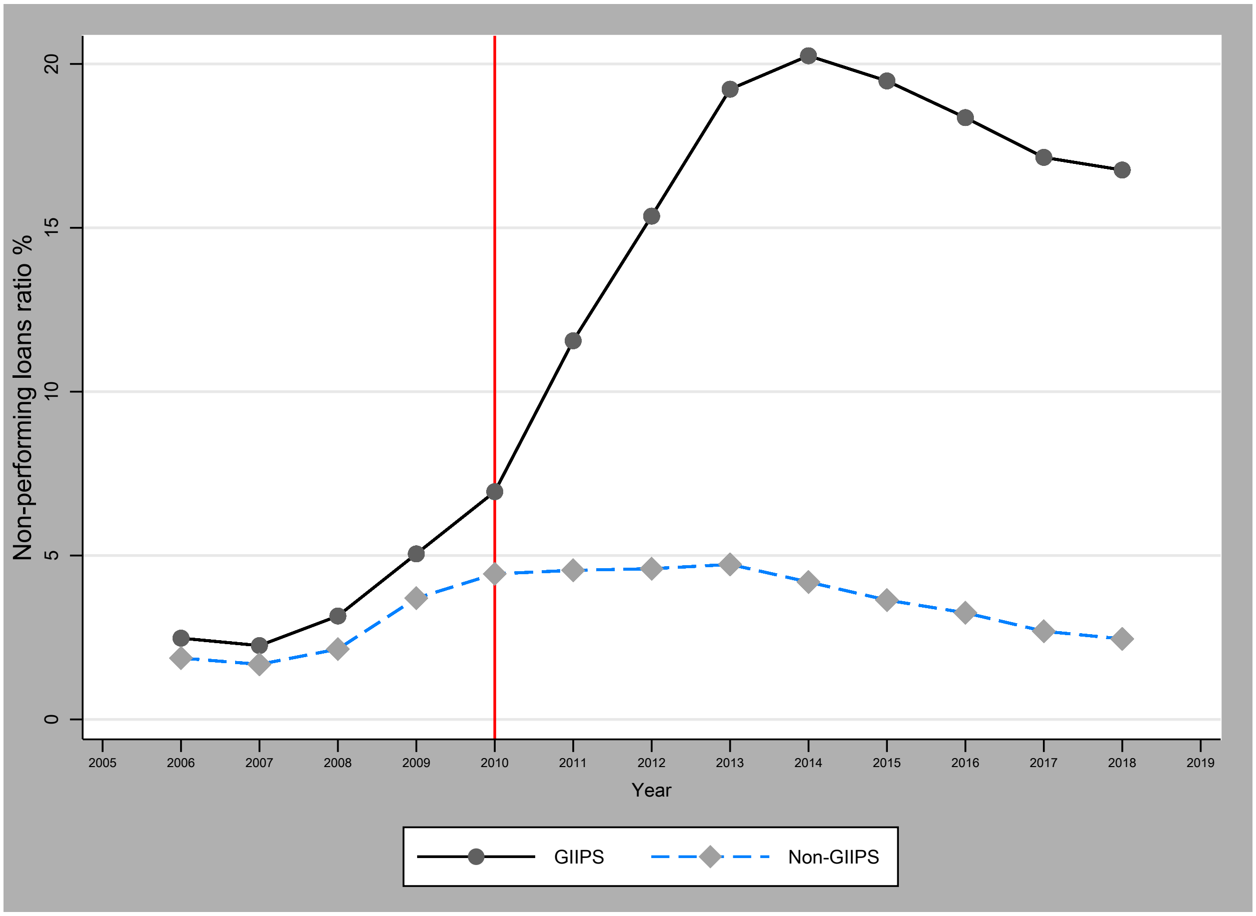


Figure B.13: Loan Loss Provisions Ratio – All Banks

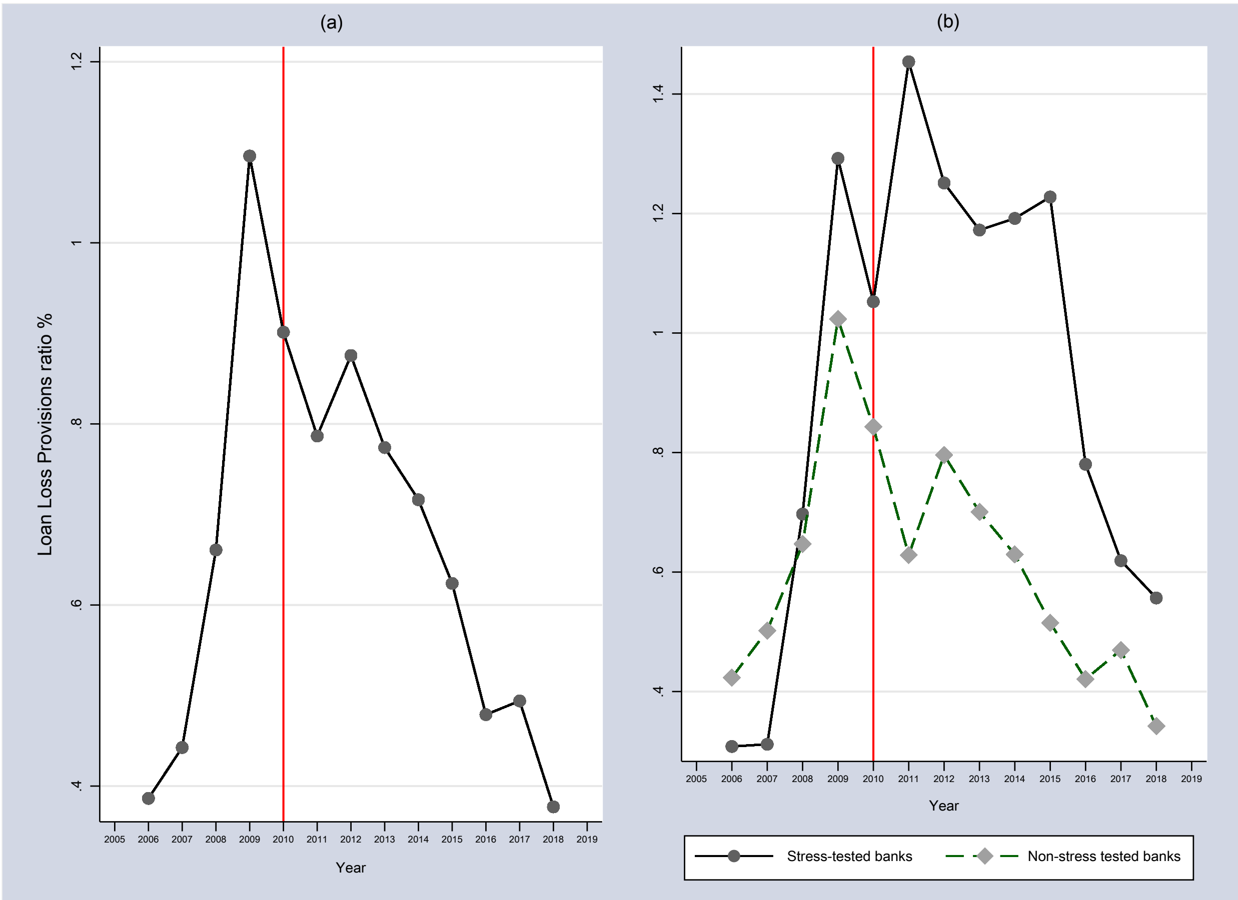


Figure B.14: Loan Loss Provisions Ratio – GIIPS Banks

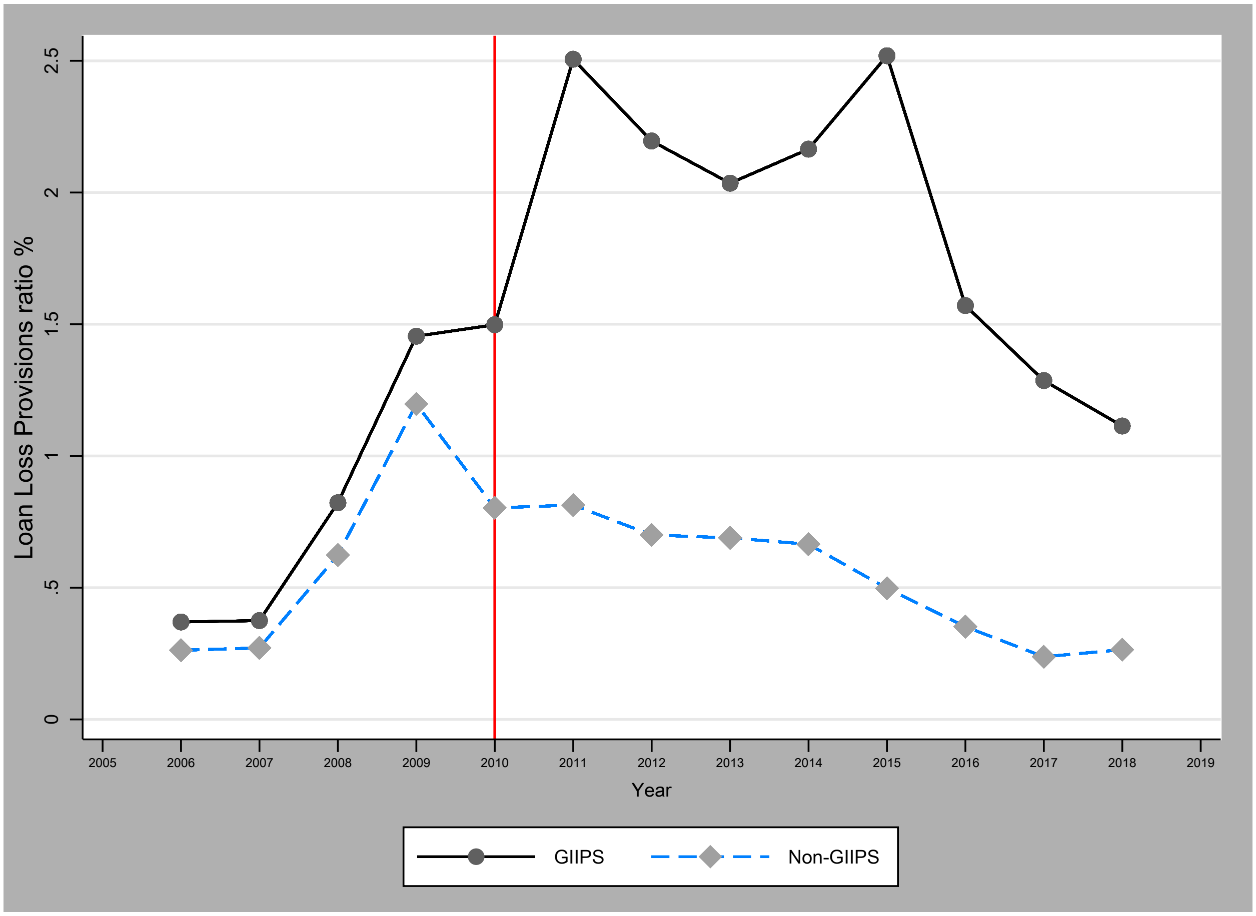


Figure B.15: Loan Loss Reserves Ratio – All Banks

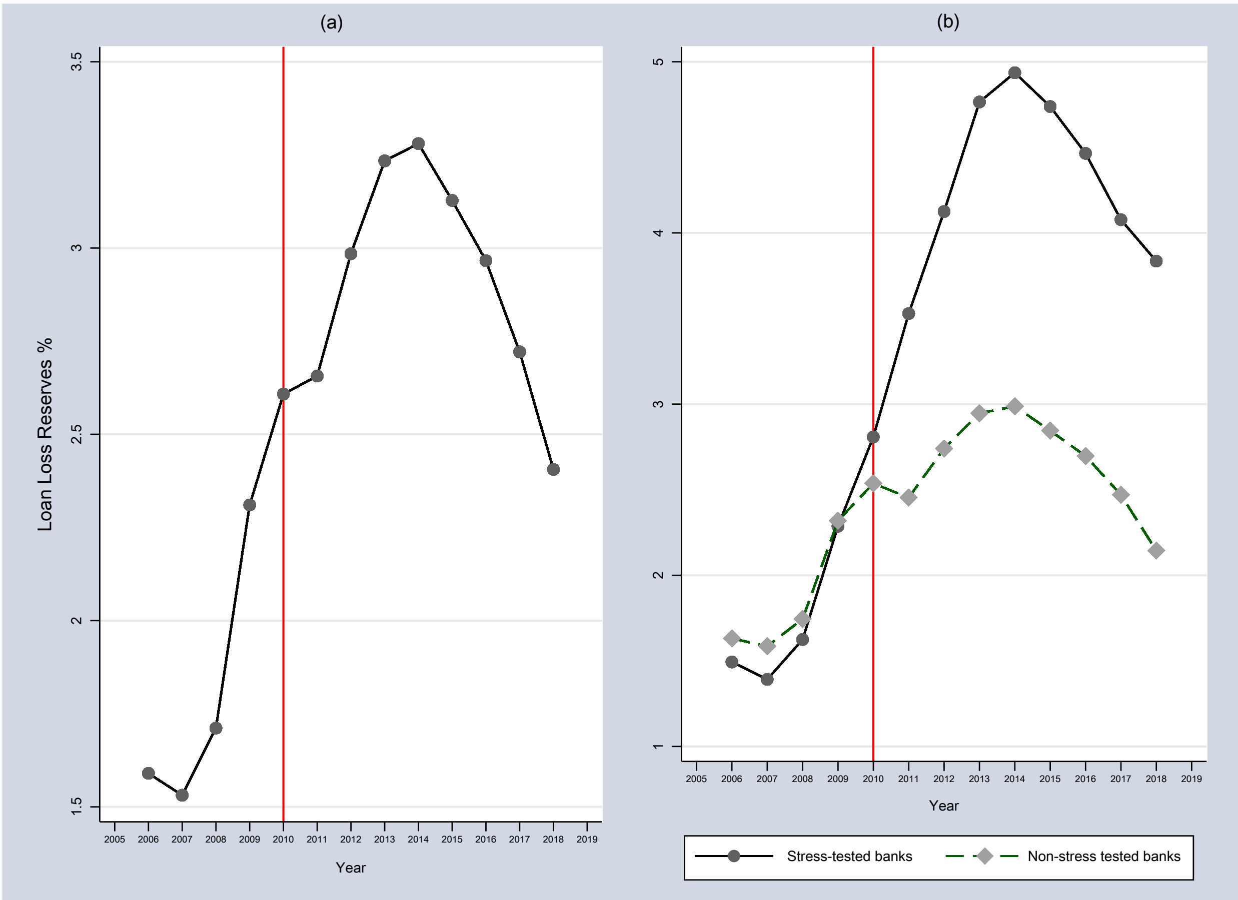


Figure B.16: Loan Loss Reserves Ratio – GIIPS Banks

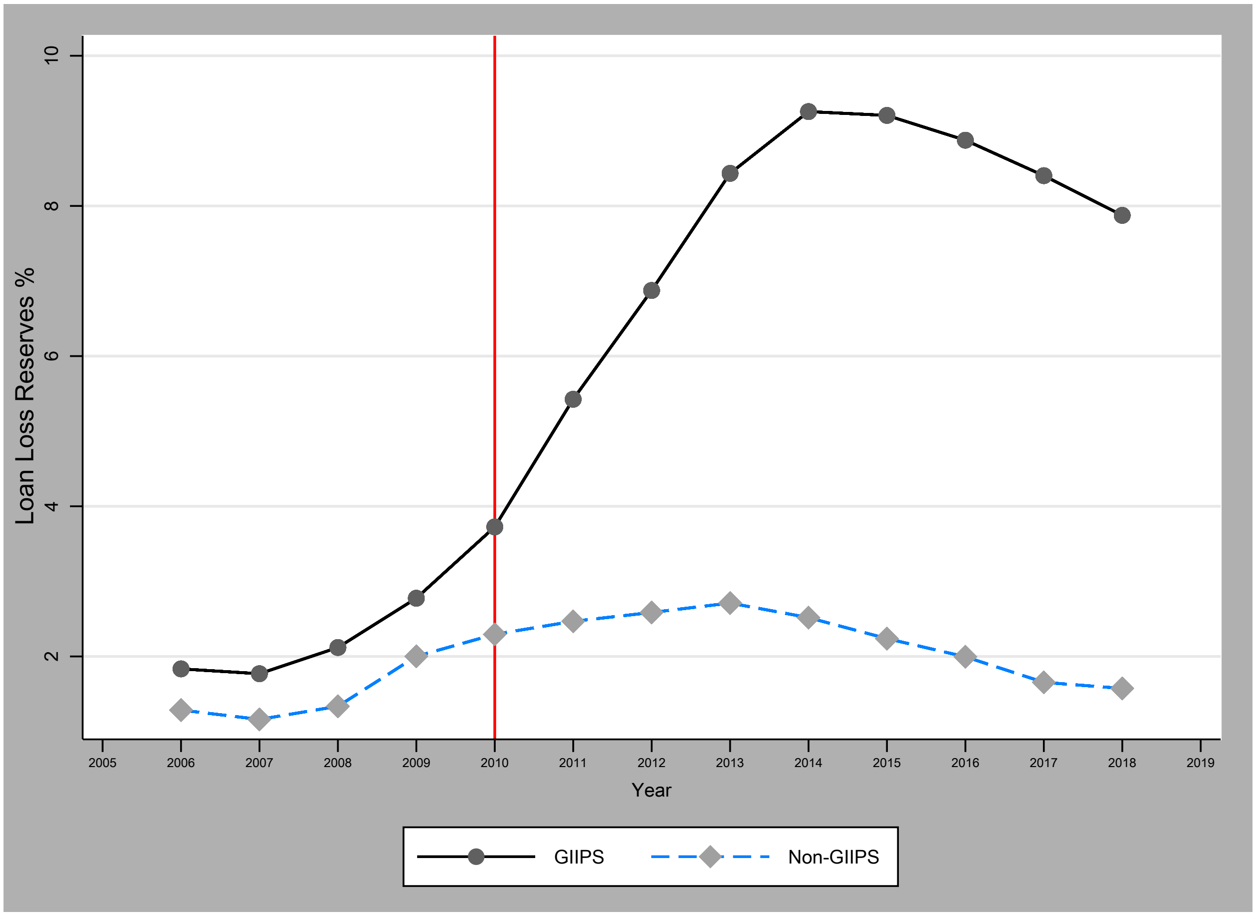


Table B.1: t test – Stress-tested Banks

	Full sample			2006-2009			2010-2018		
	Stress-tested banks	Non-stress tested banks	Difference	Stress-tested banks	Non-stress tested banks	Difference	Stress-tested banks	Non-stress tested banks	Difference
Total Loans Change	0.72	2.31	-1.59*	7.25	5.81	1.44	-1.34	1.72	-3.06***
Mortgage Loans Change	1.89	7.55	-5.66**	13.22	12.69	0.53	0.74	7.26	-6.52***
Corporate Loans Change	3.03	7.30	-4.27	7.07	8.42	-1.35	2.70	7.26	-4.56
Consumer Loans Change	-0.58	6.36	-6.94**	-6.37	13.34	-19.71	-0.11	6.00	-6.11**
Bank Loans Change	-2.49	5.33	-7.82***	-0.84	5.73	-6.57	-3.00	5.26	-8.26***
Non-performing Loans ratio	6.60	4.56	2.04***	2.69	3.61	-0.92*	8.24	4.75	3.49***
Loan Loss Provisions ratio	0.93	0.60	0.33***	0.66	0.68	-0.02	1.04	0.58	0.46***
Loan Loss Reserves ratio	3.41	2.51	0.9***	1.7	1.83	-0.13	4.14	2.65	1.49***
CET1 ratio	12.68	16.19	-3.51***	7.33	8.73	-1.4*	13.54	16.69	-3.15***
Tier 1 ratio	13.37	16.83	-3.46***	9.2	9.67	-0.47	14.01	17.23	-3.22***
Total Capital ratio	16.33	19.04	-2.71***	12.88	14.37	-1.49*	16.86	19.3	-2.44***
Liquidity ratio	30.07	31.67	-1.6**	31.19	35.33	-4.14**	29.59	30.86	-1.27

Table B.2: t test – GIIPS Banks

	Full sample			**2006-2009**			**2010-2018**		
	GIIPS banks	Non-GIIPS banks	Difference	GIIPS banks	Non-GIIPS banks	Difference	GIIPS banks	Non-GIIPS banks	Difference
Total Loans Change	0.48	0.85	-0.37	9.62	5.81	3.81	-2.56	-0.66	-1.9*
Mortgage Loans Change	0.58	2.72	-2.14	4.34	16.18	-11.84	0.34	1.01	-0.67
Corporate Loans Change	-0.45	5.68	-6.13	-4.16	11.75	-15.91	-0.25	5.06	-5.31
Consumer Loans Change	-3.36	1.34	-4.7	-17.57	-0.76	-16.81	-2.45	1.54	-3.99
Bank Loans Change	-0.5	-3.68	3.18	-1.05	-0.71	-0.34	-0.31	-4.57	4.26
Non-performing Loans ratio	12.15	3.41	8.74***	3.23	2.37	0.86***	16.12	3.83	12.29***
Loan Loss Provisions ratio	1.53	0.58	0.95***	0.75	0.61	0.14	1.9	0.56	1.34***
Loan Loss Reserves ratio	5.89	1.99	3.9***	2.12	1.45	0.67***	7.56	2.22	5.34***
CET1 ratio	15.53	12.26	3.27***	-	-	-	15.53	13.19	2.34***
Tier 1 ratio	13.59	13.34	0.25	-	-	-	13.59	14.08	-0.49
Total Capital ratio	15.55	16.44	-0.89	-	-	-	15.55	17.08	-1.53*
Liquidity ratio	24.66	33.16	-8.5***	23.5	35.76	-12.26***	25.17	32.07	-6.9***

Appendix C

Chapter 5 - Supplementary Material

Figure C.1: ROA – AHHI Main

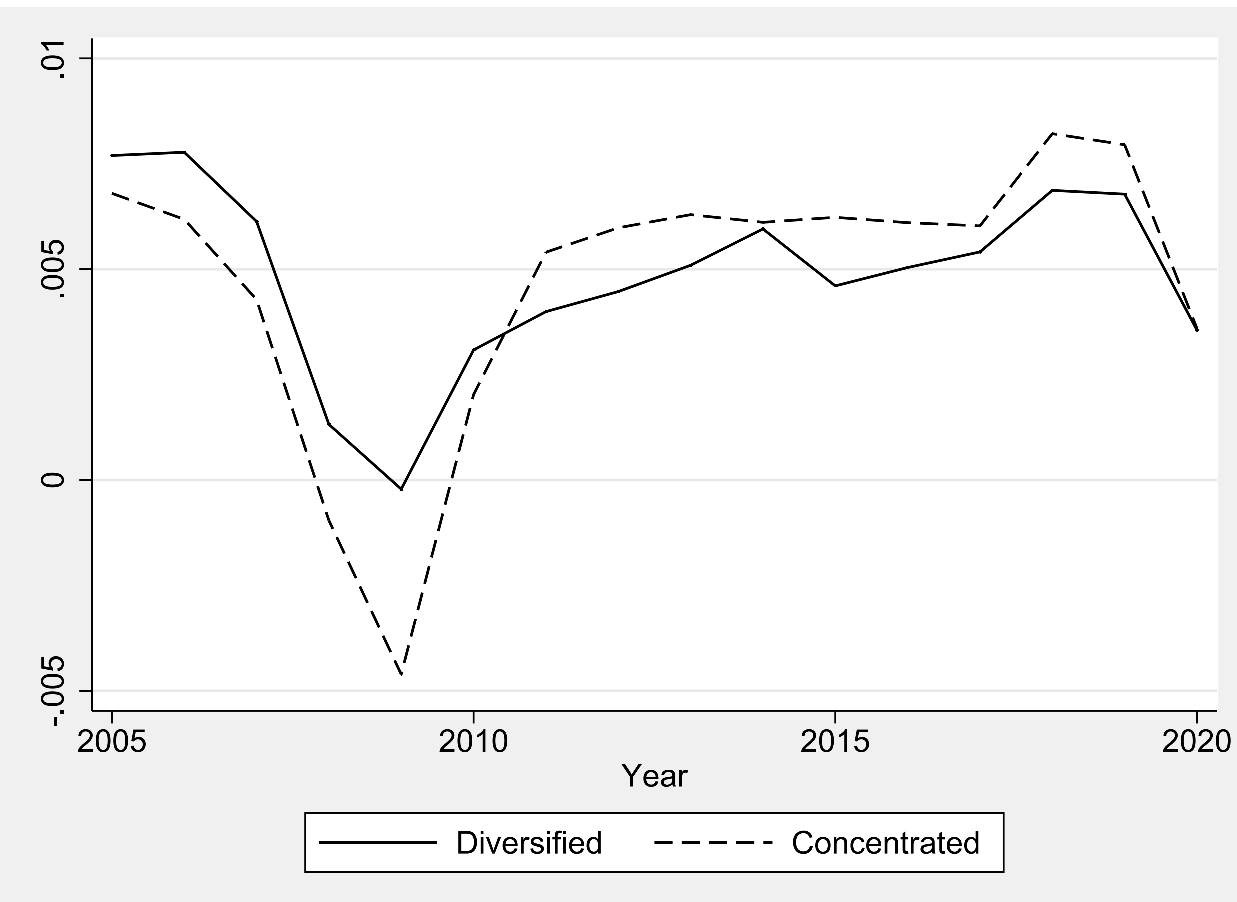


Figure C.2: Z-Score – AHHI Main

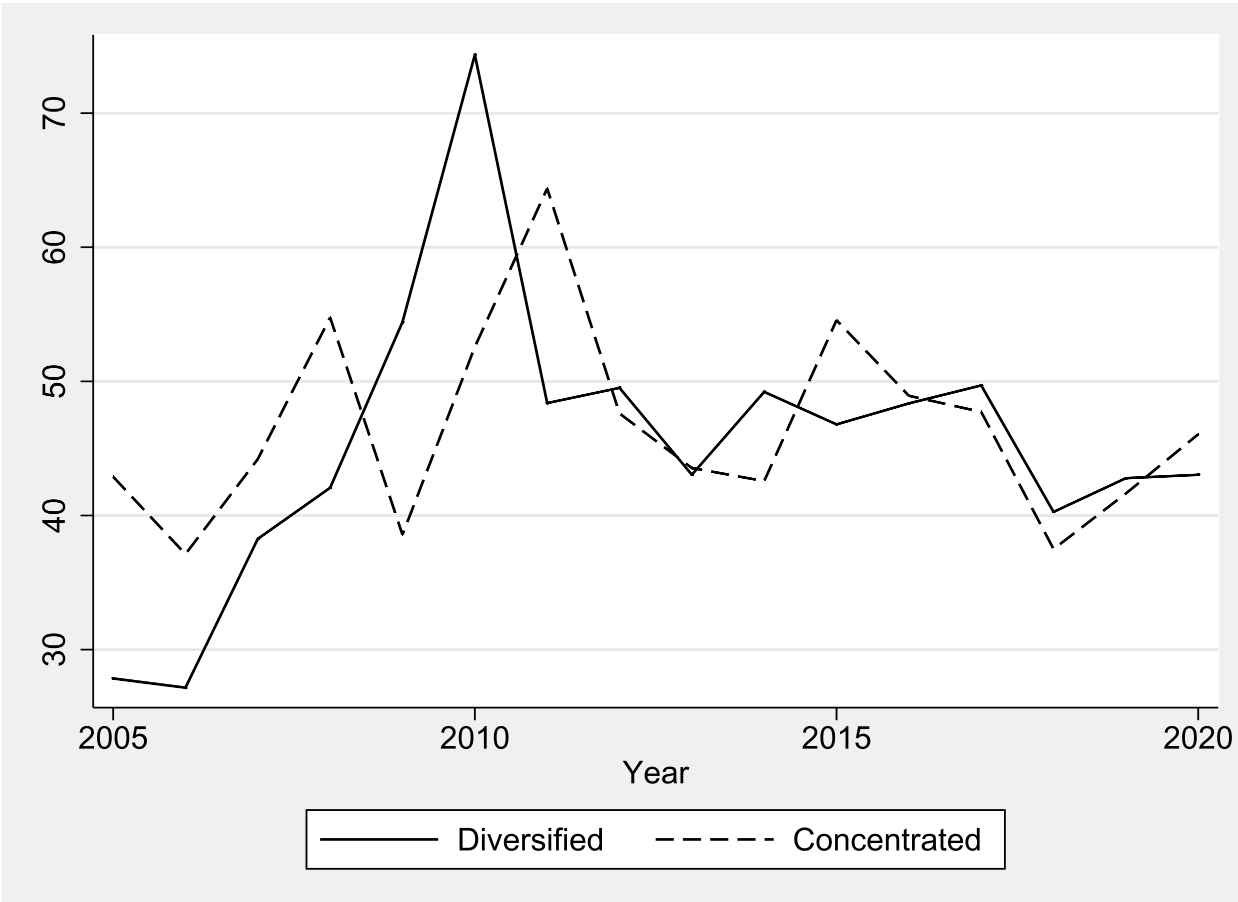


Figure C.3: NPL Ratio – AHHI Main

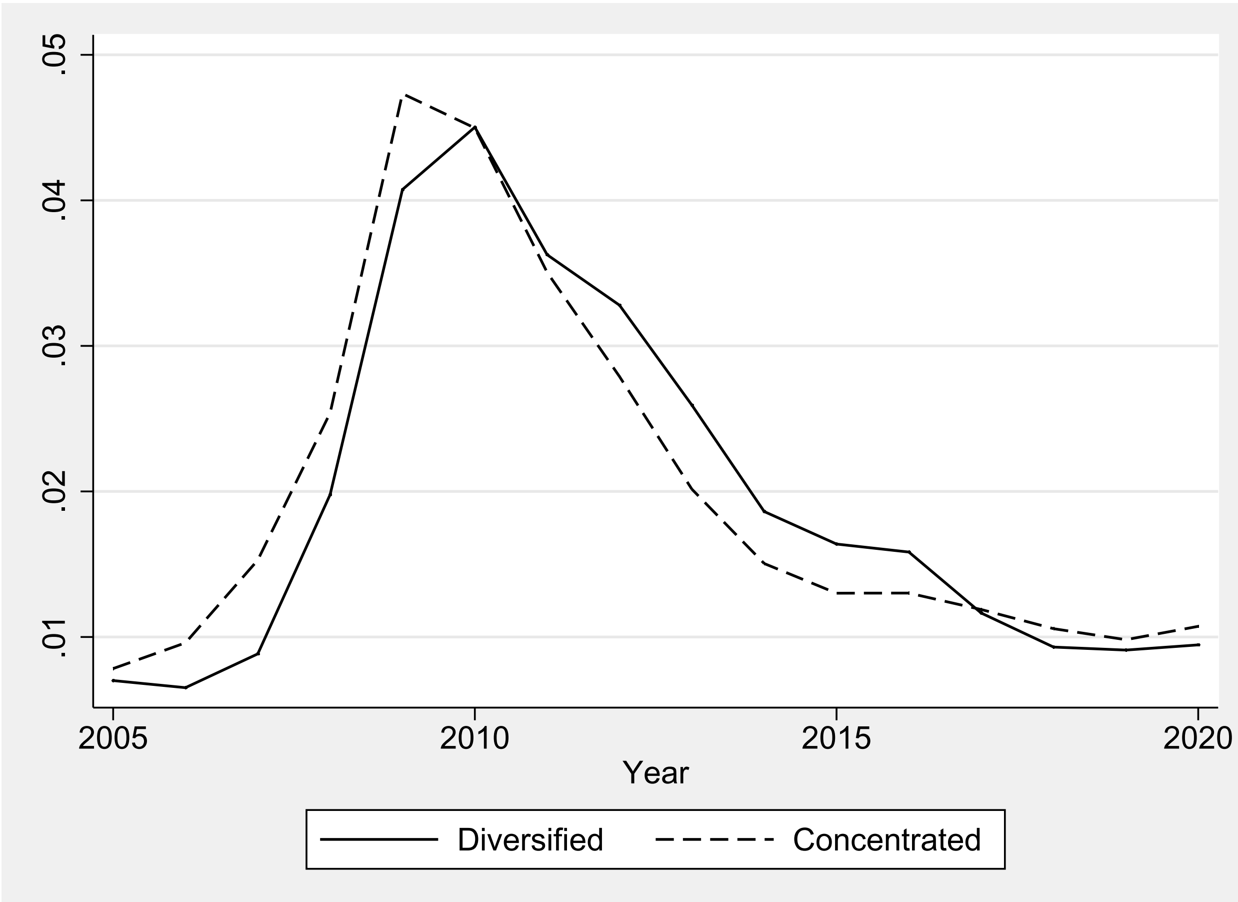


Figure C.4: Liquidity – AHHI Main

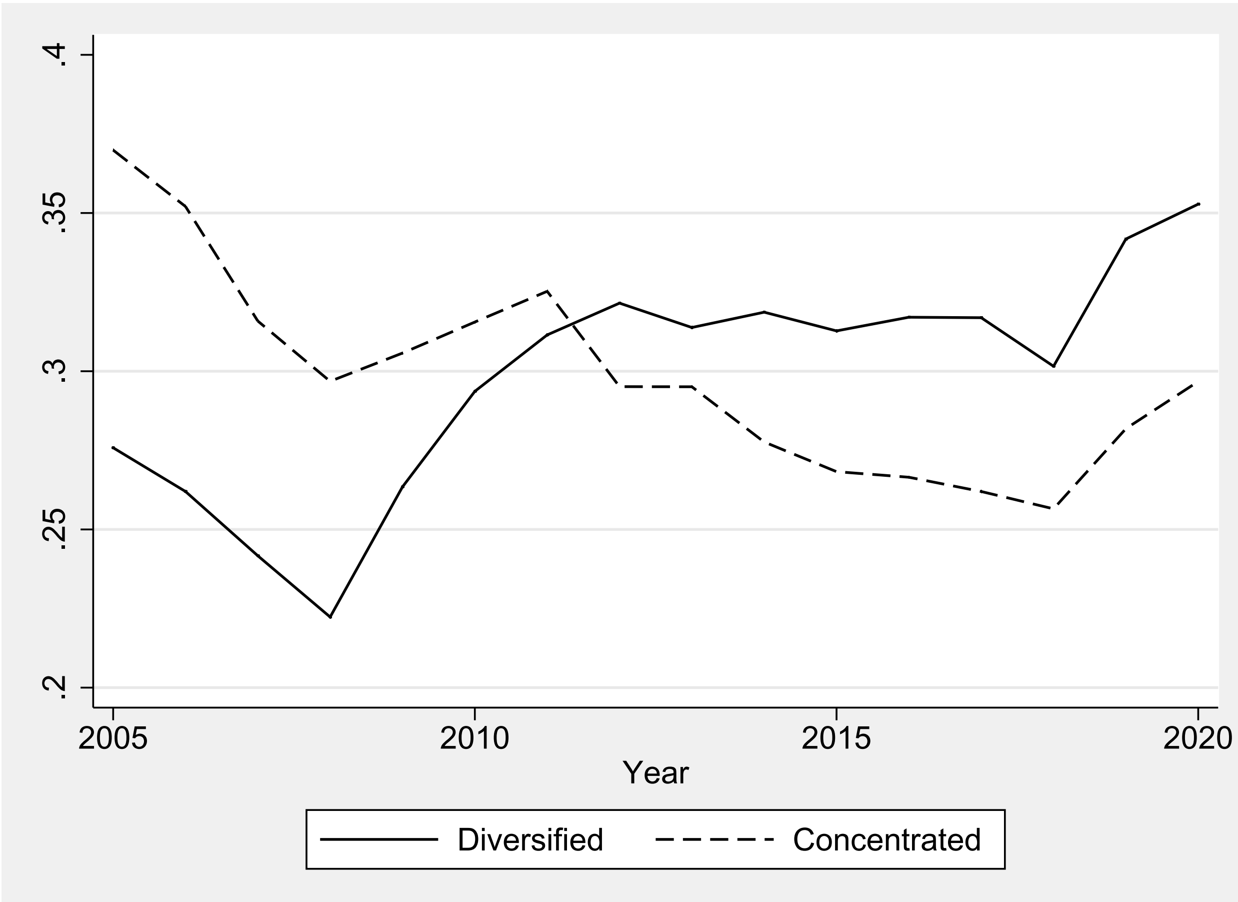


Figure C.5: Capital – AHHI Main

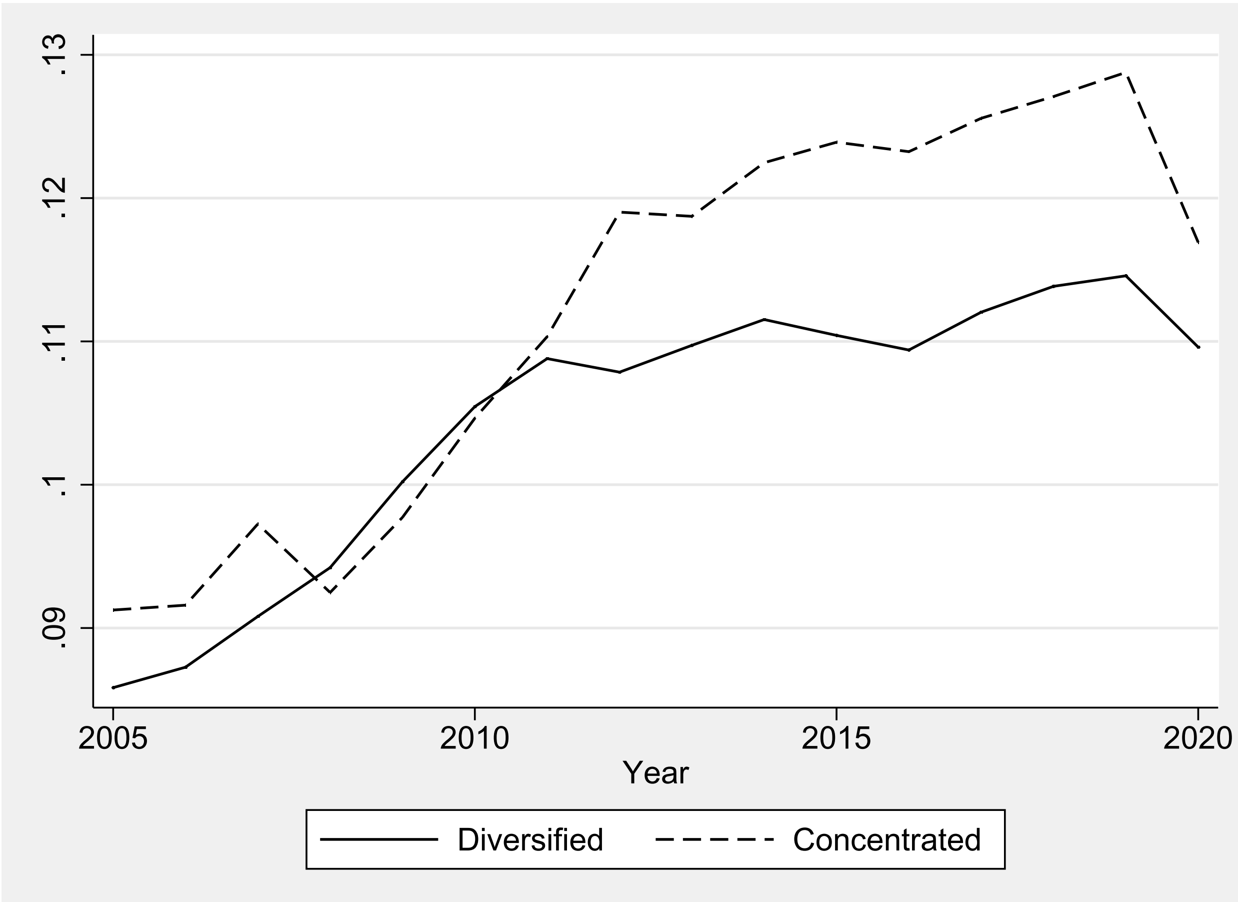


Figure C.6: ROA – Non-interest income

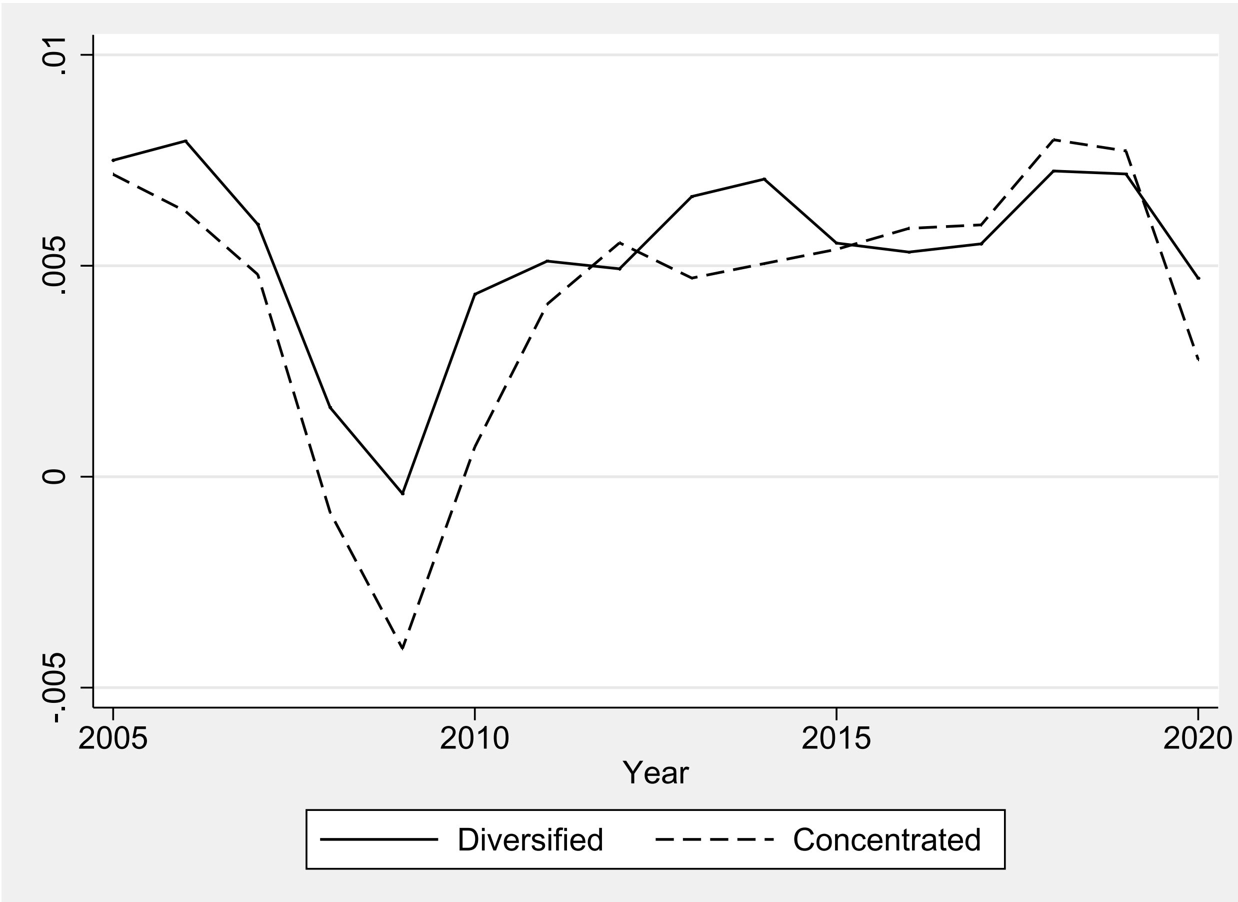


Figure C.7: Z-Score – Non-interest income

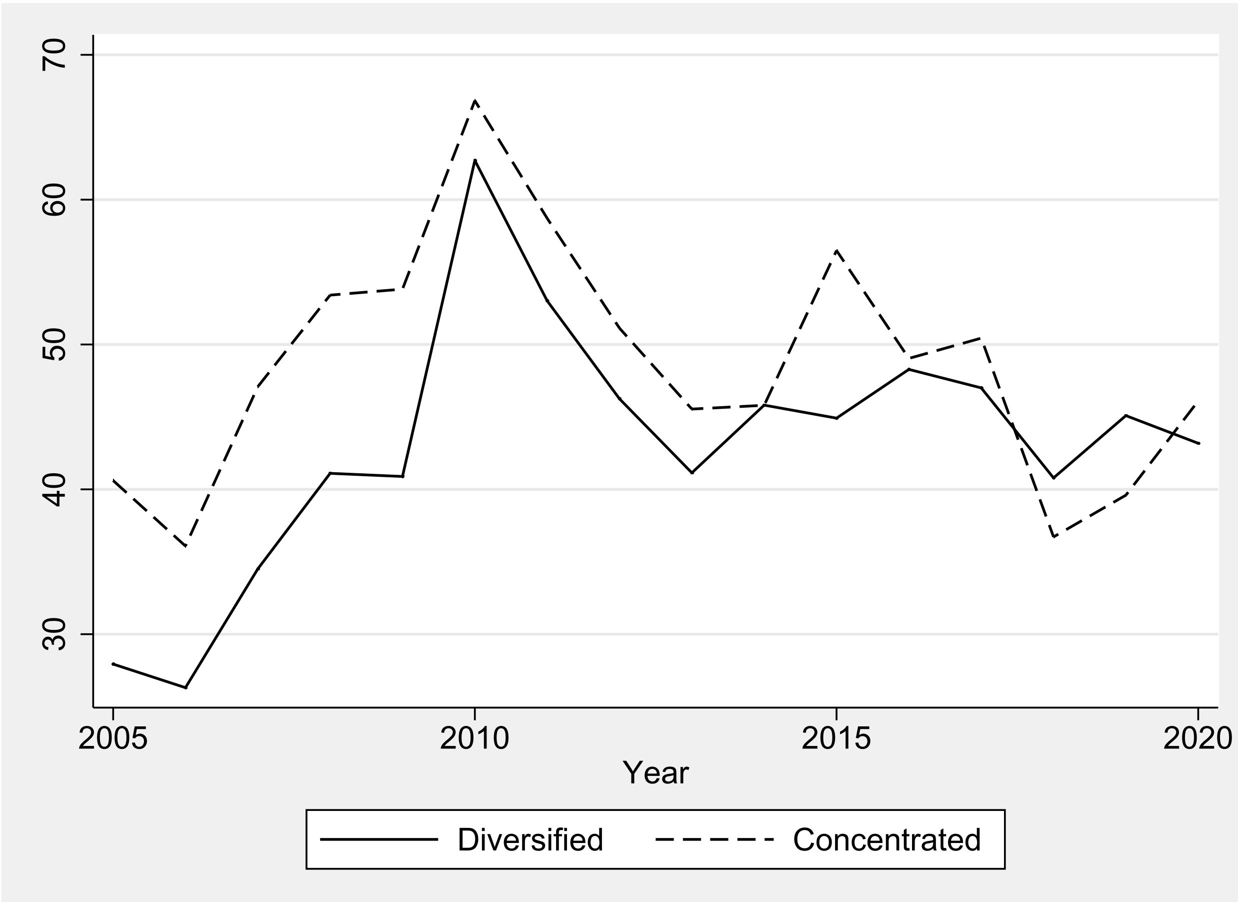


Figure C.8: NPL Ratio – Non-interest income

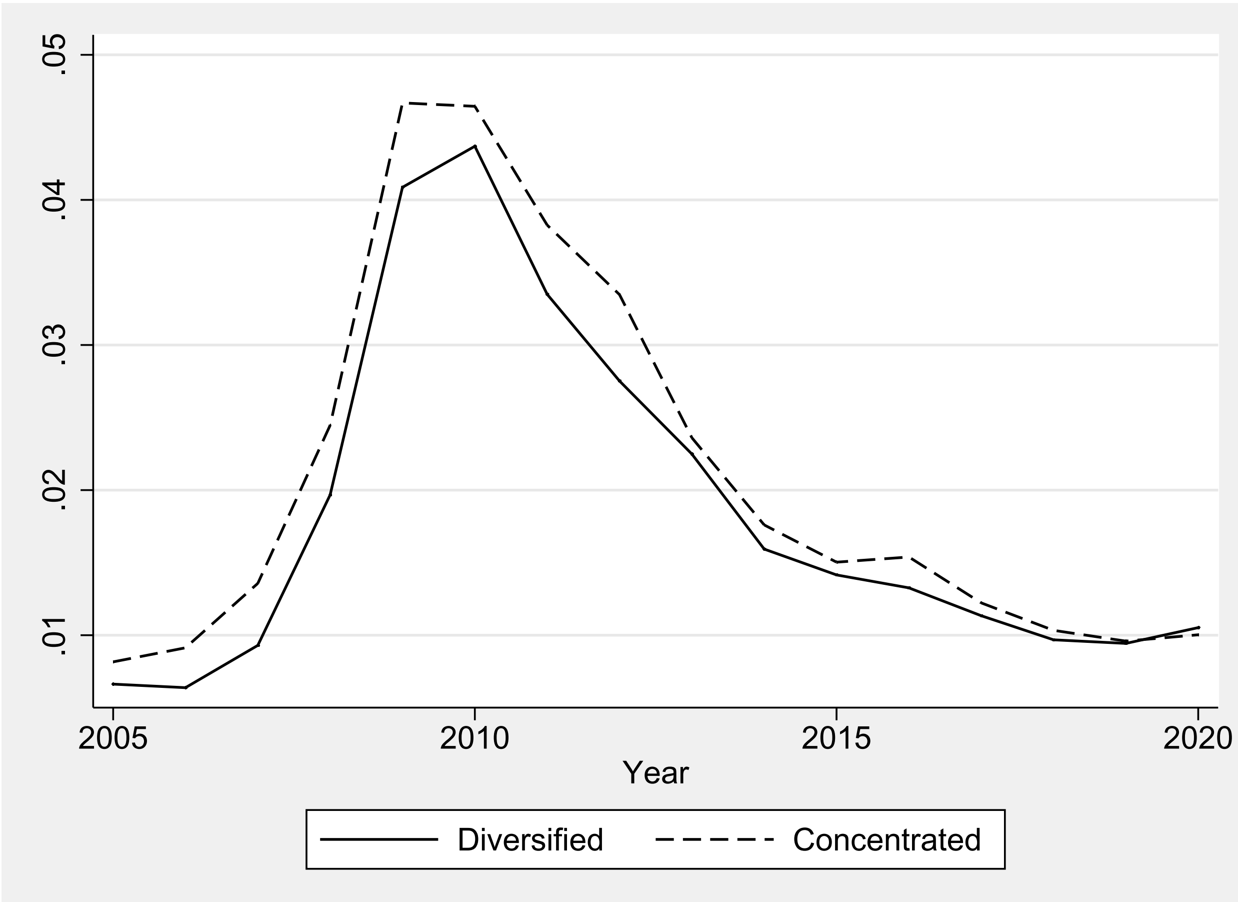


Figure C.9: Liquidity – Non-interest income

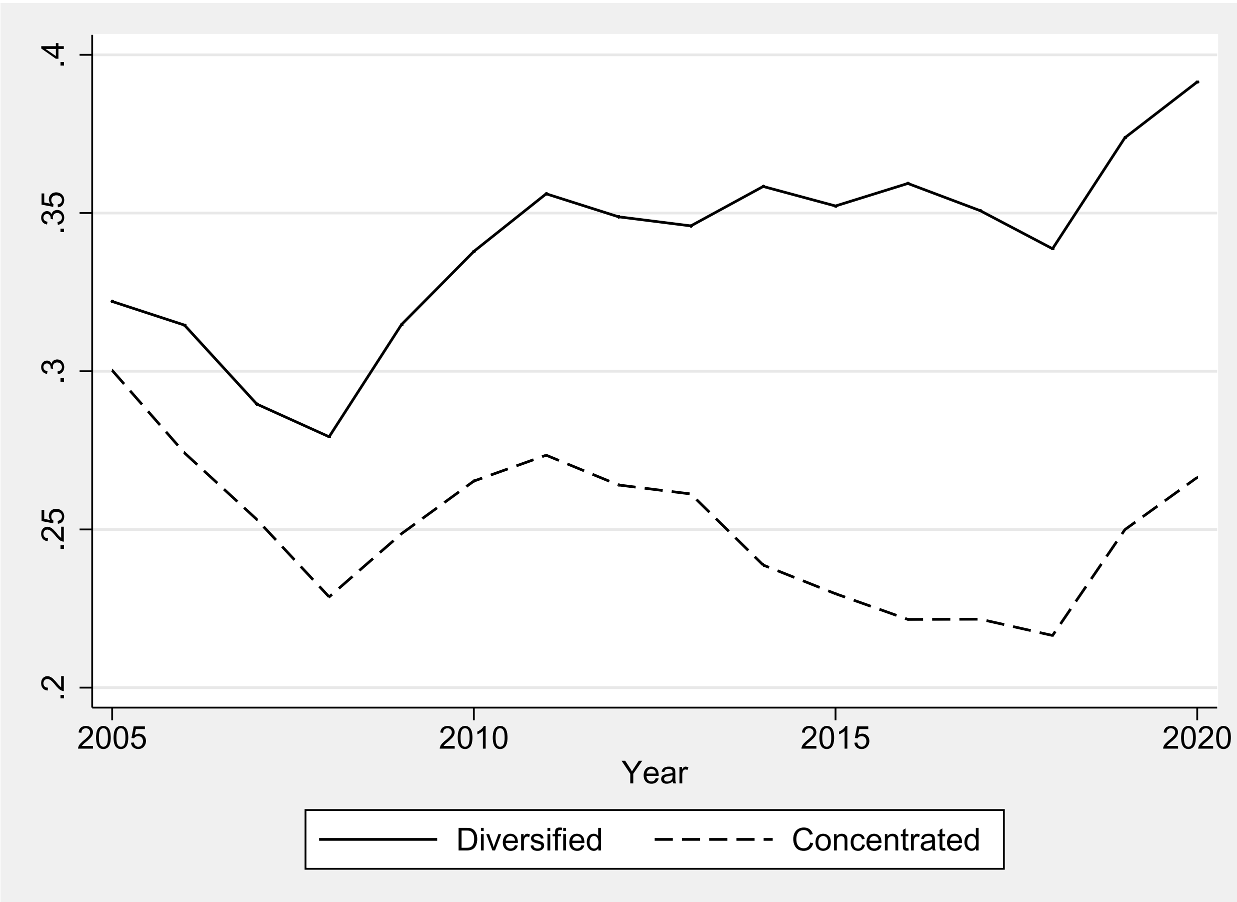


Figure C.10: Capital – Non-interest income

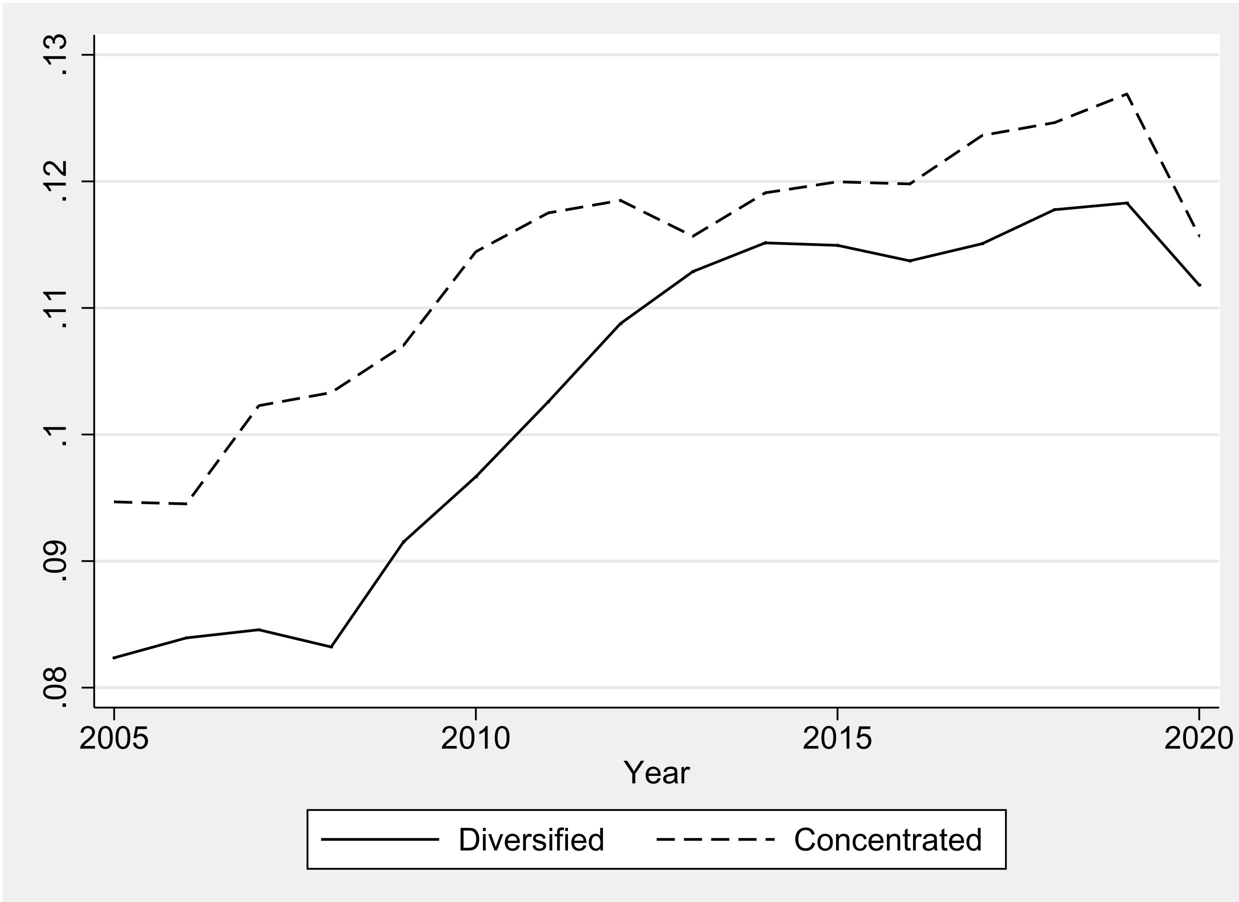


Table C.1: t test – AHHI Main

	Full sample			**2007-2009**			**2019-2020**		
	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference
ROA	0.0049	0.0051	-0.0002	0.0024	-0.0006	0.003***	0.0051	0.0056	-0.0005
ROE	0.0486	0.043	0.0056***	0.0265	-0.0119	0.0384***	0.0471	0.0463	0.0008
Z-Score	45.1463	46.1856	-1.0393	44.8378	45.4079	-0.5701	42.9146	43.9973	-1.0827
NPL Ratio	0.019	0.018	0.001*	0.0229	0.0303	-0.0074***	0.0092	0.0103	-0.0011
Capital	0.1047	0.1156	-0.0109***	0.095	0.0959	-0.0009	0.112	0.1224	-0.0104***
Liquidity	0.2994	0.2917	0.0077*	0.2426	0.3061	-0.0635***	0.3474	0.2898	0.0576***
LLP Ratio	0.005	0.0048	0.0002	0.0107	0.0109	-0.0002	0.0053	0.0051	0.0002

Table C.2: t test – AHHI Assets

	Full sample			**2007-2009**			**2019-2020**		
	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference
ROA	0.0049	0.0051	-0.0002	0.0013	0.0009	0.0004	0.0053	0.0054	-0.0001
ROE	0.0447	0.0468	-0.0021	0.0119	0.0084	0.0035	0.0445	0.0486	-0.0041
Z-Score	48.1509	43.1861	4.9648***	46.9171	43.2182	3.6989	44.734	42.4613	2.2727
NPL Ratio	0.02	0.0171	0.0029***	0.0292	0.0228	0.0064***	0.0091	0.0105	-0.0014
Capital	0.1124	0.1079	0.0045***	0.0994	0.0913	0.0081***	0.1203	0.1163	0.004**
Liquidity	0.3109	0.2802	0.0307***	0.2634	0.2757	-0.0123	0.3473	0.2801	0.0672***
LLP Ratio	0.005	0.0048	0.0002	0.0116	0.01	0.0016*	0.0053	0.0051	0.0002

Table C.3: t test – AHHI Non-interest

	Full sample			**2007-2009**			**2019-2020**		
	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference
ROA	0.0051	0.0049	0.0002	0.0028	-0.0005	0.0033***	0.0051	0.0056	-0.0005
ROE	0.0472	0.0444	0.0028*	0.0297	-0.0097	0.0394***	0.043	0.0502	-0.0072*
Z-Score	46.7841	44.5515	2.2326**	53.2939	36.7633	16.5306***	41.8218	45.2742	-3.4524*
NPL Ratio	0.0162	0.0208	-0.0046***	0.0212	0.031	-0.0098***	0.0077	0.0119	-0.0042***
Capital	0.1131	0.1073	0.0058***	0.1054	0.0851	0.0203***	0.1198	0.1168	0.003
Liquidity	0.2547	0.3362	-0.0815***	0.2158	0.3245	-0.1087***	0.2803	0.3447	-0.0644***
LLP Ratio	0.004	0.0059	-0.0019***	0.0097	0.012	-0.0023***	0.0043	0.0061	-0.0018***

Table C.4: t test – Non-interest income share

	Full sample			2007-2009			2019-2020		
	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference	Diversified	Concentrated	Difference
ROA	0.0054	0.0045	0.0009***	0.0023	-0.0001	0.0024***	0.0059	0.005	0.0009**
ROE	0.0524	0.0392	0.0132***	0.0263	-0.0059	0.0322***	0.0539	0.0411	0.0128***
Z-Score	43.3472	47.9725	-4.6253***	38.809	51.4874	-12.6784***	44.13	43.1256	1.0044
NPL Ratio	0.0177	0.0193	-0.0016***	0.0237	0.0284	-0.0047***	0.0099	0.0098	0.0001
Capital	0.1051	0.1152	-0.0101***	0.0866	0.1042	-0.0176***	0.115	0.1208	-0.0058***
Liquidity	0.3429	0.2487	0.0942***	0.2953	0.2436	0.0517***	0.3826	0.2588	0.1238***
LLP Ratio	0.005	0.0049	0.0001	0.0109	0.0107	0.0002	0.0055	0.005	0.0005