Alma Mater Studiorum – Università di Bologna

DOTTORATO DI RICERCA IN
MANAGEMENT

Ciclo 34

Settore Concorsuale: 13/B1 - ECONOMIA AZIENDALE

Settore Scientifico Disciplinare: SECS-P/07 - ECONOMIA AZIENDALE

REAL EFFECTS OF THE IFRS 9 ADOPTION IN BANKING

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Esame finale anno 2023

ABSTRACT

Within the academic research on the economic consequences of accounting, the *"real effect hypothesis"* provides theoretical arguments and empirical evidence supporting the idea that accounting measurements and disclosures have an effect on firms' operations and investment decisions. In the banking sector, due to its impact on financial stability, accounting for financial instruments has always been a controversial topic. In particular, the potential consequences of fair value accounting (FVA) and loan loss provisions (LLP) on the real economy such as: lending procyclicality, banks' capital adequacy and market discipline, have originated significant academic debates. However, as Leuz and Wysocki's (2016) explain, in their literature review on the economic impacts of disclosure and financial reporting regulation, there is still distance toward a convincing theoretical framework underpinning the real effect hypothesis, which is mainly due to the lack of extensive empirical evidence on the real effects of accounting rules. In this context, the recent adoption in 2018 of IFRS 9 (Financial Instruments), that introduces a transition on LLP approach from the incurred loss model (ICL) to the expected loss model (ECL), is a highly disruptive accounting reform for banks and can be a very important new area of academic scrutiny to test the hypothesis. In fact, it is likely that the new staging classification driving the ECL approach on provisioning affects when and under what conditions retail and corporate clients are likely to be granted financing.

The objective of this thesis is to empirically examine the real effects of the IFRS 9 accounting reform and hence contributing to the academic debate about the relevance of accounting measurements and disclosures in an industry that is highly regulated and crucial for financial stability. This thesis collects three relevant academic studies on the topic.

The first study (chapter 1) has the objective to review the literature on the real effects of the accounting regulation in the banking sector focusing the analysis on: the definitory aspects of the real effect hypothesis, the literature on the impacts of FVA and its impacts on

the real economy, the implications of accounting for bank loan loss provisions and the role of IFRS and its interconnections with climate risk management, banks accounting and banks decisions. This study contributes to the real effects of accounting debate and provide support to the idea that whether or not accounting choices and disclosure have a real effect on the decision-making process remains a debated topic especially in the banking sector. In this context, we suggest that more empirical analyses could be dedicated to study the potential effects of the new IFRS 9 accounting regime on banks' lending standards, as a laboratory setup to test the real effects hypothesis.

The second study (chapter 2) examines the role of the new measurement and recognition policy on price terms for Corporate Loans. Using a unique dataset of two major banks operating in one European country, we provide evidence of a tightening of the corporate loans pricing after the IFRS 9 adoption, which is driven by the new staging classification. In the post-IFRS 9 adoption, higher risk premiums are associated to clients with previous underperforming exposures (stage 2) and higher probability of default. We also observe that the staging classification is not affecting climate risk premiums.

The third study (chapter 3) specifically focuses on the retail banking sector, by examining Loan-to-Value conditions (Loan-to-Value is a leverage indicator defined as Loan exposure to collateral value) requested to private individuals to access to mortgage loans, before and after IFRS 9 introduction. Using a unique dataset of a major European bank, we provide evidence of a tightening of Loan-to-Value standards, after IFRS 9 adoption. In fact, we show that after the reform, the cost of LTV has increased when compared with the previous accounting regime (IAS 39). Our analyses suggest that this tightening is driven by the staging classification. Clients with previous underperforming exposures (stage 2) experience more expensive LTVs. These underperforming clients are also subject to LTV reductions when they apply for mortgages with higher maturity and higher climate-related risks.

As general evidence for the retail and corporate segment, our results highlight that the lenders, as expected by the regulation, change their risk appetite by tightening their lending standards to discourage loan origination for clients that became too risky and expensive under the new standard.

This thesis has several related contributions. First, it contributes to the ongoing debate regarding the relevance of accounting and related regulation. This thesis documents the real effects of accounting reforms on the credit market, both retail and corporate. Second, the IFRS 9 reform is expected to be a step towards a more conservative and perhaps informative financial information environment for regulatory supervision. In fact, this thesis contributes to the debate about the cost and benefits of accounting conservatism and pro-cyclical regulatory requirements for financial institutions.

Furthermore, it has important micro and macro-implications referred to customers, banks, and policymakers. The corporate study can contribute to shed light on the potential determinants of the corporate lending premiums formation. The retail study can contribute to clarify potential interconnections of accounting with macroprudential policy and household finance decisions, in fact there is evidence that extensive staging downgrades create the conditions for credit crunch phenomena.

To facilitate the reading of some sections, the most technical terms used in the thesis, which are related to the bank accounting and capital regulation, are defined in the Glossary.

Keywords: Accounting for financial instruments; Real effects of accounting; Lending standards; IFRS 9; Credit risk, Climate risk, Loan-to-Value, Loan Pricing

CONTENTS

CHAPTER ONE:
LITERATURE REVIEW OF THE REAL EFFECTS OF ACCOUNTING REGULATION IN THE BANKING SECTOR

ABSTRACT

There is still no consensus among accounting and finance scholars about the role of accounting measurement and disclosures in shaping banks' operating and investing decisions. On the one hand, seminal analytical models and some empirical studies provide support to the so-called "real effect hypothesis", according to which the reporting entity changes its allocation of resources as a result of a change in an accounting measurement method and/or disclosure requirement. On the other hand, the real effect of a relevant accounting method such as the FVA during the financial crisis 2007-2009 has been questioned and most of the recent analyses tend to exclude that the accounting method in question plays a significant role and affects banks' behaviour. However, the recent adoption of the IFRS 9 reform, with the transition from the Incurred to the Expected Loss Approach, is a very important new area of academic scrutiny to test the hypothesis. This paper reviews the literature on the real effects of the accounting regulation in the banking sector and contributes to the above-mentioned debate in an industry that is highly regulated and crucial for financial stability.

Keywords: Accounting for financial instruments; Real effects of accounting; Fair Value Accounting; IFRS 9; Loan Loss Provisioning, Climate risk, Natural disasters.

1.1 INTRODUCTION

Banks' lending has a substantial impact on economic growth and is an essential resource for economic stability, also because, in some jurisdictions, firms and households rely on the bank credit as primary, if not unique, source of financing. Hence, banks stability is a crucial subject in the economic debate and is also a significant area of research in finance. In this context, the accounting regulation for financial instruments has always been a controversial topic due to its impact on financial stability and that is particularly evident when we analyze the role of fair value accounting (FVA) within the financial crisis (2007-2009) and the recent adoption of IFRS 9 (*Financial Instruments*). The subprime crisis (2007-2009) gives initially the impression that credit loss recognition mechanism was increasing the procyclicality in the banking industry by generating "too little, too late" provisions (e.g., Gaston and Song, 2014; Bischof, Laux and Leuz, year 2010). Based on that issue, the traditional approach of assessing impairments based on incurred credit losses (ICL) has been replaced by an opposite method based on the expected credit losses (ECL). This new approach becomes the new standard with the IFRS 9 reform and is now globally implemented from the 2018 financial statements. These arguments clarify how significant is the discussion within the banking industry in the last decades on the potential real effects of the accounting regulation, not only for the evident economic impacts but also, as already mentioned, for the potential consequences in terms of financial stability that are particularly important in the aftermath of the global pandemic[1].

[1] In 2020, potential real effects of IFRS 9 attracted the attention of capital markets and banking regulators. Considering the Covid-19 emergency, EU Authorities (EBA, ESMA, ECB) made statements urging the avoidance of procyclical effects of the IFRS 9 reform on the industry. ECB (2020) stated: *" In order to mitigate volatility in institutions' regulatory capital and financial statements stemming from IFRS 9 accounting practices in the current context of extraordinary uncertainty, we recommended that banks ii) avoid excessively procyclical assumptions in their IFRS 9 models to determine their provisions."*

The objective of this paper is to review the literature on the real effects of the accounting regulation in the banking sector and hence to contribute to the academic debate about the relevance of accounting measurements and disclosures in an industry that is highly regulated and crucial for financial stability. In the context of a growing attention to the financial stability as a fundamental element for investors' protection, the analysis can represent an element of interest for the academic community, standard setters, policy makers and supervisory authorities. The research method of this study consists of a literature review that analyzes the most relevant works discussing the areas of interest of the paper. In particular, we classify prior empirical and theoretical literature on the real effects of accounting hypothesis in the banking industry. More precisely, all the selected papers are reviewed and classified by adopting the following scheme[2] (see Menicucci and Paolucci, 2016):

- References.
- Subject and focus of the study.
- Research design (theoretical or empirical).
- Findings.

In terms of contents, we firstly review the academic research on the economic consequences of accounting disclosure, particularly the general stream of research that provides theoretical argument and empirical evidence supporting the idea that accounting measurements and disclosures have an effect on firms' operations and investment decisions (i.e., *real effect hypothesis*). Prior literature on that topic shows that there is still no consensus among accounting and finance scholars about the role of accounting measurement and disclosures in shaping banks' operating and investing decisions. On the one hand, seminal analytical models (e.g., Kanodia and Sapra, 2016) and some empirical studies (e.g., Christensen, Floyd, Liu and

[2] The results of the classification work is reported in dedicated tables (see from Table1 to Table6).

Maffett, 2017) provide support to the so-called "real effect hypothesis", according to which the reporting entity changes its allocation of resources as a result of a change in an accounting measurement method and/or disclosure requirement. On the other hand, the real effect of a relevant accounting method such as the FVA during the financial crisis 2007-2009 has been questioned and the most recent analyses tend to exclude that the accounting method in question played a significant role and affected banks' behaviour. The distance between a convincing theoretical framework underpinning the real effect hypothesis and the lack of extensive empirical evidence on the real effects of accounting rules is highlighted by Leuz and Wysocki's (2016) literature review. They emphasize: *"we need more empirical research on the prevalence and magnitude of real effects with respect to corporate investment and other real economy actions".*

Secondly, we focus specifically on literature that investigates the alleged real effect of a relevant accounting rule for financial institutions, such as the fair-value accounting, during the financial crisis. In fact, the use of fair value is one of the most investigated cases of potential real effects of an accounting method in the banking industry, since it was seen as a contributing factor to worsening the crisis after 2008. The consequent downturn immediately generates a debate on the reasons of the crisis and on the possible cures. This debate involves a significant list of stakeholders: policy makers, prudential and market regulators, standard setters, supervisors and central banks, academic communities, banking industries and auditors. One of the elements that dominates the discussion at that time is the link of the Fair Value Accounting (FVA) with the financial crisis. The literature, emerged shortly after the crisis, is divided between academics who considered the FVA as a simple messenger of the crisis, with little or no role in the downturn propagation, and the academics promoting the idea that FVA was contributing to the crisis. According to the "contributor theory", the early emergence of strong accounting losses, due to the FVA, generates regulatory capital erosions for the financial

industry, so that banks were obliged to initiate massive fire sales of assets, in order to preserve the capital adequacy, with evident pro cyclical contagion effects on the other good banks. In this context, the opacity of the accounting disclosure particularly has exacerbated the severity of the crisis. On the other hand, the "messenger theory" found no or limited evidence of the propagation mechanism described above. Ten years after the crisis, this literature review highlights that the picture is different, since most of the recent literature sustains that there is no evidence of a material role of FVA in the subprime crisis. Nevertheless, after several years, the literature seems to suggest that the fair value played a little, if any, role in either starting or worsening the financial crisis (Menicucci and Paolucci, 2016).

Thirdly, we present a selected sample of studies on the LLP (Loan loss provisions) that show the relevance of this accounting item in the banking industry for both managers and regulators within the context of the transition from IAS 39 principle (incurred loss approach) to the IFRS 9 (expected loss approach), that is a highly disruptive accounting reform, with a significant impact on how and when negative news (i.e., negative adjustments to reported earnings) are recognized on the financial statements. To the extent that IFRS 9 significantly affects performance indicators and likely regulatory scrutiny, it is important to examine the spillover effects of this accounting regulation on the real economy (i.e., access to finance). It is likely that the new measurement and recognition of bad news on banks' financial statements affects when and under what conditions retail and corporate clients are likely to be granted financing. In Europe, this is particularly evident in the aftermath of the global pandemic when European banks adjust their staging mechanisms to comply with the European banking regulators and supervisors (EBA, ECB). The Authorities requested adjustments aimed at avoiding procyclical effects on the industry due to a rigid adoption of the staging triggers. However, the exam of the literature shows there is not yet a complete understanding of the effects of ECL provisioning

and that there is a lack of extensive empirical evidence on the economic consequences of this accounting treatment.

Lastly, within the analysis of the real effects of the accounting in the banking sector we also review a specific strand of the literature covering the interconnections between accounting regulation and climate-related risks. In fact, in the recent years both financial regulators[3] and supervisors[4] recently push banks to enhance the consideration of climate-related risk factors in the accounting classification and measurement. Thereby, it is particularly interesting to analyze the current research on the relation between climate-related risk factors and accounting provisioning.

The main contribution of this paper is twofold. Firstly, it contributes to the ongoing debate on the real effects of accounting and the impacts of the related regulatory reforms. By reporting a precise summary of the current and prior research, this paper can be of great support for academics and practitioners interested in exploring the relationship between accounting and financial crisis. Secondly, the IFRS 9 reform is expected to be a step towards a more conservative and perhaps informative financial information environment for regulatory supervision. In this sense, this paper contributes to shed light on the debate about the cost and benefits of accounting conservatism and pro-cyclical regulatory requirements for financial

[3] From a European perspective, on December 2019 the EBA released an action plan that will require banks to include ESG factors in their risk management policies. As set out in the following *EBA Guidelines on loan origination and monitoring* (May 2020 final report and June 2019 the consultative version) *"Institutions should take into account the risks associated with ESG factors on the financial conditions of borrowers, and in particular the potential impact of environmental factors and climate change, in their credit risk appetite, policies and procedures"*. In the same guidelines the regulator highlights the importance of including accounting allowances measures in banks' credit risk policies and procedures determination: *"Institutions should set out, in their credit risk policies and procedures, the criteria for identifying, assessing, approving, monitoring, reporting and mitigating credit risk, and the criteria for measuring allowances for both accounting and capital adequacy purposes. Institutions should document the framework and update it regularly"*.

[4] In May 2020, the ECB issued a guide for banks on climate-related and environmental risk management. The guidance included assessing the potential impact of climate-related and environmental factors on market risk positions and future investments, developing stress testing scenarios and evaluating the benefit of including stress testing into baseline and adverse scenarios for those institutions with material climate-related and environmental risks

institutions. Particularly, this study can contribute to understanding the effect of the ECL model on procyclicality and its interconnection with climate-related risks. We also provide some conclusions for future empirical research to get evidence on the real effects of ECL.

The rest of the paper is organized as follows. In Section 1.2 we review the literature on the real effects of accounting hypothesis. In Section 1.3, we review the literature on the effects of accounting regulation in banking. Conclusions are provided in Section 1.4.

1.2 REAL EFFECTS OF ACCOUNTING DEFINITION

1.2.1 PRIOR LITERATURE ON REAL EFFECTS OF ACCOUNTING DEFINITION

In this section, we discuss the real effects of accounting disclosure. We are building on Kanodia and Sapra (2016) in defining real effects. According to Kanodia and Sapra (2016), the real effects hypothesis states that measurement and disclosure have a significant effect on the real decisions that firms make. In their view, firms are influenced in their decision-making process by *"which economic transactions are measured, and which are not measured, how they are measured and aggregated, what is disclosed to capital markets and how frequently such disclosures are made.*" According to Kanodia (2007), the real effects of accounting disclosure hypothesis is beneficial for the firms for two reasons. Firstly, because accounting disclosure facilitates more efficient contracts of the firms with their major stakeholders, secondly because it can generate value for the firm's shareholders through the capital markets vehicle. In the following paragraph we present the different streams of the literature supporting the real effects of accounting hypothesis. Table 1.1 reports a summary of the prior theoretical and empirical literature on real effects of accounting definition and impacts.

1.2.1.1 Real effects of accounting disclosure

A first stream of the academic literature (Diamond and Verrecchia, 1991; Leuz and Verrecchia, 2000) is promoting the insight that a good disclosure is beneficial, since it produces a reduction of the firm's cost of capital in the capital market. This real effect is supposed to be generated by the reaction of the capital market to a high-quality disclosure. In fact, Lambert et al. (2007), Botosan (1997), explain that a transparent and large disclosure, by reducing the adverse selection connected to the information asymmetry among traders in the capital market, can generate a decrease in non-diversifiable risk that reduces the firm's cost of capital in the capital market. Lambert et al. (2007) highlight that the quality of accounting information has impacts

on a firm's cost of capital. They find a link between accounting information and market expectations of future cash flows and of the relevant real decision on their distribution. In line with the considerations of this stream, Graham et al. (2005) indicate that financial statements reporting considerations do in fact affect real corporate decisions; also, Biddle and Hilary (2006) report evidence that investment efficiency is improved by the accounting quality, since it reduces information asymmetry between managers and capital providers. Furthermore, Bird et al. (2018), in their empirical research on the real effects of accounting standards, provide evidence that standard setting matters and have economically significant real effects. Particularly, they lead to a reallocation of capital in financial markets.

A second stream of the literature, supporting the real effects of accounting hypothesis, is related to the so called "classification manipulation" theory, that Dye (2002) Dye et al. (2015) have explored in their research. According to the authors, managers are used to manipulate[5] firm's decisions with the goal of receiving the most useful and preferred accounting treatment and this circumstance does represent another way in which accounting standards can influence corporates decisions.

Another stream of the literature (Admati and Pfleiderer, 2000) supports the real effects of accounting hypothesis by showing the presence of positive externalities via information transfers in capital markets. The disclosure on cash flows (that are supposed to be correlated with the value of the firm) operated by one firm, can influence the ability of investors to evaluate other firms, so to potentially increase willingness to invest in shares in other corporations. Jorgensen and Kirschenheiter (2007) highlight the presence of similar externalities linked to the disclosures about firms' sensitivity to market risk factor. Even if on

[5] The possibility of switching the classification between operating and capital lease (in order to benefit from an operating lease classification when in substance the transaction is a capital lease) by redefining the term of the lease or postponing the accounting treatment is an example the authors mention to explain their manipulation theory.

an individual firm perspective these effects are small, they can become large if cumulated for all firms in the market. In line with these considerations, other authors (Coffee, 1984; Diamond, 1985) highlight how corporate specific disclosures[6] eliminate duplicative efforts of information for intermediaries and investors. According to some authors (Fishman and Hagerty, 1989) firms reporting can also generate costly externalities producing negative effects. For example, if a firm improves its disclosure, it is likely that attracts new investors that leave other firms. However, in the circumstances that capital markets are not perfectly competitive, this can generate negative externalities, by reducing the price efficiency of other firms, especially those that have not improved their disclosure, because processing information was too expensive. This argument of course applies across markets or countries. In case markets are not perfectly competitive, high transparency in one capital market can reduce the price efficiency in other capital markets.

1.2.1.2 Criticism on empirical research

It is important to emphasize that the traditional financial economics, is not supporting the real effects hypothesis, on the contrary, it supports the opposite theory that financial statements considerations do not affect decision-making. In his work on accounting disclosure and real effects, Kanodia (2007) explains that a part of the literature is convinced that accounting measurement and disclosure do not actually affect capital market pricing and corporate decisions. According to the author, one of the clearest examples of this view is related to the empirical studies on "value relevance" of accounting (e.g., Landsman, 2007, studies the information relevance of fair value accounting), which highlight how the accounting disclosure is affecting the correlation between accounting numbers and security returns but is not affecting

[6] While the mentioned authors mainly discuss the effects of the voluntary disclosure, Easterbrook and Fischel (1984) focus on the mandatory disclosure impacts on market efficiency.

the capital market price. In this sense, the value relevance school is more in favor of the accounting regimes that generate higher correlation with the capital market pricing in order to provide investors with more useful info to estimate capital market pricing. Whether or not accounting choices and disclosure have a real effect on the decision-making process is a debated topic. Kanodia (2007) observes that attempts to formulate a comprehensive theory of the real effect of accounting disclosure would be futile or sterile. Trombetta et al. (2012) stressed the importance of the research on potential real effects of accounting as a valuable tool to help standard setters and policymakers understanding ex ante and ex post potential consequences of accounting rules. However, the distance between a convincing theoretical framework underpinning the real effect hypothesis and the lack of extensive empirical evidence on the real effects of accounting rules is highlighted by Leuz and Wysocki's (2016) literature review. They emphasize: *"we need more empirical research on the prevalence and magnitude of real effects with respect to corporate investment and other real economy actions".*

1.3 ACCOUNTING REGULATION IMPACTS IN BANKING

In this chapter we firstly present the debate about the relation between Fair-Value Accounting (FVA) and the financial crisis of 2007-2009 (i.e., credit crunch and subprime crisis), which has been a very debated topic on the potential real effects of accounting with economically significant implications, especially in the financial industry. In the following part we go through the literature covering the discussion about the economic impacts of the different loan loss provisioning approaches. Lastly, we review the research covering the interconnection between climate risks, banks accounting and relative lending decisions.

1.3.1 FAIR-VALUE ACCOUNTING AND ITS IMPACT ON THE REAL ECONOMY

The financial crisis 2007-2009 has significant implications for the financial stability[7] of the global banking sector and more in general for the financial industry and leads to a complex debate among different stakeholders. The debate on the reasons of the crisis and on the possible cures involves policy makers, prudential and market regulators, standard setters, supervisors and central banks, academic communities, banking industries and auditors. One of the elements that dominates the discussion at that time is the link of the fair-value accounting with the financial crisis. At the time of the crisis, especially among policy makers and prudential supervisors, the idea of the FVA as the main element generating the crisis is quite common (Wallison, 2008).

[7] The crisis impacts on the Italian jurisdiction are well represented in Carosio, G. (2008), "La crisi finanziaria e il principio del Fair Value" and in Banca d'Italia (2009), "Financial sector pro-cyclicality, lessons from the crisis. For Spain, Glavan (2010), "Fair value accounting in banks and the recent financial crisis", carifys the impact of the crisis on the financial stability.

There are conflicting arguments about the role of FVA in fueling the deterioration of financial stability during the financial crisis of 2007-2009. Some of the critics argued that the FVA had an important role to the financial crisis or exacerbated its severity. In contrast, other arguments suggest that FVA has a limited role in the crisis, being a simple messenger. To some extent, there seems to have a consensus in academic research that despite its role in the downturn, FVA would not have been a concern in the absence of stressed market conditions (e.g., Khan, 2018). Table 1.2 and 1.3 report respectively a summary of the prior theoretical and empirical literature on FVA's role within the financial crisis (see Menicucci and Paolucci 2006).

1.3.1.1 The initial post crisis debate: messenger theory

It is interesting to notice that the potential role of the FVA as source of procyclical effects, affecting the financial stability, is an academic debated argument prior to the 2007-2009 crisis. Barth et al. (1995) show that increased earnings volatility resulting from FVA is not correlated with increases in risk perception by the markets. They find evidence that the FVA is increasing the earnings volatility, but this is not correlated with bank share prices. In this sense, they affirm that the possible increase in regulatory risk originated by the FVA is actually not perceived by the investors. In their research, Laux and Leuz (2009 and 2010) examine the role of fair-value accounting in the financial crisis. They find evidence that it is unlikely that FVA contributed to the current financial crisis in a major way. In fact, there is little evidence that the downward spirals or asset-fire sales are the result of FVA. In line with this conclusion, Shaffer (2010) shows how FVA had a little impact on the capital of most banks in the sample analyzed (period 2007 end 2008). In fact, the capital erosion was mainly due to deterioration of the credit quality of the loans, exacerbated by proprietary trading losses. In this sense, the major reason of the capital downward is connected to the lending practices and the managerial measures activated by the banks. The analysis highlights that the capital raising has not been obtained by deleveraging through distressed asset sales, rather by the adherence to government programs

or by the recourse to the debt and equity markets. Wallace (2008), Pozen et al. (2009), Barth and Landsman. (2010), Bonaci et al. (2010), Bischof et al. (2010), Jarolim and Oppinger (2012) also conclude that FVA played little or no role in the subprime crisis. However, Barth and Landsman (2010) recognize that the quality of the disclosure on asset securitizations and derivatives was inadequate for investors to assess the values and riskiness of bank assets and liabilities. Badertscher et al. (2012) examine whether banks engage in procyclical selling of assets which is considered one of the main reasons of the crisis. Their evidence is that banks did not sell securities in response to the crisis. They focus on Other-Than-Temporary Impairment (OTTI[8]) charges as the only fair value write-downs of AFS and HTM debt securities with impacts on regulatory capital. *"We find that although OTTI charges reached unprecedented levels during the financial crisis, the impact on regulatory capital was minimal. Moreover, the majority of the OTTI charges were not recognized until the later part of 2008, well after the financial crisis was underway"*. They also find that the lower are the capital ratios of the banks, the lower is the selling of the assets that is in evident contrast with the assumption of FVA introducing cyclicality.

1.3.1.2 The initial post crisis debate: contributor theory

The initial considerations of the academics are often supporting the thesis of the FV as a source of unintended income volatility and procyclicality effects. In fact, Plantin et al. (2007) in comparing the measurement regime based on past prices (historical cost) with a regime based upon current prices (FVA) find that the historical cost regime is inefficient because it ignores price signals, but the FVA is adding an extra component to price fluctuations. Ryan (2008) helps us understand the nature of the stakeholders that considered the FVA as

[8] OTTI *"is the amount of other-than-temporary impairments of available-for-sale (AFS) and held-to-maturity (HTM) securities. Bad debt expense is a charge related to management's expectations about future uncollectible loan amounts. Earnings is the amount of net income loss"* (Badertscher et al., 2012)

strong crisis contributor. In the Author's view, several stakeholders – such as traditional banks, financial institutions, most bank regulators, some investors and accounting academics – believe that fair value accounting hurts investors compared to historical cost accounting, at least in particular situations. Bignon et al. (2009) in their article "An economic analysis of fair value accounting as a vector of crisis" affirm that *"a report by the "Group of Thirty" (G30) condemned fair value for its role in creating systemic risks, low resilience and financial instability… … The fair-value accounting model not only failed to prevent the crisis but accelerated the collapse…".* According to Veron (2008), the idea that market prices are the best basis for estimating FV is not correct, because it boosts the banks' balance sheets at the top of the cycle and reduces it by the same measure at the bottom. By granting too much relevance to markets, accounting standards would thus be emphasizing the procyclicality not only when FV refers to illiquid securities. Bowen et al. (2009), Bout et al. (2010) show that FVA has dampened pro-cyclical effects. An IMF working paper (Novoa et al. 2009) helps us summarize the reasons why FVA has been considered as a crisis contributor. They highlight "*three key points regarding FVA and its potential regulatory and financial stability implications: (i) strong capital buffers and provisions make an important contribution to withstanding business cycle fluctuations in balance sheets, especially when FVA is applied more extensively to assets than liabilities; (ii) when combined with additional liquidity shortages in financial markets, the FVA framework magnifies the cyclical volatility of capital; and (iii) fair valuing an expanded set of liabilities acts to dampen the overall procyclicality of the balance sheet* (see also Strampelli 2010). *However, the latter may also give rise to the counterintuitive outcome of producing gains when the valuation of liabilities worsens. .... results in a false sense of improvement in the bank's equity position."* Kolasinsky (2011) in his paper, commenting the work of Bhat et al. (2011), reports that the crisis produces a warning for absolute reliance on market prices for policy and regulation. In fact, Bhat et al. (2011)

explain that market prices are not perfect, especially in case of stressed and illiquid conditions, and so regulators have to guarantee that a market is active and liquid before requiring price inputs in standards and rules.

1.3.1.3 Recent developments in the literature on FVA

More recently, several academic studies provide evidence that the debate on the role of the FVA as messenger or contributor of the downturn is still in place some years after the subprime crisis (e.g., Skoda and Slavikova, 2015). Menicucci and Paolucci (2016) in their literature review affirm that there are very little reasons to consider FVA one of the major causes[9] of financial crisis. They also observe that the current debate is more focused on which is the most appropriate general regulatory framework (prudent and accounting) to avoid other financial crises. Acharya and Ryan (2016) recognize that "*severe downturns such as the 2007–2009 financial crisis tend to be accompanied by a high degree of bank opacity*[10] *that motivates banks and other market participants to take self-protective, stability impairing actions, such as racing to the exits to sell assets or withdrawing financing to other banks."*

Bischof et al. (2019) scrutinize the more comprehensive connection between accounting and financial stability. In their research, the authors investigate the lessons learnt from the financial crisis and find that the picture of the debate ten years after the crisis is very different from the picture shortly after the crisis. They recognize that the significant concerns on the role of FVA in the crisis have been demystified, mainly due to five reasons: (1) FVA had a limited role for most banks. Actually, loans constitute the largest category, and the highest losses occurred in the loan books; (2) most assets classified at FV before the crisis, were priced using mark-to-

[9] However, Menicucci (2010) recognizes that FVA can accentuate earning volatility and procyclicality.

[10] Magnan et al. (2011) find that as fair value increases, there is a decrease in the precision of common information, in particular the informational properties of fair value disclosure decrease as we move from level 2 to mark-to-model data (level 3).

model approach rather than marked to actual market prices; (3) within the accounting rules, banks had many safeguards[11] useful to handle downward spirals and contagion; (4) little evidence that banks systematically engaged in fire sales; (5) in aggregate, banks' FV gains are not procyclical.

As general remark, this literature review shows that the recent debate about the role of the FVA has fundamentally changed. In particular, 10 years after the crisis there is evidence that the role of the FVA in the crisis has been modest (Bischof et al. 2019). It also becomes evident that in normal times, with liquid and efficient markets, FVA is reliable and solid enough to be adopted for valuation purposes. In normal market conditions, FVA is beneficial to investors in their decision-making process (Menicucci and Paolucci, 2016).

1.3.2. IMPLICATIONS OF ACCOUNTING FOR BANK LOAN LOSS PROVISIONS AND THE ROLE OF IFRS 9

1.3.2.1 Implications of accounting for bank loan loss provisions

Loan loss provisions (LLPs) are banks' accruals, that have the goal of covering losses deriving from the lending activity. According to Curcio and Hasan (2015), LLPs have an essential role on the banks' financial statements, because they provide substantial information on the quality of the credit portfolio, with string impacts on the reported earnings, on the regulatory and accounting capital. The topic of loan loss provisions (LLPs) and its implications on the real economy is a major component of the literature on the real effects of accounting in commercial banks. More specifically, research on the effects of LLPs significantly contributes to two research topics: (1) financial stability with a scope on procyclicality of provisioning and

[11] In particular (1) use of mark to model for illiquid markets, (2) prohibition of using fire-sale prices, (3) OTTI approach to protect income from the effects of short-lived declines in the assets FV (4) for some jurisdictions, prudential filters in place that shield the regulatory capital from FV losses on AFS securities. Bischof et al. (2019)

relevant effects on banks' capital and market discipline, and (2) earnings, capital management and value introduced with discretionary choices related to provisioning.

With regard to the relation between provisioning and pro-cyclicality, Beatty and Liao (2011), and Bushman and Williams (2012) find that in case banks promptly recognize LLP there is a substantial procyclicality reduction. According to the above-mentioned authors, the empirical evidence is that delays in loan losses recognition can generate credit crunch in the downturn periods while the opposite trend is present in case of growing periods. In particular, they observe that: "*When LLP cannot absorb recessionary credit losses, greater provisioning is required and reduces capital adequacy, potentially accentuating capital pro-cyclicality."* They actually recognize a tradeoff between incurred loss models (like IAS 39) and forward-looking provisioning models (like IFRS 9)". In particular, by regressing LLP on future changes in non-performing loans, the authors measure the relation between accounting discretion in provisioning and future losses. They find that there is a reduction of the risk-taking discipline when provisioning is designed to smooth earnings, while there is a higher discipline in risk taking when provisioning is designed to reflect timely recognize future losses.

Beatty and Liao (2014) in their review of the empirical literature on financial accounting in the banking industry highlight how most studies analyze the interconnection of the accounting discretion in LLP with the regulatory capital and earning management. Bushman and Williams (2012) study whether discretionary provisioning is associated with greater vulnerability of banks. They show how earnings smoothing dampens disciplinary pressure on banks' risk-taking, while anticipation on future changes in non-performing loans is associated with the opposite situation.

Wheeler (2019) give evidence that LLP can have negative impact on bank lending and can amplify business cycle volatility. Pool et al. (2015) obtain similar results in their

macroeconomic study, they also explain that this finding is in line with the evidence of micro-oriented empirical literature, such as Bikker and Metzemakers (2005) and Laeven and Majnoni (2003). Specifically, delayed provisioning, like that experienced within the incurred loss model, has been viewed as recognizing impairment losses ‘‘too little and too late’’ and “promoting cyclicality.” As represented by Lobo (2017), in his review of accounting research in the banking industry, a significant number of research explores the use of discretion over LLP for smoothing income, or to manage capital and risk. According to Bouvatier and Lepetit (2012), backward looking provisioning approaches (like IAS 39) aggravate banks' lending variance in both developed and emerging economies, with a stronger impact for emerging markets.

With regard to the relation between LLP and earnings/capital management and value, early contribution is from Ahmed et al. (1999) that in their empirical work support the hypothesis that LLP are used for capital management purposes. In line with these conclusions, Laeven and Majnoni (2003) highlight that provisioning for bad loans are often delayed by the financial institutions in order to manage the impact on their income and capital with clear effects on the economic cycle. According to Leventis et al. (2011), IAS 39 adoption in the EU has been a source of improvement of earning quality since managers limited the use of LLP earning management in listed banks. Lim et al. (2014) in their empirical study, explore the relationship between accounting and credit pricing. The authors show how a conservative approach in the definition of LLP has effects on the pricing of syndicated bank loans. They find evidence that the timelier is the approach in loss recognition the higher the spreads charged to clients. Aristei and Gallo (2018) in their empirical analysis of the Italian financial statements over the period 2006–2013 find that banks with growing risk levels are characterized by higher LLPs and are more frequently experiencing tendency to adopt earnings management practices to preserve stable income returns across time. On the other hand, Perez et al. (2008), in their analysis of

the LLP practices adopted by the Spanish banking industry, also highlight the use of loan loss provisions to smooth earnings. Actually, the authors do not find evidence of capital management practices in the industry. Curcio and Hasan (2015) in their comparison of the Euro/non-Euro Area banks' provisioning practice, investigate the relationship between loan-loss provisions and earnings management. The authors find that during the financial crisis period, bank managers of the Euro Area were targeting the credit portfolio quality without adopting LLP for discretionary purposes, on the other hand LLPs at non-EA banks are used by the bank managers to stabilize income or market performance to the market.

A stream of the LLP literature: Beaver et al. (1989) have found positive association between market value and loan loss reserves. According to Beaver et al. (1989), by reporting higher LLP, manager communicates to the market that the bank's profitability can withstand the negative LLP impact on earnings. Similar interpretations, that a higher LLP is a signal of a bank's willingness and ability to resolve its bad debt situation, have been presented in other following studies (Elliot et al. 1991; Griffin and Wallach, 1991). Ahmed et al. (1999) show that LLP is negatively associated with the stock returns, so questioning the signal interpretation and arguing that LLP discretion is more motivated by an attempt to meet regulatory capital requirements rather than by financial information incentives. Commenting prior literature, Ryan (2011) and Beatty and Liao (2014) explain that the determinants of LLP reporting and its impact on capital market are nuanced and depend on many factors. These authors stress the importance to call for more research on these factors.

Table 1.4 reports a summary of the prior theoretical and empirical literature on real effects of loan loss provisions.

1.3.2.2 The effect of the transition to IFRS 9 accounting regime

In response to the subprime crisis 2007-2009, the International Accounting Standards Board (IASB)[12] invests in developing rules for financial instrument valuation. The transition from IAS 39 (*"Financial Instruments: Recognition and Measurement",* old standard) to IFRS 9 ("*Financial Instruments*", new standard) has been a radical change for the banking industry. For commercial banks, the new Loan Loss Provisioning[13] (LLP) mechanism under IFRS 9 is a revolutionary approach to measuring and recognizing expected losses with potential real effects on banks' credit price and non-price terms. The IASB issues the first exposure draft of a new accounting principle on financial instrument (Exposure Draft ED/2009/7 Financial Instruments: Classification and Measurement) in July 2009, but the final version of IFRS 9 is released only in July 2014[14]. IFRS 9 replaces IAS 39 "*Financial Instruments: Recognition and Measurement"* and is effective for annual periods beginning on or after January 1, 2018. Earlier application is permitted. The new standard aims to simplify the accounting for financial instruments and address perceived deficiencies that were highlighted by the financial crisis. The IFRS 9 simplifies IAS 39, particularly for LLP calculations, by introducing a staging classification based on credit quality and estimating provisions on the basis of the expected credit losses (ECL). This ECL approach requires that an entity should recognize an allowance for the future estimated credit losses, instead of waiting for the default to happen as in the previous accounting regime (IAS 39) based on the incurred credit loss approach (ICL).

[12] International Accounting Standards Board (IASB) is the body responsible for issuing international accounting standards.
[13] Loan loss provisions (or credit provisions) are the Banks set aside to take account of the likelihood that some loans may not be repaid in full.
[14] IASB issued two preceding versions of IFRS 9 (2009 and 2010) that should have been effective on 1 January 2013 and on 1 January 2015, respectively. Given the critiques and the intense debate on some of the new rules, the IASB decided to postpone the effective dates of both IFRS 9 (2009) and IFRS 9 (2010), and then it made some further changes to the standard that resulted in the IFRS 9 (2014 version).

Initial articles on IFRS 9 transition mainly refer to impact assessment of the accounting principle adoption on financial and market stability. Onali and Ginesti (2014) investigate the price reaction to news related to IFRS 9 adoption events. They find that investors are confident that IFRS 9 addresses the problems inherent in IAS 39. Bischof and Daske (2016) recognize the ECL approach as a significant change for the industry and that the most significant change comes from the new ECL approach to the impairment of loans. Novotny-Farkas (2016) sustain that IFRS 9 can mitigate the procyclical effects related to the ICL approach and increase the capital adequacy in the downturn periods. Abad and Suárez (2017) develop a model for assessing the implications of IFRS 9 to measuring credit impairment losses. They find that IFRS 9 implies banks' capital decrease when the cycle moves from expansion to downturn. However, Lejard (2018) explains that IFRS 9 first-time adoption is expected to generate earnings volatility.

More recent literature, Gaffney and McCann (2018), Ertan (2019), Loew et al. (2019) Buesa et al. (2019) give evidence that the adoption of the ECL accounting models can increase the stock of provisions and reducing the credit amount. According to Kim et al. (2021) the ECL model significantly improves loan loss recognition timeliness, but on other hand, Szigel (2022), by simulating the adoption of the ECL model on the Hungarian banking system during the 2008–2013 crisis, demonstrates that the introduction of the IFRS 9 increases the procyclicality of banks' impairments. Furthermore, Beatty and Liao (2020) and (Lopez-Espinosa et al. 2020) show how the adoption of the ECL model enhances the informativeness of reported provisions compared with the reporting of the previous accounting regime. In line with this conclusion, o Orbison (2021) explains that the ECL approach improves the relevance of LLPs for credit default swap (CDS) pricing, since LLPs under IFRS 9 are incrementally more relevant than under IAS 39 for CDS pricing.

According to Jin, Q, Wu, S, (2022), another effect of the shifting from the incurred loss model of the IAS 39 to the expected credit loss model of the IFRS 9 is a reduction of the stock price crash risk of the banks.

Lopez-Espinosa et al. (2020) suggests that the switch from ICL to ECL provisioning has impacts in terms of procyclicality." In line with Neisen and Schulte-Mattler (2021), they also explain that without the 2020 regulatory and supervisory intervention, indicated in Europe as Capital requirement regulation Quick Fix adjustment, the accounting rule could have amplified[15] the COVID-19 crisis.

Table 1.5 reports a summary of the prior theoretical and empirical literature on real effects of IFRS 9 adoption.

1.3.3. CLIMATE RISKS, ACCOUNTING AND LENDING DECISIONS

In this section, we explore the literature related to the interconnections between climate risk management, banks accounting and banks decisions. This subject is having a substantial role in the recent literature, and it is becoming essential within the regulatory framework.

In fact, in the recent years, both regulators[16] and supervisors[17] push to enhance the consideration of the climate-related risks factors in all relevant stages of the credit process from

[15] According to Engelmann and Nguyen (2022) we observed different LLP pro-cyclicality across the globe in reaction to COVID.

[16] On a European perspective, on December 2019 EBA released an action plan that will require banks to include ESG factors in their risk management policies. As set out in the following *EBA Guidelines on loan origination and monitoring* (May 2020 final report and Jun 2019 the consultative version) *"Institutions should take into account the risks associated with ESG factors on the financial conditions of borrowers, and in particular the potential impact of environmental factors and climate change, in their credit risk appetite, policies and procedures".* In the same guidelines the regulator highlights the importance to include the accounting allowances measures in the bank credit risk policies and procedures determination.

[17] In May 2020 ECB issued a guide for banks on climate-related and environmental risk management. The guidance included assessing the potential impact of climate-related and environmental factors on market risk positions and future investments, developing stress testing scenarios and evaluating the benefit of including stress testing into baseline and adverse scenarios for those institutions with material climate-related and environmental risks.

the origination to the accounting classification. Table 1.6 reports a summary of the prior theoretical and empirical literature on climate risk, accounting and banks' decisions.

1.3.3.1 Accounting and climate risk

As a general remark, as observed by Ding et al. (2021), climate risk can have both a direct and an indirect effect on the firm performance. Huang et al. (2018) highlight that a direct impact is connected to the potential physical damage that climate-related risks can have on the firm's assets and their value, while an indirect impact is connected to the consequent interruption of business operations with related loss of benefits and productivity. More generally Huang et al. (2018) show that, for listed companies, climate-related risk has a negative association with firms' earnings while a positive relation with firms' earnings volatility.

According to Dyng et al. (2021), in case the firm has a higher exposure to climate risk, it is more plausible that managers use accrual-based and real earnings management to mitigate the negative effect on reported earnings (i.e., earning manipulation[18] by managers).

With regard to the banking sector, the IFRS foundation highlights that climate risk factors may affect the accounting for financial instruments in a number of ways. In a recent document (Nov 2020) *"Effects of climate-related matters on financial statements"* the IFRS foundation explains that: "*Climate-related matters may also affect a lender's exposure to credit losses. Additionally, assets could become inaccessible or uninsurable, affecting the value of collateral for lenders. In recognizing and measuring expected credit losses, IFRS 9 on financial instruments requires use of all reasonable and supportable information that is available*

[18] Manipulation of reported earnings by managers to protect their performance-based compensation is in Holthausen et al. (1995). Furthermore, DeFond and Jiambalvo, (1994) Kim and Park (2005) explain that risks can increase the likelihood that firms violate debt covenants so that managers can be motivated to manipulate accruals and real activities in order to reduce the debt burden to reasonable levels.

without undue cost or effort. Climate-related matters may therefore be relevant for example: they could affect the range of potential future economic scenarios, the lender's assessment of significant increases in credit risk, whether a financial asset is credit impaired and/ or the measurement of expected credit losses".

1.3.3.2. Climate risks implications on Banks' lending decisions

Finance literature on climate-related risks implications on banks' lending mainly focuses on changes in credit demand, credit supply and lending conditions in areas impacted by natural disasters (Dal Maso et al., 2022) or highly exposed to physical climate risk (Nguyen and Wilson, 2020). Beside the evident impact of the climate-related risk to the economic growth, prior literature highlights the formation of credit shocks (Cortes and Strahan, 2017; Powell, 2019), changes in lending conditions (Nguyen et al., 2022; Jiang et al., 2020; Ouazad and Kahn, 2021) with impacts on financial stability (Klomp, 2014; Noth and Schuwer, 2018) in the areas hit by natural disasters or those mainly exposed to climate risk. In this paragraph we introduce: (1) the literature exploring the credit shocks arising from natural disasters, (2) the impact of a high climate risk exposure on lending conditions and (3) the impact of natural disasters on financial stability.

With regard to the credit shocks following natural disasters, we highlight that a significant stream of the literature is supporting the thesis that natural disasters affect the credit supply. Nguyen and Wilson (2020) show negative effect on credit supply due to the 2004 Indian Ocean Tsunami. In line with this conclusion Cortes and Strahan (2017) show that small banks reallocate credit in the areas hit by natural disasters, while large banks do not adjust lending in connected markets. Koetter et al. (2016), by analysing the banks' lending data in the areas hit by the flooding of the river Elbe in 2013, demonstrate a statistically significant recovery lending effect. Schuwer et al. (2019) analyse the reaction of banks in the aftermath of the

Hurricane Katrina in 2005. They find that, in the areas impacted by the hurricane, banks that are part of holding company do not increase on average their regulatory capital, while independent banks increase their capital ratios. Hosono et al. (2016) find that firms that operate with banks located in areas impacted by the Japan's Great Hanshin-Awaji earthquake in 1995 present lower capital investments if compared with firms operating with banks located outside of that earthquake area. Garmaise and Moskowitz (2009) show evidence that earthquake risk reduced commercial real estate lending in California in the 1990s.

With regard to the impact on lending conditions in areas highly exposed to climate risk, we highlight that there is a significant stream of recent literature (Nguyen et al., 2020; Jiang et al., 2020; Ouazad and Kahn, 2021) which empirically supports the claim that climate-related risks are included in individual lending decisions and capital allocation. A recent study of Nguyen et al. (2020) shows that financial institutions use the mortgage pricing as lever to handle sea level rise risk (SLR) on prices of residential properties. The authors analyze loans originated in the U.S. between January 1992 and June 2018 and show an "SLR premium" in the mortgage market. Furthermore, Jiang et al. (2020) in their empirical work, highlight the fact that lenders charge a higher cost of credit for firms exposed to higher SLR risk. Further contribution is in Ouazad and Kahn (2021), the authors show that, *"in the aftermath of natural disasters, lenders are more likely to approve mortgages that can be securitized, thereby transferring climate risk".* On the corporate lending side, Javadi and Masum (2021) find empirical evidence that "*firms in locations with higher exposure to climate change pay significantly higher spreads on their bank loans".* The empirical evidence that climate-related risk influences corporate lending decisions is also in Delis et al. (2021).

From a financial stability perspective, the impact on the viability and business continuity of banks operations, is highlighted by Klomp (2014) that explains how geophysical and meteorological disasters increase the banks default probability. In line with these

considerations, Noth and Schuwer (2018) highlight the impact of natural disasters in weakening bank stability[19], given the deterioration of the asset quality and probability of default along with a decrease in return on assets, bank equity ratios, and z-scores.

[19] In "*Climate-related risk and financial stability"* by a joined ECB/ESRB Project Team on climate risk monitoring (2021), the European Authorities explain that: "*The impacts of climate change on financial stability hinge on both the distribution of financial exposures and the evolution of prospective financial system losses….. EU banking sector credit risk losses under adverse climate scenarios could amount to 1.60-1.75% of corporate risk-weighted assets in a 30-year timeframe"*

1.4 CONCLUSIONS

This work has the aim at classifying and interpreting prior literature on the real effects of accounting hypothesis in the banking industry. We concentrate the study on the streams of the empirical and theoretical literature related to the impacts of accounting regulation in that industry. By focusing our analysis on: (1) fair value accounting and its impacts on the real economy, (2) accounting for bank loan loss provision and transition to IFRS 9, (3) climate risks implications on accounting and lending, we provide a significant and consistent perspective to exploring the hypothesis and supporting further research.

As general remark, whether or not accounting choices and disclosure have a real effect on the decision-making process remains a debated topic. There is still discussion between the literature supporting the idea that measurement and disclosure have a significant effect on the real decisions[20] and the traditional financial economics which concludes that financial statements considerations do not affect firms' decision-making (Kanodia, 2007). However, the distance between a convincing theoretical framework underpinning the real effect hypothesis and the lack of extensive empirical evidence on the real effects of accounting rules is highlighted by Leuz and Wysocki's (2016) literature review. They emphasize: *"we need more empirical research on the prevalence and magnitude of real effects with respect to corporate investment and other real economy actions"*.

With regard to the role of FVA in the subprime crisis, our literature review shows that the recent debate about the role of the FVA has fundamentally changed. In particular, 10 years after the crisis there is evidence that the role of the FVA in the crisis has been modest (Bischof et al., 2019). Actually, the recent literature seems to suggest that the fair value played a little,

[20] See Kanodia and Saora (2016). In their view, firms are influenced in their decision-making process by "*which economic transactions are measured, and which are not measured, how they are measured and aggregated, what is disclosed to capital markets and how frequently such disclosures are made*".

if any, role in either starting or worsening the financial crisis. It also becomes evident that in normal times, with liquid and efficient markets, FVA is reliable and solid enough to be adopted for valuation purposes and that in normal market conditions, FVA is beneficial to investors in their decision-making process (Menicucci and Paolucci, 2016).

With regard to the relation between LLP and earnings/capital management, our analysis shows that there are not conclusive arguments. In fact, the possibility to realize earnings management with discretionary approach to provisioning remains a debated topic in the related literature. On the one hand, a part of the analyzed studies considers a higher LLP as a signal of the bank's intention and ability to resolve bad debt situations that generates a positive association between market value and loan loss reserves. On the other hand, prior studies suggest that LLP is negatively related to stock returns, so conflicting with the signaling explanation and arguing that discretion on LLP is more driven by the goal to meet regulatory capital requirements rather than by the purpose of handling financial reporting to get incentives.

With regard to the relation between provisioning and pro-cyclicality, most of the research analyzed sustain the hypothesis that there is a relation between provisioning method and pro-cyclicality. In particular, the incurred loss model, as implemented under IAS 39, has been viewed by the accounting literature and by the banking regulators as recognizing impairment losses *''too little and too late''* and *"promoting cyclicality."*

On the transition to IFRS 9, according to most of the recent analyzed literature conducted after the implementation of new accounting principles, the transition to the new regime, based on ECL approach, enhances the informativeness of reported provisions if compared with the reporting of the previous accounting regime (IAS 39). Lopez-Espinosa et al. (2020) suggest that the switch from ICL to ECL provisioning has impacts in terms of procyclicality and first order consequences when credit conditions deteriorate. A significant stream of the recent

literature is supporting the idea that without regulatory and supervisory intervention[21], the accounting regime could have amplified the COVID-19 crisis. However, the literature focused on the effect of ECL provisioning is still limited and there is a need for future research as more data becomes available.

With regard to the implications of climate risk on banks' accounting and lending, most of the literature agrees that climate risks can have both a direct and an indirect effect on banks performance and related lending business. Finance literature seems to be focused on showing changes in credit demand, credit supply and lending conditions in areas impacted by natural disasters or highly exposed to physical climate risk. Some authors support the idea that managers use accrual-based and real earnings management to mitigate the negative effect on reported profits of climate related risks.

By detecting and classifying useful references, this paper will not only contribute to further understanding the debate regarding the real effects of accounting in the banking sector, but it might also support future dedicated research. This paper can also feed the modern debate, present in literature, on the role of the accounting as messenger or contributor to the economic cycle, with particular emphasis on the behavior of the banking industry. We also contribute to the debate about the cost and benefits of accounting conservatism and pro-cyclical regulatory requirements for financial institutions. In fact, the new IFRS 9 accounting regime is expected to be a step towards a more conservative and perhaps informative financial information environment for regulatory supervision. From a policy perspective, this paper - that also highlights the interconnection between climate related risk, banks accounting and lending decisions – adds to the literature on the accounting implication for financial stability.

[21] In 2020 in light of the Covid emergency, EU Authorities agreed that Stage 2 classification should be adjusted and/or relaxed in the context of extraordinary uncertainty, thus avoiding procyclical effects on the industry.

As mentioned above, this literature review is also significant to stimulate further research. In particular, since IFRS 9 represents an unprecedented change in the LLP rules with the switch from ICL to ECL provisioning, we suggest that more empirical analyses could be dedicated to study the potential effects of the new accounting regime on banks' lending standards. The theoretical and practical relevance of this additional research could also support a better understanding on how accounting implications should be managed during downturn.

Table 1.1. Prior literature on real effects of accounting definition and impacts. Theoretical and empirical studies.

References	Subject	Object of the study	Methodology	Findings
Coffe (1984)	Accounting real effects	Economic Impact of accounting disclosure	Critical analysis	Low information cost
Easterbrook & Fischel (1984)	Accounting real effects	Impact of mandatory disclosure on mkt efficiency	Critical analysis	Not conclusive results
Diamond (1985)	Accounting real effects	Economic Impact of accounting disclosure	Critical analysis	Welfare improvement
Fishman & Hagerty (1989)	Accounting real effects	Economic Impact of accounting disclosure	Critical analysis	More efficient price
Dimond &Verrecchia (1991)	Accounting real effects	Impact of high-quality disclosure on cost of capital	Critical analysis	Lower cost of capital
Botosan(1997)	Accounting real effects	Impact of high-quality disclosure on cost of capital	Statistical evidence	Lower cost of capital
Admati &Fleiderer (2000)	Accounting real effects	Economic Impact of accounting disclosure	Theoretical analysis	Positive externalities
Leuz &Verrecchia (2000)	Accounting real effects	Impact of high-quality disclosure on cost of capital	Statistical evidence	Lower cost of capital
Dye (2002)	Accounting real effects	Impact of accounting discretion on Firms' decisions	Critical analysis	Managers' manipulation
Graham et al. (2005)	Accounting real effects	Impacts of accounting disclosure on reported earnings	Statistical evidence	Earning management
Kanodia & Sapra (2006)	Accounting real effects	Real effects of accounting hypothesis	Critical analysis	Hypothesis definition
Biddle & Hilary (2006)	Accounting real effects	Economic Impact of accounting quality disclosure	Statistical evidence	Enhance investment efficiency
Lambert et al. (2007)	Accounting real effects	Impact of high-quality disclosure on cost of capital	Critical analysis	Lower cost of capital
Kanodia (2007)	Accounting real effects	Real effects of accounting hypothesis	Critical analysis	Hypothesis definition
Jorgensen & Kirschenheiter (2007)	Accounting real effects	Impact of accounting disclosure on risk premiums	Theoretical analysis	Positive externalities
Trombetta et al. (2012)	Accounting real effects	Understanding Effects of Accounting Standards	Critical analysis	Need for additional research
Dye et al. (2015)	Accounting real effects	Impact of accounting discretion – Managers' decisions	Critical analysis	Managers' manipulation
Leuz & Wysocki's (2016)	Accounting real effects	Real effects of accounting hypothesis	Critical analysis	Lack of evidence
Bird et al. (2018)	Accounting real effects	Economic Impact of accounting standards	Statistical evidence	Reallocation of capital

Table 1.2. Prior literature on FVA's role within the financial crisis. Theoretical studies (see Menicucci and Paolucci, 2016)

References	Subject	Object of the study	Methodology	Findings
Carosio (2008)	FVA	Impact on financial crisis–Application effects	Critical analysis	Pro-cyclicality
Ryan (2008)	FVA	Impact on financial crisis–Application effects	Theoretical analysis	No pro-cyclical effects
Veron (2008)	FVA	Impact on financial crisis–Application effects	Descriptive analysis	No role
Wallace (2008)	FVA	Impact on financial crisis–Accounting issues	Theoretical analysis	No role
Wallison (2008)	FVA	Impacts on financial stability	Critical analysis	Instability/Procyclicality
Banca d'Italia (2009)	FVA	Impact on financial crisis–Accounting issues	Critical analysis	Pro-cyclicality
Bignon et al. (2009)	FVA	Impact on financial crisis–Application effects	Theoretical analysis	Volatility
Laux & Leuz (2009)	FVA	Impact on financial crisis–Application effects	Theoretical review	No role
Magnan (2009)	FVA	Impact on Financial system–Application effects	Case study	Volatility/Pro-cyclicality
Pozen (2009)	FVA	Accounting impacts of FVA–Accounting issues	Theoretical analysis	No role
Menicucci (2010)	FVA	Impact on financial crisis–Application effects	Critical analysis	Volatility/Pro-cyclicality
Barth and Landsman (2010)	FVA	Impact on financial crisis– Accounting issues	Critical analysis	Little or no role
Bonaci et al. (2010)	FVA	Impact on financial crisis–Descriptive evidence	Theoretical analysis	No role
Glavan (2010)	FVA	Impact on financial crisis–Application effects	Literature review	Descriptive results
Jaggi et al. (2010)	FVA	Impact on financial crisis–Application effects	Critical analysis	Descriptive results
Laux and Leuz (2010)	FVA	Impact on financial crisis–Application effects	Theoretical review	No role
Skoda adn Slavikova (2015)	FVA	Accounting impacts of FVA–Application effects	Critical analysis	No role
Acharya and Ryan (2016)	FVA	Impact on financial stability - Economic impacts	Critical analysis	Distorted effects
Menicucci and Paolucci (2016)	FVA	Accounting impacts of FVA–Application effects	Literature review	No role

Table 1.3. Prior literature on FVA's role within the financial crisis. Empirical studies. (see Menicucci and Paolucci, 2016)

Empirical studies	**FVA**	**Object of the study**	**Methodology**	**Findings**
Barth et al (1995)	FVA	FVA vs historical cost accounting	Statistical evidence	No incremental volatility
IMF (2008)	FVA	Impact on Financial System– Volatility/Pro-cyclicality	Simulation model	No significant role
Bowen et al. (2009)	FVA	Effects of Relaxing FVA–Application effects	Statistical evidence	Dampened pro-cyclicality
Novoa et al. (2009)	FVA	Impact on Financial system–Volatility/Pro-cyclicality	Simulation Model	No significant role
Bischof et al. (2010)	FVA	Effect of amendment to IAS 39–Accounting issues	Statistical evidence	No role
Bout et al. (2010)	FVA	Accounting impacts of FVA–Application effects	Statistical evidence	Dampened pro-cyclicality
Shaffer (2010)	FVA	Relation with Regulatory capital, pro-cyclicality	Statistical evidence	No role
Strampelli (2011)	FVA	Impact on legal capital system–Pros and cons of FVA	Statistical evidence	Distorted effects
Badertscher et al. (2012)	FVA	General impacts of FVA-Application effects	Statistical evidence	No pro-cyclical effects
Benjamin et al. (2012)	FVA	Accounting impacts of FVA–Application effects	Descriptive evidence	Descriptive results
Jarolim & Oppinger (2012)	FVA	Effect of amendments to IAS 39 and IFRS 7– Accounting issues	Descriptive evidence	No role
De Jager (2014)	FVA	Impact on real economy–Economic impacts	Statistical evidence	Accelerating role
Khan (2018)	FVA	Impact on systemic risk –Economic impacts	Statistical evidence	No role

Table 1.4. Prior literature on real effects of LLP. Theoretical and empirical studies

References	Subject	Object of the study	Methodology	Findings
Beaver et al. (1989)	LLP	LLP impacts on market value	Statistical evidence	Positive association price with market value
Elliot et al. (1991)	LLP	LLP impacts on market value	Statistical evidence	Positive association price with market value
Griffin & Wallach (1991)	LLP	LLP impacts on market value	Statistical evidence	Positive association price with market value
Ahmed et al. (1999)	LLP	LLP accounting impacts	Statistical evidence	LLP used for capital management
Laeven & Majnoni (2003)	LLP	Economic impacts of delayed LLP	Statistical evidence	Procyclicality of capital and lending
Bikker &Metzemakers (2005)	LLP	Economic impacts of LLP	Statistical evidence	Procyclicality of capital and lending
Leventis et al. (2010)	LLP	Accounting impacts IAS 39	Statistical evidence	Reduced Earning management
Ryan (2011)	LLP	"Incurred Loss" LLP accounting impacts	Critical analysis	Procyclicality of capital and lending
Beatty & Liao (2011)	LLP	Economic impacts of "Incurred Loss" LLP	Statistical evidence	Smaller delays in loss recognition, less pro-cyclical lending
Bouvatier & Lepetit (2012)	LLP	Economic impact of "backward looking " LLP	Theoretical analysis	Pro-cyclicality of lending
Bushman & Williams (2012)	LLP	Economic impacts of LLP discretion	Theoretical analysis	LLP discretion can have beneficial or negative real effects for discipline of bank risk-taking
Beatty & Liao (2014)	LLP	Accounting and economic impacts of LLP	Literature review	Descriptive results
Lim et al. (2014)	LLP	Economic impacts of timely LLP	Statistical evidence	Banks timelier in loss recognition charge higher spreads
Curcio & Hasan (2015)	LLP	LLP and earning management	Statistical evidence	Use for discretionary purposes in non-EU banks
Pool et al. (2015)	LLP	Impact of IAS 39 on lending	Simulation Model	Pro-cyclicality of lending
Lobo (2017)	LLP	Accounting impacts in banking	Literature review	Descriptive results
Aristei & Gallo (2019)	LLP	LLP determinants	Statistical evidence	LLP are driven by non-discretionary factors

Table 1.5. Prior literature on real effects of IFRS 9. Theoretical and empirical studies

References	Subject	Object of the study	Methodology	Findings
Onali & Ginesti (2014)	IFRS 9	Market reaction to IFRS 9 adoption	Statistical evidence	Positive reaction to IFRS 9 adoption
Bischof & Daske (2016)	IFRS 9	Analysis of potential impacts of IFRS 9 adoption	Critical analysis	Descriptive results
Novotny-Farkas (2016)	IFRS 9	Analysis of potential impacts of IFRS 9 adoption	Critical analysis	Higher financial stability, timely loss, Pro-cyclicality
Abad & Suarez (2017)	IFRS 9	Analysis of potential impacts of IFRS 9 adoption	Simulation Model	Timely loss recognition & Procyclicality
Gaffney and McCann (2018)	IFRS 9	Accounting Impact of IFRS 9	Simulation Model	Higher procyclicality of LLP
Buesa et al (2019)	IFRS 9	Accounting impact of IFRS 9	Theoretical analysis	IFRS 9 less procyclical than IAS 39
Ertan (2019)	IFRS 9	Impacts of IFRS 9 on lending	Statistical evidence	Decline in credit supply
Loew et al. (2019)	IFRS 9	Accounting Impact of IFRS 9	Statistical evidence	Higher stock of LLP
Wheeler (2019)	IFRS 9	Accounting impacts of LLP and regulatory action	Statistical evidence	Relation between regulatory actions, LLP and procyclical lending
Beatty & Liao (2020)	IFRS 9	Accounting Impact of CECL	Statistical evidence	Higher LLP informativeness
Lopez-Espinosa et al. (2020)	IFRS 9	Accounting Impact of IFRS 9	Statistical evidence	Higher LLP informativeness
Neisen & Schulte-Mattler (2021)	IFRS 9	Economic Impact of IFRS 9 transition rules	Statistical evidence	Lower pro-cyclicality in lending
Kim et al (2021)	IFRS 9	Accounting Impact of IFRS 9	Statistical evidence	Timely loss recognition
Lejard et al. (2021)	IFRS 9	Accounting Impact of IFRS 9	Statistical evidence	Reduced LLP comparability
Oberson (2021)	IFRS 9	Economic impact of IFRS 9	Statistical evidence	LLP credit risk relevant for CDS price
Goh et al. (2021)	IFRS 9	Accounting Impact of IFRS 9	Simulation Model	More timely loss recognition
Szigel (2021)	IFRS 9	Accounting impact of IFRS 9	Simulation Model	Higher procyclicality of LLP
Jin and Wu (2022)	IFRS 9	Impact on real economy of IFRS 9	Statistical evidence	Reduced risk of stock crash
Engelmann and Nguyen (2022)	IFRS 9	Accounting Impact of IFRS 9 transition rules	Statistical evidence	Different LLP pro-cyclicality across the globe in reaction to COVID

Table 1.6. Prior literature on Climate risk, accounting and banks' decisions. Theoretical and empirical studies

References	Subject	Object of the study	Methodology	Findings
Garmaise & Moskowitz (2009)	Climate risk	Natural disasters impact on lending	Statistical evidence	Earthquake risk reduced commercial real estate lending
Klomp (2014)	Climate risk	Natural disasters impact on banks' stability	Statistical evidence	Increase banks default probability
Koetter et al. (2016)	Climate risk	Natural disasters impact on lending	Statistical evidence	Banks provide recovery lending to firms affected
Schuwer et al. (2016)	Climate risk	Natural disasters impact on banks' capital	Statistical evidence	Independent banks increase their capital ratios
Hosono et al. (2016)	Climate risk	Natural disasters impact on lending & firms' investment	Statistical evidence	Loan supply shocks affect firm investment
Cortes & Strahan (2017)	Climate risk	Impact of natural disasters on banks' capital	Statistical evidence	Small banks reallocate credit to hit areas
Noth & Schuwer (2018)	Climate risk	Natural disasters impact on banks' stability	Statistical evidence	Damages from natural disasters significantly weaken Banks' stability
Huang et al (2018)	Climate risk	Impacts of climate risks on firms' reporting	Statistical evidence	Negative association with earnings, positive with their volatility
Nguyen & Wilson (2020)	Climate risk	Impact of natural disasters on credit supply	Statistical evidence	Long-lasting negative effects on lending
Javadi & Masum (2021)	Climate risk	Climate risk exposure (CRE) impacts on lending	Statistical evidence	Firms with higher exposure to climate risk pay significantly higher loan spreads
Delis et al. (2021).	Climate risk	CRE impacts on lending decisions	Statistical evidence	Higher spread to non "green" company
Dyng et al. (2021)	Climate risk	Impacts of climate risks on firms' reporting	Statistical evidence	Climate risks influence firms reporting
Dal Maso et al. (2022)	Climate risk	Impact of natural disasters on banks' LLP	Statistical evidence	Banks in U.S. counties with higher disaster risk recognize larger LLP
Nguyen et al. (2022)	Climate risk	Impact Sea level Risk (SLR) on Loan price	Statistical evidence	Higher rates for mortgages on high SLR properties
Jiang et al. (2022)	Climate risk	CRE impact on firms' cost of capital	Statistical evidence	Cost of long-term loans increases with SLR

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CHAPTER TWO:
REAL EFFECTS OF IFRS 9 ADOPTION ON CORPORATE LOAN SPREADS

ABSTRACT

Accounting for financial instruments is always a controversial topic due to its impact on financial stability. The recent adoption of IFRS 9 is a highly disruptive accounting reform, with significant impacts on how and when negative news (i.e., negative adjustments to reported earnings) are recognized on the financial statements. Using a unique dataset of two major banks operating in one European country we provide evidence of a tightening of the corporate loans pricing after the IFRS 9 adoption. Furthermore, by focusing on the post reform period, we show that the tightening is driven by the new staging classification. Higher risk premiums are associated to clients with previous underperforming exposures (stage 2) and higher probability of default. We also observe that the staging classification is not affecting climate risk premiums. Our results highlight that the lenders, as expected by the regulation, change their risk appetite by charging higher spreads to discourage loan origination for clients that became too risky and expensive under the new standard.

Keywords: Accounting for financial instruments; Real effects of accounting; Fair Value Accounting; IFRS 9; Loan Spread, Loan Loss Provisioning, Credit Risk, Climate risk, Seismic Risk.

2.1 INTRODUCTION

Corporate lending in Europe is an essential resource for the majority of the firms and has a substantial impact on economic growth, also because, in some European jurisdictions, companies rely on the bank credit as primary, if not unique, source of finance (Adalid et al., 2020). Hence, the cost of credit for companies is a crucial subject in the economic debate and is also a significant area of research in finance (Fungacova et al., 2017).

In this context, the adoption of the new IFRS 9 accounting regime in January 2018 represents a major shift in the reporting of financial instruments with relevant impacts on the perceptions of regulators and market participants about banks performance, and ultimately about the stability of the financial system. The supposed link between the new accounting reform and the relative adoption in the corporate lending standards attracts concerns (Lopez-Espinosa et al., 2020). Even four years after the introduction, in the context of extraordinary uncertainty due to the covid emergency[22], the adoption of the IFRS 9 accounting risk classification[23] gets strong attention from capital markets and banking supervisors.

In this paper we examine the real effects of the IFRS 9 accounting reform and hence we contribute to the academic debate about the relevance of accounting measurements and disclosures in making operation and investment decisions. In particular, we investigate how banks' lending decisions are affected by the change in loan loss provisions (LLP) quantification defined by the new accounting standard.

The analysis of the determinants of the credit price is relevant for a number of significant academic fields and is useful to study several subjects. As general remark, the determinants identified

[22] It is worth mentioning that due to the Covid emergency, EU Authorities made immediately statements and interventions in order to avoid procyclical effects on the industry by promoting adjustments on the staging mechanism.

[23] The general approach of the IFRS 9 reform that entered into force in January 2018 is to recognize loan loss provisions based on a three-stage process where the deterioration in credit quality of loan is properly reflected as follows: Stage 1 covers performing loans for which LLP are calculated as 12 months expected credit losses. Stage 2 covers underperforming loans for which LLP are calculated as lifetime expected credit losses, Stage 3 covers impaired loans for which LLP are calculated as lifetime expected credit losses.

by the prior literature (D'Auria and Foglia, 1997; Angelini et al., 1998; Bellucci et al., 2013; Wang et al., 2020; Chiu et al., 2021) are mainly attributable to the following factors: loan characteristics, macroeconomic and lender conditions, and other borrower and risk characteristics.

The sample used to conduct the analysis comprises 21,634 corporate loans transactions, originated by two major banks operating in one European country in the period 2017-2020. The dataset contains information related: to risk characteristics (individual and transaction specific), to loan (transaction specific) and borrower characteristics (individual specific). It has been also complemented with public information related to macroeconomic, market and lender conditions variables (country, industry, or bank specific, sourced by OECD or ECB). Leveraging on this unique dataset we perform analyses to shed light on the fundamental factors explaining the cost of credit, both on the entire period under analysis and focusing only on the post-IFRS 9 adoption.

Our empirical analysis on the entire period (2017-2020) shows that the post-IFRS 9 period is associated to an increase of the risk premium, in fact, the effect of a firm's risk profile (Probability of default) on spread is stronger than in the pre-IFRS 9 period. In the period following the IFRS 9 adoption, the lenders tighten their lending standards by charging - proportionally to the client's probability of default (PD) - higher risk premiums compared with the previous accounting regime (IAS 39). On the tightening observed in the post-IFRS 9, it is worth mentioning that the European banking industry experienced difficulties and delays in the implementation of the IFRS 9. These difficulties mainly originate from the uncertainty on the adoption of the staging classification rules. In this context, the empirical evidence is consistent with the thesis that local banks may have increased their risk premiums in response to the higher cost of lending (especially for the high-risk clients), related to the new accounting regime.

Our empirical analysis focusing on the post-IFRS 9 adoption suggests that the tightening (Loan spread increase) is driven by the accounting risk classification. In fact, the credit price increase is explained by a fixed effect associated to clients with previous underperforming exposures (stage 2). Furthermore, we also observe that, within the post reform period, the stage 2 classification has also

positive moderating effects on the relation between the probability of default of the firm and the relative loan spread. In fact, there is evidence that banks apply higher risk premiums to clients with previous underperforming exposures (stage2). These conclusions are in line with the thesis that banks, in response to the reform adoption and in line with the regulation, change their risk appetite and adopted mechanisms to discourage loan origination for clients that became too risky and expensive under the new standard (McKinsey 2017).

We also perform additional analyses with the goal to understand how and to what extent the adoption of the IFRS 9 produces effects on the management of the climate-related risk (i.e., the seismic risk). In fact, in the recent years, both regulators[24] and supervisors[25] push to enhance the consideration of the climate-related risks factors in all relevant stages of the credit process from the origination to the accounting classification. In fact, since seismic risk is likely to be an effective credit risk factor not affecting the new LLP model envisaged by IFRS 9 (as opposed to the probability of default), it is interesting to investigate potential moderating effects on the relation between climate-related risk factors and credit price, due to the IFRS 9 adoption. This analysis allows us to indirectly assess whether the change in PD pricing is actually driven by the new accounting standard.

In this context, we perform additional analyses covering the interconnection of the IFRS 9 with the climate-related risk in explaining loan spread levels; the first analysis refers to the entire period while the second focuses on the post-IFRS 9 adoption. With the aim to perform the above-mentioned

[24] On a European perspective, on December 2019 EBA released an action plan that will require banks to include ESG factors in their risk management policies. As set out in the following *EBA Guidelines on loan origination and monitoring* (May 2020 final report and Jun 2019 the consultative version) *"Institutions should take into account the risks associated with ESG factors on the financial conditions of borrowers, and in particular the potential impact of environmental factors and climate change, in their credit risk appetite, policies and procedures".* In the same guidelines the regulator highlights the importance to include the accounting allowances measures in the bank credit risk policies and procedures determination.

[25] In May 2020 ECB issued a guide for banks on climate-related and environmental risk management. The guidance included assessing the potential impact of climate-related and environmental factors on market risk positions and future investments, developing stress testing scenarios and evaluating the benefit of including stress testing into baseline and adverse scenarios for those institutions with material climate-related and environmental risks

analyses, we have complemented the dataset with public information related to the seismic risk of the firm's headquarters location (source: local national agency).

Our additional analysis conducted on the entire period (2017-2020), which includes both pre and post-IFRS 9 reform data, suggests that there is a seismic risk premium in the spread applied to corporate lending, in line with the thesis that climate risks factors are included in the corporate lending decision process. This result is in line with the literature. Germaine and Moskowitz 2009 show evidence that earthquake risk reduced commercial real estate lending in California in the 1990s, and Jiang et al. 2020 in their empirical work, highlight how lenders charge a higher cost of credit for firms exposed to higher SLR risk. Empirical evidence that climate-related risk influence corporate lending decision is also provided by Delis et al. 2021. These additional analyses on the entire period are also highlighting that the seismic risk premium is not affected by the post-IFRS 9 adoption. This suggests that the increased relevance of the probability of default in determining the spread of a new loan, after the IFRS 9 adoption, is driven by the new accounting rules rather than by an increased banks' sensitivity to clients' risk factors.

The first immediate contribution of this work is on the debate on the real effects of accounting. This empirical study may help address the broad research question of whether accounting affects banks operating and investment decisions[26]. The paper can contribute to the debated question on the role of the accounting as messenger or contributor to the economic cycle, with particular emphasis on the behavior of the financial industry.

The second contribution is related to the policy implications. In fact, for accounting standard setters and capital regulators, the existence of empirical interactions between the new accounting risk measures (i.e., staging) and the prudential risk measures (i.e., probability of default) represents a very

[26] The question is still debated since *"traditional financial economics would argue that financial reporting should not affect corporate decision-making while other research indicates that financial statement reporting considerations do in fact affect real corporate decisions"*(Kanodia 2007).

relevant information. In this sense, the recent public statements[27] and following recommendations of the EU Authorities, aimed at avoiding procyclical effects on the industry due to a rigid adoption of the IFRS 9 principles, represent an evident sign of the importance of this study for policy implications in Europe.

The third contribution is on the market discipline side, since knowing to what extent the staging classification is a credit risk relevant information (i.e., banks are using staging information to determine relevant credit spread) helps banks optimize their business model by better shaping their relationships with firms.

Lastly, the paper is also contributing to the recent literature on the climate-related risk management and its potential interconnections with the new accounting regulation. We add to this literature by showing that banks include climate-related risks in their lending practices, but that there is no evidence that the staging classification is affecting the climate risk premium or relative structural changes in the post IFRS 9 reform period.

The rest of the chapter is organized as follows. In Section 2.2, we provide the institutional background of the IFRS 9 reform, and we review the literature that inspires this study. In Section 2.3, we present the research question and the hypotheses development, in section 2.4 we present the corporate lending dataset and the empirical models. Section 2.5 reports the results of the regressions performed to test the hypotheses and the robustness checks with the additional analyses on climate risk. Conclusions are provided in Section 2.6.

[27] On the matter: IASB (2020) stated: *"Entities should not continue to apply their existing ECL methodology mechanically. For example, the extension of payment holidays to all borrowers in particular classes of financial instruments should not automatically result in all those instruments being considered to have suffered an SICR".* ECB (2020) stated: *" In order to mitigate volatility in institutions' regulatory capital and financial statements stemming from IFRS 9 accounting practices in the current context of extraordinary uncertainty, we recommended that banks ii) avoid excessively procyclical assumptions in their IFRS 9 models to determine their provisions."*

2.2 INSTITUTIONAL BACKGROUND AND PRIOR LITERATURE

The chapter is structured as follows. In the first paragraph we introduce the institutional background of the IFRS 9. In the second paragraph we review the academic research on the economic consequences of accounting disclosure and we focus specifically on the literature that investigates the alleged real effect of the fair-value accounting on the financial crisis 2007-2009. Finally, we present a sample of studies showing the relevance of LLP for the corporate banking industry. In the last paragraph we focus on the literature on the corporate loans' determinants.

2.2.1 IFRS 9 INSTITUTIONAL BACKGROUND

In response to the subprime crisis 2007-2009, the International Accounting Standards Board (IASB)[28] invested in developing rules for financial instrument valuation. The transition from IAS 39 (*"Financial Instruments: Recognition and Measurement",* i.e., the old standard) to IFRS 9 ("*Financial Instruments*", i.e., the new standard) has been a radical change for the banking industry. For commercial banks, the new Loan Loss Provisioning[29] (LLP) mechanism under IFRS 9 is a revolutionary approach to measuring and recognizing expected losses with potential real effects on banks' credit price and non-price terms. The IASB issues the first exposure draft of a new accounting principle on financial instrument (Exposure Draft ED/2009/7 Financial Instruments: Classification and Measurement) in July 2009, but the final version of IFRS 9 is released only in July 2014[30]. IFRS 9 replaces IAS 39 "*Financial Instruments: Recognition and Measurement"* starting from the fiscal year beginning on or after January 1, 2018. Earlier application is permitted. The new standard aims to simplify the accounting for financial instruments and to address perceived deficiencies that were

[28] International Accounting Standards Board (IASB) is the body responsible for issuing international accounting standards.
[29] Loan loss provisions (or credit provisions) are the Banks set aside to take account of the likelihood that some loans may not be repaid in full.
[30] IASB issued two preceding versions of IFRS 9 (2009 and 2010) that should have been effective on 1 January 2013 and on 1 January 2015, respectively. Given the critiques and the intense debate on some of the new rules, the IASB decided to postpone the effective dates of both IFRS 9 (2009) and IFRS 9 (2010), and then it made some further changes to the standard that resulted in the IFRS 9 (2014 version).

highlighted by the financial crisis. The IFRS 9 simplifies IAS 39, particularly the paragraphs related to LLP calculations, by introducing a staging classification based on credit quality. The general approach of IFRS 9 is to recognize loan loss provisions based on a three-stage process where the deterioration in credit quality of the loan is properly reflected as follows: (i) **Stage 1** covers loans that have not deteriorated significantly in credit quality since initial recognition or, where the optional low credit risk simplification is applied, that have low credit risk. LLP are calculated as 12-month expected credit losses. (ii) **Stage 2** covers loans that have deteriorated significantly in credit quality since initial recognition (unless the low credit risk simplification has been applied and is relevant), but for which objective evidence of a credit loss does not exist. LLP are calculated as lifetime expected credit losses. (iii) **Stage 3** covers loans that have objective evidence of a loss at the reporting date. LLP are calculated as lifetime expected credit losses.

2.2.2 LITERATURE ON REAL EFFECTS OF ACCOUNTING IN BANKING

2.2.2.1 Real effects of accounting disclosure

In defining real effects, we are building on Kanodia and Sapra (2016). According to the authors, the real effects hypothesis states that measurement and disclosure have a significant effect on the real decisions that firms make[31]. Whether or not accounting choices and disclosure have a real effect on the decision-making process is a debated topic. In his work on accounting disclosure and real effects, Kanodia (2007) explains that a part of the literature is convinced that accounting measurement and disclosure do not actually affect capital market pricing and corporate decisions. Other research indicates that financial statement reporting considerations do affect real corporate decisions (Graham et al., 2005).

Bird et al (2020) in their empirical research provide evidence that accounting standard setting matters and have economically significant real effects on the reallocation of capital in financial

[31] In their view, firms are influenced in their decision-making process by "*which economic transactions are measured, and which are not measured, how they are measured and aggregated, what is disclosed to capital markets and how frequently such disclosures are made*".

markets. Lambert et al (2007) demonstrate that the quality of accounting information has impacts on a firm's cost of capital. Trombetta et al (2012) stressed the importance of the research on potential real effects of accounting as a valuable tool to help standard setters and policymakers understanding ex ante and ex post potential consequences of accounting rules.

2.2.2.2 Fair-value accounting (FVA) and its impact on the real economy

At the time of the 2008 crisis, the idea of the FVA as the main element generating the crisis[32] was quite common (Wallison, 2008). There are conflicting arguments about the role of FVA in fueling the crisis 2007-2009. Some of the critics argued that the FVA had an important role to the financial crisis or exacerbated its severity (contributor theory). In contrast, other arguments suggest that FVA had a limited role in the crisis, being a simple messenger (messenger theory).

On the messenger theory side, Laux and Leuz (2009 and 2010) examine the role of FVA in the financial crisis and find evidence that it is unlikely that FVA contributes, and that there is little evidence that the downward spirals or asset-fire sales are the result of FVA. In line with this conclusion, there are Wallace (2008), Veron (2008) and also Shaffer (2010) who shows how FVA has a little impact on the capital of most banks in the sample analyzed (2007-2008). The capital erosion is mainly due to deterioration of the credit quality of the loans. Barth and Landsman (2010) also conclude that FVA plays little or no role in the crisis. However, they recognize that the quality of the securitization disclosure was inadequate[33]. Badertscher et al. (2012) find that, during the crisis, the lower is the capital ratios of the banks, the lower is the selling of the assets, in contrast with the assumption of FVA introducing cyclicality.

On the contributor side, we can include Ryan (2008) who concludes that several stakeholders believe that FVA hurts investors compared with historical cost accounting, at least in particular situations.

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[32] Early concerns on FVA are expressed by Plantin et al. (2007) that, in comparing the measurement regime based on past prices (historical cost) with a regime based upon current prices (FVA), find that the historical cost regime is inefficient because it ignores price signals, but the FVA is adding an extra component to price fluctuations.

[33] The research of Magnan et al. (2011) is in line with this conclusion, since they find that as fair value increases, there is a decrease in the precision of common information, in particular the informational properties of fair value disclosure decrease as we move from level 2 to mark-to-model data (level 3).

Bignon et al. (2009) report arguments on the fair value accounting as a vector of crisis. In 2009 the IMF issued a working paper (Novoa et al., 2009) that really helps us summarize the reasons[34] why FVA is considered as a crisis contributor.

However, after several years, the literature seems to suggest that FVA plays a little, if any, role in either starting or worsening the financial crisis. Menicucci and Paolucci (2016) in their literature review affirm that there are very little reasons to consider FVA one of the major causes of financial crisis. Bischof et al. (2014) highlight that the use of fair value-related information is substantially heterogenous across analysts and across instruments. Acharya and Ryan (2016) recognize that a high degree of bank opacity is associated with the crisis. Bischof et al. (2019) scrutinize the connection between accounting and financial stability, and they find evidence of modest FVA role in the crisis.

2.2.2.3 Implications of accounting for bank loan loss provisions and the role of IFRS

Literature on the impacts of loan loss provisions (LLPs) on the banking sector significantly covers two main research areas: (1) earnings and capital management, introduced with discretionary in provisioning, and (2) procyclicality of provisioning and its effects on financial stability. On the first LLP research area, early contribution on implications of LLP is from Ahmed et al. (1999) who in their empirical work support the hypothesis that LLP are used for capital management purpose. According to Leventis et al. (2011), the adoption of the IAS 39 in the EU has improved the earning quality since managers has limited the use of LLP earning management at the listed banks. Beatty and Liao (2014), in their review of the empirical literature on financial accounting in the banking industry, highlight how most studies analyze the interconnection of the accounting discretion in LLP with the regulatory capital and earning management. As represented by Lobo, (2017) a significant

[34] The paper highlights "*three key points regarding FVA and its potential regulatory and financial stability implications: (i) strong capital buffers and provisions make an important contribution to withstanding business cycle fluctuations in balance sheets, especially when FVA is applied more extensively to assets than liabilities; (ii) when combined with additional liquidity shortages in financial markets, the FVA framework magnifies the cyclical volatility of capital; and (iii) fair valuing an expanded set of liabilities acts to dampen the overall procyclicality of the balance sheet. However, the latter may also give rise to the counterintuitive outcome of producing gains when the valuation of liabilities worsens. .... results in a false sense of improvement in the bank's equity position."*

number of studies also explore the use of discretion over LLP for smoothing income, or to manage risk.

On the financial stability implications of LLP, Beatty & Liao (2011) observe that LLP potentially accentuates capital pro-cyclicality. According to Bouvatier and Lepetit (2012), backward looking provisioning approaches (like IAS 39) aggravate banks' lending variance in both developed and emerging economies, with a stronger impact for emerging markets. Bushman and Williams (2012) recognize a trade-off between incurred loss models (like IAS 39) and expected credit losses (ECL) models (like IFRS 9). Pool et al. (2016) give evidence that LLP has a negative impact on bank lending and amplifies business cycle volatility, in line with the previous micro-oriented empirical literature, such as Bikker and Metzemakers (2005) and Laeven and Majnoni (2003). Specifically, the incurred loss model, like IAS 39, recognizes impairment losses ‘‘too little and too late’’ and “promotes cyclicality.”

Initial articles on IFRS 9 transition mainly refer to impact assessment of the new accounting standard adoption on financial and market stability. Onali and Ginesti (2014) investigate the price reaction to news related to IFRS 9 adoption events. They find that investors are confident that IFRS 9 addresses the problems inherent in IAS 39. Abad and Suárez (2017) develop a model for assessing the implications of IFRS 9 to measuring credit impairment losses. They find that IFRS 9 implies banks’ capital decrease when the cycle moves from expansion to downturn. Bischof and Daske (2016) recognize the ECL approach as a significant change for the industry. Lejard (2018) explains that IFRS 9 first-time adoption is expected to generate earnings volatility. More recent literature, Gaffney and McCann (2018), Ertan (2019) and Low et al. (2019) give evidence that the adoption of the ECL accounting models can increase the stock of provisions and reducing the credit amount. Furthermore, Beatty and Liao (2020) and Lopez-Espinosa et al. (2020) show how the adoption of the ECL model enhances the informativeness of reported provisions compared with the reporting of the previous accounting regime. Lopez-Espinosa et al. (2020) also show that the switch from ICL to ECL provisioning has impacts in terms of procyclicality. In line with Neisen and Schulte-Mattler (2021),

they explain that without the 2020 regulatory and supervisory intervention, indicated in Europe as Capital requirement regulation Quick Fix adjustment, the accounting rule could have amplified[35] the COVID-19 crisis. According to Jin, Q, Wu, S, (2022), another effect of the shifting from the incurred loss model of IAS 39 to the expected credit loss model of IFRS 9 is a reduction of the stock price crash risk of the banks. However, the literature focused on the effect of ECL provisioning is still limited and there is a need for future research as more data becomes available.

2.2.3 LITERATURE ON CORPORATE LOAN PRICING DETERMINANTS

The literature on corporate loans pricing determinants is encompassing the use of both micro and macro[36] level data. Consistently with the goal of this paper, we focus on the microecomic literature. The dependent variable is generally the loan spread, defined as the difference between the nominal interest paid by the client and the reference interest rate observed in the market (e.g., Euribor, Libor etc.). In the context of the corporate banking, Angelini et al. (1998), in their empirical study, analyze the link of customer relationships with cost of credit and relevant availability in the Italian banking cooperative industry. The target variables are the interest rate paid on loans and the credit demand from the firm's side. Dietrich (2010) investigates the loan rate differentials between small and large companies. Chiu et al. (2021) analyze the relation between corporate debt maturity dispersion and the pricing and terms of bank loans. Wang et al. (2020), in their empirical study of the U.S. syndicated loans from 1990 and 2014, analyze if the firm's debt maturity structure affects the cost of bank loans.

As general remark, the determinants highlighted by the prior literature are mainly attributable to following factors: default risk and other borrower characteristics; loan characteristics; macroeconomic, market and lender conditions. We present the prior literature of the determinants of the cost of credit according to this classification.

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[35] According to Engelmann and Nguyen (2022) we observed different LLP pro-cyclicality across the globe in reaction to COVID.

[36] As an example of macroeconomic approach in the study of the credit price see Collin-Dufresne et al. (2001), in their empirical analysis of the determinants of the bonds credit spread changes the authors consider several macroeconomic and financial variables as explanatory factors of the bonds' credit spread dynamic.

Default risk and other borrower characteristics. Default risk is a central information adopted in literature to predict the loan pricing and loan volume to the corporate segment. Berger and Frame (2007) show the importance of credit scoring for the lending decision in the US banking industry. Kremp and Sevestre (2013), in their analysis of the effect of the subprime crisis on the SME credit volumes in France, adopt default risk measures[37] to explain loan conditions to SME firms. Turnbull (2003) highlights positive relation between probability of default and Loan Pricing. Prior literature also considers other borrower characteristics to explain loan pricing, among others: the consolidation of the banking sector (Berger et al., 2005; Bonaccorsi and Gobbi 2005; Craig and Hardee 2007), the solidity of the customer relationships (Angelini et al., 1998; Cole 1998; Cotugno et al., 2013), the gender board diversity (Karavitis et al., 2021) and the borrower physical proximity (Bellucci et al., 2013). Furthermore, according to Bellucci et al (2010) the gender matters in bank–firm relationships and conditions. Santos and Winton (2008), in their empirical analysis of the corporate bond and of the loan market after the subprime crisis, find negative association of the size of the borrower with the loan spreads.

Loan characteristics. Dietrich (2010) in his empirical work for the Swiss banking industry, on the determinants of the loan rate differentials between small and large companies, explains that the term (maturity) of the loans affects the loan rate. According to Chiu et al. (2021), in their empirical work for debt maturity dispersion and the cost of bank loans, interest rates are positively related to the loan maturity while loan interest rates are negatively related with the issuance amount. These results are in line with Bradley and Roberts (2015) and with Furfine (1999); in particular this latter shows, in his empirical paper on the determinants of the credit cost in the market for federal US funds, that the size of the transaction is negatively related with the loan pricing. For loan duration, Wang et al., 2020 observe a U-pattern, with lower interest rate in case of an intermediate duration, but a higher rate for loans with the shortest or longest durations. Brockman et al. (2010) in their study

[37] Within the list of the possible indicators explaining the loan conditions, the authors include: the ratio of financial debt to net cash flow, the firm's profitability, the age of the firm and the firm rating.

on the corporate bond spread determinants in the US market find a positive and significant relation with the loan duration; as far as the spreads in the loans market is concerned, Campello et al. (2011) and Houston et al. (2014) find the same positive relation with the loan duration.

Angelini et al. (1998) explains how the higher the number of banks granting credit to the client the lower the interest rate charged by the lender. Bellucci et al. (2013) and Cotugno et al. (2013) explain that collateralization appears relevant for loan pricing purposes.

Macroeconomic, market conditions and lender characteristics. Within the literature on the loan spread determinants in corporate banking, there is a large use of macroeconomic and market variables to control for the real economy and the competitive conditions: real GDP growth, banks' refinancing cost with the central bank, other aggregate changes in banks' supply environment (Kremp and Sevestre, 2013). Angelini et al. (1998) find correlation between loan conditions and the growth of the industrial production. Dietrich (2010) finds evidence that the category of banks has significant impact on lowering the credit rates (see also Ferri et al., 2014), whereas size does not influence the pricing of loan rates.

In Table 2.A we report Reference literature of the Loan Spread determinants/controls in corporate banking.

2.3 RESEARCH QUESTION AND HYPOTHESES DEVELOPMENT

The literature review presented in the previous chapter shows that there is still no consensus among accounting and finance scholars about the role of accounting measurement and disclosures in shaping banks' operating and investing decisions. On the one hand, seminal analytical models (e.g., Kanodia and Sapra, 2016) and some empirical studies (see Christensen et al., 2017) provide support to the so-called "real effect hypothesis", according to which the reporting entity changes its allocation of resources as a result of a change in an accounting measurement method and/or disclosure requirement. On the other hand, the real effect of a relevant accounting method such as the FVA during the financial crisis 2007-2009 has been questioned and the most recent analyses tend to exclude that the accounting method in question plays a significant role and affects banks' behaviour.

The distance between a convincing theoretical framework underpinning the real effect hypothesis and the lack of extensive empirical evidence on the real effects of accounting rules is highlighted by Leuz and Wysocki's (2016) literature review. They emphasize: *"we need more empirical research on the prevalence and magnitude of real effects with respect to corporate investment and other real economy actions*". Following Leuz and Wysocki's (2016) call for more empirical study on the real effects of accounting rules, and given the change imposed by IFRS 9 on the LLP model illustrated in previous chapters, we pose the following research question:

RQ1: Does the IFRS 9 change in loan loss provisioning method affect commercial banks' lending decisions?

The recent adoption of the IFRS 9 principle in 2018 represents a major change in accounting rules, which offers the opportunity to empirically investigate the real effects of accounting. In this context, commercial banking is, in our opinion, an interesting setting for at least two reasons. First, commercial banks are highly regulated firms, and in such a setting, the relative importance of accounting rules might be lower than for non-financial firms. This can also be the reason why the empirical literature struggles to find evidence of real effects of FVA. At the same time, this means

that if we show the presence of real effects on commercial banks' lending decisions caused by the new accounting rules, it will help to reconcile the most convincing theoretical framework (i.e., the real effect hypothesis) with the empirical findings in the industry where empirical evidence lacks the most. Second, the lending activity of commercial banks is crucial both for sustaining economic growth and for the financial stability of the entire economy. This makes the alleged real effects of IFRS 9 adoption interesting for a wide range of stakeholders, beyond the accounting and finance academic community. In order to cope with the complexity of the empirical analysis and the institutional differences of different banking segments, in answering the RQ1, we focus on the lending decisions related to the corporate segment. We would like to assess if IFRS 9 accounting reform is affecting lending decisions by changing the conditions to access to credit for loans applicants (credit price). In fact, as represented by ECB[38] in 2017, the expected impacts of the reform in terms of regulatory capital erosion and increase of LLP is expected to be significant. Moreover, there is empirical evidence of a positive association between the time of loss recognition - which should be increased by IFRS 9 - and spreads charged by banks (Lim et al., 2015). In this context, it is reasonable to suppose that European banks may have increased the loans' price, in response to the higher cost of lending (especially for high-risk loans) due to the introduction of the new accounting requirements. On the other hand, we tend to exclude significant changes in the lending standards prior to the reform introduction due to anticipation effects of the IFRS 9. This is particularly evident by considering that the SSM in its thematic review on IFRS 9 of November 2017 (very close to the deadline for the first-time adoption) explain that: *"As expected, the implementation of the new standard is a major challenge and institutions are making a considerable effort to be adequately prepared for the first application date".* At that time, according to the Supervisor, the most challenging aspects of the IFRS 9 implementation, within the European banking industry, was the implementation of the new ECL framework. In fact, the major difficulties originated from the application of the significant increase

[38] See "SSM thematic review on IFRS 9: Assessment of Institutions' preparedness for the implementation of IFRS 9 (2017).

of credit risk mechanism that requested a new role of risk management, data availability and expert judgement for accounting purposes, for which strong governance and clear internal processes would have to be in place. Hence, we formulate the following research hypotheses:

H0: In the post-IFRS 9 period, the effect of a firm's risk profile (probability of default) on spread is stronger than in the pre-IFRS 9 period.

If the reform has real effects on the credit market, we expect that banks tighten their lending standards for firms that have a position in stage 2 (i.e., firms with at least one previous stage 2 transaction in the last 12 months). According to the IFRS 9, banks have to increase provisions for loans whose credit quality has significantly deteriorated since initial recognition (i.e., stage 2 transactions/loans), even if there is no evidence of any credit loss event. It is worth emphasizing that under the new IFRS 9 regime, the banking practice have also adopted some "significant increase of credit risk" triggers (determining the stage 2 classification) at a client's level, with the effect of potential stage 2 contamination to all client-related exposures. In this context it is likely that previous stage 2 exposures could attract to this stage also new originated transactions in the following reporting periods. Hence, a client who has already a loan/transaction classified in stage 2 might be considered riskier than a client who has only stage 1 transactions/loans, in response to the higher provisions requested by the new accounting standard. For this reason, we pose the following research hypotheses:

H1A: Under IFRS 9 regime, banks charge higher spreads to firms with previous transactions classified in stage 2.

The relevance of the stage 2 information in banks' lending decision-making process should not be taken for granted. In fact, stage 2 is indeed a new information that is available in banks' ERP only after the IFRS 9 adoption. It is plausible that when a client has previous stage 2 transactions, the bank increases its sensitivity to risk profile variables in making lending decisions. Reasonably, banks may enhance the relevance of a client's probability of default (PD) when they decide the loan spread to charge to clients with previous stage 2 transactions. In fact, we expect the adoption of the IFRS 9 has

positive effects on corporate loan spreads, since we expect banks to incorporate the new accounting risk classification in their credit risk management policy and to allocate capital consistently with the new risk profile of their clients. For this reason, we pose the following research hypotheses:

H1.B: Under IFRS 9 regime, the effect of a firm's risk profile (probability of default) on spread is stronger for firms with previous transactions classified in stage 2.

Of course, the two hypotheses (H0 and H1) are connected and not mutually exclusive; we suppose that higher risk premium, associated to the post-IFRS 9 adoption, is reasonably due to the adoption of a different risk appetite for the new transactions originated by clients that already experienced previous stage 2 exposures.

2.4 DATA AND EMPIRICAL MODEL

2.4.1 DATA

2.4.1.1 Banks included in the study

The two commercial banks involved in the analysis have similar size and similar branches geo-distribution in the European country in which they operate, where they together represent a material share of the corporate credit market. For both banks the commercial banking business is predominant over the investment banking activities. The banks are characterized by consistent governance profiles and control structures and are supervised by the single supervisory mechanism under the ultimate ECB control.

2.4.1.2 Reference Dataset

Our analysis is developed on a unique database that covers the lending of the banks, mentioned above, in a recent period of analysis (2017 - 2020). In this paper the target statistical unit is the loan application approved to a certain client on a certain date in the timeframe analyzed. In most of the sampled cases, we have one application for each client, but given the nature of the segment analyzed (Corporate Lending), we can also find some clients with more than one application in the sampled timeframe. The Bank's data refer to the microeconomic characteristics of the sample of the new corporate loans originated in the target period. In particular, the bank's data include information related to four areas: (1) loan characteristics (facility type, guarantee type, maturity, loan amount, etc.); (2) borrower characteristics (geo-residence, sector etc.); (3) risk characteristics (accounting risk indicators, presence of previous stage 2 transactions, probability of default of the client, outstanding loans with other banks, etc.). Furthermore, information on a fourth area of analysis have been retrieved from public sources, i.e. (4) Macroeconomic, corporate lending market and lender conditions (lending rates, total bank's asset growth, domestic industrial production growth, etc.).

With the goal to perform additional analyses on the relation between accounting and climate risk, this dataset has been complemented with public information regarding physical risk exposure

(seismic risk) of the borrower residence area (the final dataset that collects banks' data and public information is presented in Table 2.A1). In the following paragraph we provide more details on the information collected for the IFRS 9 accounting risk classification.

2.4.1.3 Accounting Risk Indicators

The accounting risk indicators analyzed in this paper are relative to the adoption of the IFRS 9. As already mentioned, the general approach of the IFRS 9 reform is to recognize loan loss provisions based on the three-stage process reflecting the deterioration in credit quality. According to the accounting principle, each new performing loans originates in stage 1 and only after breaching some specific underperforming triggers, the transaction can be classified in stage 2. The deterioration of the exposure to stage 3 derives from the emergence of impairment losses. The rationale of the principle is to correlate the loan loss provisions to the staging classification, since stage 2 and stage 3 require higher provisions compared with stage 1 loans.

To analyze the lending standards applied by the bank at the granting phase, we are interested in understanding if the client, that originates the new mortgage, has at least one prior exposure classified in stage 2. In fact, under the new accounting classification rules, stage 2 transactions have a higher cost of credit provisions, hence clients with previous transactions in stage 2 at the time of application are considered riskier by the lenders. For our research, we recognize those situations based on a dummy variable *(S2)* that identifies clients with previous stage 2 exposures in the 12 months before the origination date.

2.4.2 EMPIRICAL MODEL

2.4.2.1 Baseline model

We estimate a baseline OLS regression model to explain the cost of credit (in terms of loan spreads) of the corporate market following the strand of literature that examines the cost of corporate credit using micro data (e.g., Angelini et al., 1998; Wang et al., 2020). The dependent variable is defined as the log of the difference between the nominal interest paid by the client and the reference

interest rate observed in the market (e.g. 3 months Euribor) (*LN_SPREAD)*. The independent and control variables adopted in the regressions have been selected based on the prior literature represented in chapter 2.3 (see in particular: Wang et al., 2020; Angelini et al., 1998; D'Auria and Foglia 1997; Bellucci et al., 2013; Chiu et al., 2021).

In fact, the baseline model explains loan spreads levels based on information related to creditworthiness, loan, and borrower characteristics, while controlling for market conditions, macroeconomic and lender conditions.

The general baseline model is defined as follow:

$$SPREAD_{it} = \beta_0 + \beta_1 \mathrm{POST_t} + \beta_2 (POST_t \times LN\_PD_{it}) + \beta_R' R_{it} + \beta_L' L_{it} + \beta_B' B_{it} + \beta_M' M_t + u_{it} \quad (1)$$

In equation (1) the dependent variable is (*LN_SPREAD)*[39], charged to a client at time t of origination, $POST_t$ is an indicator variable indicating the period after the date of the adoption[40] of the IFRS 9 by the two banks. This dummy variable is defined as:

$$POST_t = \begin{cases} 1 & if\ the\ application\ time\ t\ falls\ under\ the\ period\ after\ the\ IFRS\ 9\ adoption \\ 0 & if\ the\ application\ time\ t\ falls\ under\ the\ period\ preceding\ \text{the}\ IFRS\ 9\ adoption \end{cases} \quad (2)$$

Furthermore, $POST_t \times LN\_PD$ (also *POST_PD*) is the variable indicating the interaction between the log of the probability of default of the client *(LN_PD)* and the period after the IFRS 9 introduction *(POST)*. All the other regressors can be grouped in the following sets:

- R is the set of the risk variables, including accounting risk indicators (firm and transaction specific),
- L is the set of the loan characteristics variables (transaction specific),
- B is the set of other borrower characteristics variables (firm specific),

[39] As in previous studies (Wang et al., 2020; Campello et al., 2011), we use the logarithm of the loan spread in order to mitigate the effect of data skewness.

[40] We refer to the date of the managerial implementation of the reform, which is different for the two banks, since they implemented the reform in two different months at the beginning of 2018.

- M is the set of the macroeconomic, market and lender conditions variables (country, industry, or bank specific variables).

Within the set of the risk variables (R), explaining *LN_SPREAD* levels of the equation (1) we include, in line with the literature (Thurnbull 2003, Kremp and Sevestre 2013), the log of the client's probability of default *(LN_PD)* to reflect the repayment capacity of the debtor, with expected positive association with the target variable, and the fixed effects related to the type of guarantees assisting the loan *(GUARANTEE_FE),* since according to Bellucci et al. (2013) and to Cotugno et al. (2013) collateralization also appears relevant for pricing purposes.

Within the set of the loan characteristics (L), in line with the credit risk management practice of the corporate lending and with the pertinent literature (Bradley and Roberts, 2015; Furfine 1999; Angelini et al. 1998, D'Auria and Foglia, 1997), we also control for the log of the Loan Amount *(LN_AMOUNT)* and for the log of the total outstanding of additional exposures at industry level, as recorded at a central registry *(LN_OTHER_LOANS).* We expect negative relation with the credit price for both variables, in fact, in line with Angelini et al 1998, a significant loan amount and the exposure to multiple banks are signals that the firms are "price-maker", since they can threaten to move to other banks. In line with Angelini et al (1998), Campello et al. (2011) and Houston et al. (2014), we introduce the log of the maturity of the loan *(LN_MATURITY)* which is expected to be positively associated to the loan spread. We also control for the facility type of the loan by introducing fixed effects related to the type of loans the client has been granted *(LOAN_TYPE_FE),*

On the set of the other borrower characteristics (B) that explain the loan spreads levels, consistently with loan contracting literature, we control for the size of the firm (Santos and Winton, 2008) by introducing fixed effects related to the size segment[41] of the client *(SEGMENT_FE)*. This variable should estimate the greatest bargaining power vis-à-vis the banks of the largest customers (D'Auria and Foglia, 1997).

[41] The size segmentation adopted by the bank is reported in table A2.

For what concerns macroeconomic, market and lender conditions variables (M), in line with Angelini et al (1997) that find association between loan conditions and the growth of the local industrial production, we additionally control for this variable *(G_IND_PROD)* and for the total asset growth of the bank *(ASSET_GROWTH)*. Growing bank's total assets are expected to be negatively associated to the spread applied in the market.

2.4.2.2 Analysis of the pre- and post-IFRS 9 reform period (2017-2020)

In order to test the hypothesis that after the accounting reform, banks charge higher risk premium on the same loan compared with the previous accounting regime (H0), we analyze the sign and the significance of two estimated parameters in the equation (1). We refer to the coefficient associated to the log of the probability of default of the borrowers within the group of variables (R) and to the sign and the significance of the coefficient associated to the variable indicating the interaction between the log probability of default of the client and the IFRS 9 introduction *(POST_PD)* in the equation (1). In fact, under H0 we expect that those coefficients have positive and significant sign. It is worth noting that the change of the lending standards represents a regime effect[42], meaning that the accounting reform introduction is associated with a period of structural changes in the bank's credit practice.

However, by using difference in differences (DID) approach, we can enhance the robustness and the causal[43] significance of the test for H0 hypothesis. To apply DID we exploit the circumstance that one of the two banks *(BANK1)* has implemented the reform after the other bank *(BANK2)*. In this context, the observations of *BANK1* represent a control group that as opposed to *BANK2,* which represents the treatment group that adopts IFRS 9 earlier. The introduction of this counterfactual data is necessary in order to apply the DID approach and represents an enhancement of the causal

[42] i.e., a set of structural economic conditions that exist for a certain period (Verbeek, 2012)
[43] DID method is intended to mitigate the effects of confounders and selection bias.

significance of our test. For implementation purposes we need to introduce an additional dummy compared with the framework prepared to test H0. The dummy in question is:

$$BANK_t^2 == \begin{cases} 1 & if\ the\ transaction\ is\ originated\ by\ \ Bank\ 2 \\ 0 & if\ the\ transaction\ is\ not\ originated\ by\ Bank\ 2 \end{cases} \quad (3)$$

By introducing the dummy bank variable under (H0) hypothesis, the baseline regression (1) changes as follows:

$$SPREAD_{it} = \beta_0 + \beta_1 POST_t + \beta_2(POST_t \times BANK_t^2 \times LN\_PD_{it}) + \beta_R' R_{it} + \gamma_R'(R_{it} POST_t) +$$

$$\gamma_{R1}'(R_{it} BANK_t^2 POST_t) + \gamma_{R2}'(R_{it} BANK_t^2) + \beta_L' L_{it} + \beta_B' B_{it} + \beta_M' M_t + u_{it} \quad (4)$$

The additional coefficient of interest of the DID approach is β_2 that identifies the effect of the treatment on the treated units. The adoption of DID approach allows us to remove bias due to permanent differences between groups, as well as biases from comparisons over time in the treatment group that could be the result of trends. The adoption of the DID standard[44] case as in the equation (4) requires limiting the analysis timeframe to the date of the implementation of *BANK1,* so to identify a bank *(BANK2)* exposed to the treatment and a bank that is not exposed to the treatment during either period *(BANK1)*. Given the hypothesis that the treated bank *(BANK2)*, after the adoption of the accounting reform charge higher risk premium on the same loan compared with the previous accounting regime, we expect a positive and significant sign of the coefficient of $POST_t \times BANK_t^2 \times LN\_PD_{it}$ (also *POST_BANK2_PD).* This variable represents the interaction of the post treatment variable *POST* (i.e., the dummy indicating the implementation of the accounting reform) with the treated units *BANK2_PD (BANK2*LN_PD,* i.e., the interactions of the group of the treated bank *BANK2* with the treated variable *LN_PD).*

[44] The standard DID case is the situation where outcomes are observed for two groups for two time periods. One of the groups is exposed to a treatment in the second period, but not in the first period. The second group is not exposed to the treatment during either period (Wooldridge 2007).

2.4.2.3 Analysis of the post-IFRS 9 reform adoption 2018-2020

In order to test (H1), we define a new dummy stage variable *(S2),* in the sample after the reform period (2018-2020) as:

$$S2_t = \begin{cases} 1 & if\ the\ client\ has\ transactions\ in\ stage\ 2\ in\ the\ 12\ month\ \ before\ the\ origination \\ 0 & if\ the\ client\ does\ not\ have\ transactions\ in\ stage\ 2\ in\ the\ 12\ mont\ \ \ before\ the\ origination \end{cases} \quad (5)$$

By introducing the dummy stage variable under (H1) hypothesis, the baseline regression (1) changes as follows:

$$SPREAD_{it} = \beta_0 + \gamma_0 S2_{it} + \gamma_1 S2_{it} x\ LN\_PD_{it} + \ \beta_R' R_{it} + \beta_L' L_{it} + + \beta_B' B_{it} + \beta_M' M_t + u_{it} \quad (6)$$

To test the above-mentioned hypothesis (H1), we analyze the sign and the significance of the coefficients associated to the introduction of $S2_t$: its fixed effects coefficient (γ_0) on the cost of credit (in order to test H1A) and its moderating effect coefficient (γ_1) on the relation of the probability of default with the loan spread (in order to test H1B).

Given the hypothesis (H1A) of higher spread for underperforming clients under IFRS 9 regime, we expect a positive and significant sign of the coefficient of the variable indicating *S2* clients and given the hypothesis (H1B) of higher risk premium we also expect positive and significant coefficient of the variable indicating the interaction of *S2* clients with the borrower probability of default $S2_{it} x\ LN\_PD_{it}$ (also *S2_PD*). It is worth noting that the change in the loan pricing model due to *S2* represents an IFRS 9 reform treatment.

2.5 RESULTS

The results presented in this paragraph are obtained by excluding the period after the adoption of the state credit measures to confront with the covid emergency (activated from the second quarter of 2020). This is because the post-covid period represents a very peculiar timeframe where banks strongly deviate from their ordinary lending policies generating discontinuity in their lending practices for two main reasons. Firstly, the public measures in the corporate lending sector are not only dedicated to sustaining the actual debtors but also to massively originating new loans. A public guarantee scheme is adopted to support the banks providing exceptional liquidity to the real economy, despite the growing credit risks levels of their corporate clients. Secondly, due to the uncertainty on the IFRS 9 application in the aftermath of the pandemic, European banks make adjustments in their staging mechanisms, to comply with the European banking regulators and supervisors (EBA, ECB) requests to avoid procyclical effects on the industry due to a rigid adoption of the staging triggers.

2.5.1 SUMMARY STATISTICS

The sample adopted to conduct the analysis comprises 21,634 corporate loans originated in the period 2017-2020 by two banks; the total outstanding exposure generated by the bank amounts to approximately 11 billion EUR of which 71.5% originated in the period post-IFRS 9 adoption.

Table 2.A2 - Panel A presents summary statistics for the key variables. The sample includes loans originated to clients located in 94 geographical areas. The average loan amounts approximately to €512,000. The 63.4% of the loans is unsecured while the 36.6% is assisted by guarantees (personal, collateral, or other guarantees). The average maturity of the sampled loans is 3.5 years with an average probability of default of 2.45%.

Table 2.A2 – Panel B (1) provides a detailed breakdown of the average exposure and of the average spread difference between the period before and after the IFRS 9 adoption. In sample, approximately 31% of loans (6,671 out of 21,634) is issued before the adoption of the IFRS 9, which is effective in different dates at the beginning of 2018 for the two banks. It is worth noting that on

the overall sample and on average, we observe a decrease of the credit spread and an increase of the loan amount after the IFRS 9 adoption. If we focus on the statistics of the post-IFRS 9 adoption, we note that banks charge, on average, higher spreads to clients with stage 2 loans in the previous 12 months. Table 2.A2 – Panel B (2) provides further information regarding this breakdown.

In the Annex to this chapter, we have analysed the underlying pre-trends of the Banks. Figures 2.1 and 2.2 report the plotted quarter-by-quarter evolution of observable characteristics salient to the banks' risk profile (i.e., Loan Amount and PD). The evident stability of the risk profile in the period before and after IFRS 9 reform let us understand that potential changes in the spread dynamics post-IFRS 9 cannot be attributed to underlying pre trends.

With regard to the climate-related risks, it is worth mentioning that almost 33.5% of the loans in the sample are granted to firms that are located in high seismic risk provinces. Furthermore, we also note that on average, banks charge higher spreads to firms that reside in higher seismic risk areas, to whom they actually grant lower loan amounts (see. Table 2.A2 Panel B (3)).

2.5.2 PRE- VS POST-IFRS 9 ADOPTION RESULTS

Following the model in the equation (1), Table 2.1 reports the result of the regressions of the log of the loan spread *(LN_SPREAD)* levels, for the sample of the loans originated in the period 2017-2020 by *BANK1* and *BANK2* that adopt IFRS 9 in 2018. The main independent variable of interest is *POST_PD* which is defined as the interaction between the client probability of default transformed into logarithmic form *(LN_PD)* and the dummy variable identifying loans originated after the adoption of IFRS 9 *(POST)*. In Table 2.1, the specification in the second column (2) is the baseline regression, while the others are used to evaluate the significance of the main independent variable and its robustness to a wide range of controls. The most relevant evidence observed in the regression (2) is that the coefficient of the interaction variable, between the post- reform adoption and the natural logarithm of the client probability of default (*POST_PD*), has a positive sign and is statistically significant. This coefficient estimates the moderating effects of the post-IFRS 9 reform adoption on the relation between the credit price and the client's probability of default.

Our results in Table 2.1 are broadly in line with what the literature observes, more specifically the signs of the coefficients of the variables are similar to those reported in prior literature. Specifically, we estimate negative relation of *LN_SPREAD* with the log of the loan amount *(LN_AMOUNT)*, with the log of the outstanding exposure of the firm at banking industry level *(LN_OTHER_LOANS),* with the total asset growth of the Bank *(ASSET_GROWTH),* with the growth of the domestic industrial production *(G_IND_PROD).* We estimate positive relations of *LN_SPREAD* with the log of the probability of default of the client *(LN_PD)*, the log of the loan maturity *(LN_MATURITY).* We use fixed effects to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), the facility type *(LOAN TYPE_FE)* and the guarantee type (*GUARANTEE_FE).*

Following the model in the equation (4), Table 2.2 reports the result of the regressions of the log of the loan spread *(LN_SPREAD)* levels for Panel B, that includes all data before the adoption of the IFRS 9 by BANK1 (which delayed the implementation of the IFRS 9 compared with BANK2) and reports the results of the difference-in-differences approach. The dependent variable is the natural log of Loan Spread at transaction level *(LN_SPREAD)*. The main independent variable of interest is *POST_BANK2_PD,* representing the effect of the adoption of the accounting reform in 2018 *(POST,* i.e., the treatment) on the *PD* of the banks that adopt IFRS 9 (*BANK2*LN_PD = BANK2_PD,* i.e., the treated units). In Table 2.2, specification in column (2) is the baseline regression, while the other columns are used to evaluate the significance of the main independent variable and its robustness to a wide range of controls. The most relevant evidence observed in the regression (2) is that the coefficient of POST_BANK2_PD has positive and statistically significant sign. It is interesting to notice that the same coefficient simulated in the hypotheses that BANK2 adopts the reform at the end of the third and of the second quarter 2017 is not significant (see Table 2.14 and 2.15 in the Appendix).

With regard to (H0) – given the positive and significant interaction coefficients of *POST_PD* in Table 2.1 and of *POST_BANK2_PD* in Table 2.2 - we cannot reject the relevant hypothesis since we find statistical evidence that, after the adoption of the accounting reform, the lenders charge -

ceteris paribus - higher risk premium compared with the previous accounting regime (IAS 39). As represented in the following "robustness checks" chapter (2.5.4), this *POST* moderating effect is robust to a wide range of additional controls, including macroeconomic and market conditions, other loan, and borrower characteristics (see Table 2.2, columns: 1, 3, and 4). The *POST* moderating effect is particularly evident if we analyse the evolution of the spread applied to the high-risk loans which are the most impacted by the IFRS 9 adoption. Figure 2.3 in the Appendix, which represents the average credit spread evolution, by quarter and by bank, in proximity of the IFRS 9 managerial adoption for unsecured loans to non-investment grade clients, shows sharp discontinuities around the quarter when the policy change becomes effective for bank 1 e for bank2.

In terms of magnitude, according to the results in the regression (2) Table 2.1, we observe that the coefficient of *POST_PD* which applies in the post-IFRS 9 adoption corresponds to an additional premium ranging from 0.5% to 0.6% on the average *LN_SPREAD*.

2.5.3 FOCUS ON POST-IFRS 9 ADOPTION RESULTS

Following the model in the equation (6), the analyses reported in Table 2.3 are aimed at evaluating potential fixed effects of the stage 2 dummy variable (H1A) and relative interaction with the probability of default of the client (H1B). Table 2.3 reports loan-level regressions which estimate the moderating effect of staging classification, together with other control or independent variables, on the relation between the client probability of default and the spread applied to corporate clients. The dependent variable is the natural logarithm of the Loan Spread at transaction level *(LN_SPREAD)*. The main independent variables of interest are *S2* - dummy identifying clients with stage 2 exposures within the 12 months prior to the loan origination - and its interactions with the probability of default of the client *(S2_PD= S2 *LN_PD).* The statistically significant coefficients of *S2* and *S2_PD,* in the column (1) suggest that S2 has positive fixed effects on the log of the loan spread and that it interacts positively with the probability of default of the firm. The coefficient of *S2_PD* estimates the moderating effects of *S2* variable on the relation between the log of the loan spread *(LN_SPREAD)* and the log probability of default of the firm (*LN_PD*). Consequently, with

regard to (H1A) we cannot reject the relevant hypothesis since we find that in the post reform period there is significant evidence that banks charge higher spreads to firms with previous transactions classified in stage 2. Furthermore, we cannot reject (H1B), since we find that after IFRS 9 adoption, the sampled lenders charge a higher risk premium to S2 firms proportionally to the PD level. As represented in the following "robustness checks" chapter (2.5.4), this *S2* moderating effect and fixed effect are robust to a wide range of additional controls, including macroeconomic and market conditions, other loan and borrower characteristics and other fixed effects (see Table 2.3, columns: 2,3,4,5,6,7).

In terms of magnitude, according to the results of Table 2.3, we observe that clients with stage 2 transactions in the previous 12 months (*S2*) pay an additional fixed price increase, which ranges from 2.4% to 3.2% of the average *LN_SPREAD*. We also observe that, given the values of *S2_PD* coefficients in Table 2.3, we expect *S2* clients to pay a higher risk premium. Ceteris paribus, the same *LN_PD* unit increase generates for S2 clients a higher credit price increase ranging from 0.4% to 0.5% of the average *LN_SPREAD*.

2.5.4 ROBUSTNESS CHECKS

2.5.4.1 Cross-sectional analyses

We perform cross-sectional analyses with the aim to check the robustness of our findings, further addressing sample heterogeneity potentially arising from a bank's ability to adopt its LLP policy in the credit process. In particular, we reperform the regressions by segment since the size of the client can influence the loan spread. Big clients have strong bargaining power vis-à-vis the banks (D'Auria and Foglia, 1997) and symmetrically banks have strong bargaining power vis-à-vis the small clients. We find consistent results by reperforming the regressions by segment (Tables: 2.4, 2.5).

We also check if potential nonlinear correlation between *PD* and *S2* is driving our results. In order to test the effects of potential nonlinear correlations[45] between *PD* and *S2* in the Loan Spread levels explanation, we perform two additional tests. We apply the regression (1) of Table 2.4 to explain *LN SPREAD* both below and above the *PD* average. In most cases below and above the average, *S2* and its interaction coefficient with *PD* are still significant (see Table 2.8).

2.5.4.2 Endogeneity

As reported in the previous pages, we provide empirical evidence that banks' loans present higher spread in the post reform period. In this section, we use a simultaneous equation model (SEM) approach to address potential concerns[46] about reverse causality and simultaneous determination of loan spread and Loan Amount.

For Loan Spread, we use the equation (1) where the log of the loan spread *(LN_SPREAD)* is explained on the Log of the loan amount *(LN_AMOUNT)* and the other control variables. For loan amount we develop a new equation, with a regression specification in which we include the log of the loan spread as the explanatory variable and other control variables that are expected to influence the loan amount as suggested in the literature. By analyzing prior literature (Cole, 1998; Angelini et al., 1997; Bellucci et al., 2013; Cotugno et al., 2013) on the determinants of the loan amount, we find that the factors adopted to explain the loan spread are also adopted to explain the loan amount.

Therefore, our proposed loan amount *(LN_AMOUNT)* equation includes the following variables: loan term *(MATURITY),* loan spread *(LN_SPREAD),* credit risk (*PD)*, outstanding exposure of the firm at banking industry level *(LN_OTHER_LOANS).* We also control for the lending rates applied in the domestic market to non-financial corporations *(LEND_RATES),* the total asset growth of the lender

[45] The linear correlation between PD and S2 is limited (the R-squared associated to a PD regression on S2 is 0.083), but the pairwise comparison of the PD means over S2 highlights statistically significant difference (see Table 2.6). This difference decreases in case we perform the pairwise comparison below and above the PD median/average values (see Table 2.7).

[46] We follow Chiu et al. 2021, that adopt a SEM approach to test simultaneous determination between loan interest rate and debt maturity dispersion in the mortgage banking sector.

(ASSET_GROWTH) and by the fixed effects connected to the facility type *(LOAN_TYPE_FE),* the size of the firm *(SEGMENT_FE)* and the type of guarantees *(GUARANTEE_FE).*

To estimate the SEM, we use quasi maximum likelihood (QML), that uses maximum likelihood to fit the model, but relaxes the conditional normality assumptions when estimating the standard errors. QML handles nonnormality by adjusting standard errors. The technique adopted is robust to heteroskedasticity of the errors. In our SEM approach, all inputs and outputs are observed.

Table 2.9 shows the results of the SEM. We find that for the log of the loan amount and the log of loan spread, there is no evidence of a bidirectional relation: the *LN_SPREAD* coefficient in the *LN_AMOUNT* equation is positive, but not significant, while the *LN_AMOUNT* coefficient in the *LN_SPREAD* equation is negative and significant. With regard to the control variables in the *LN_AMOUNT* equation, we find that most of the control variables are statistically significant, and their signs are consistent with our expectations.

Overall, we find that the effects of the post-IFRS 9 reform adoption on the *LN_SPREAD* equation remains robust, with consistent signs, when we address the endogeneity concerns about reverse causality and simultaneous determination.

2.5.4.3 Propensity score matching

To further address sample heterogeneity, we examine whether the positive and significant relation between the log of the loans spread *(LN_SPREAD)* and the probability of default of the bank that firstly adopted the IFRS 9 *(POST_BANK2_PD)* is robust to using a matched sample, based on propensity score matching.

Table 2.10 reports the results of the DID approach adopted in Table 2.2 on the matched sample after the exact propensity score matching. The propensity score is built on a logit regression of *BANK2* (i.e., the dummy indicating the Bank treated) as target variable based on the following regressors: maturity, facility type, guarantee type, origination date (pseudo-R-squared 34.79%).

The most relevant evidence observed in regression (2) Table 2.10 is that the coefficient of (*POST_BANK2_PD*) has positive and statistically significant sign. As represented in the other regressions (1,3,4), this effect is robust to a wide range of additional controls.

It is interesting to notice that the same coefficient simulated in the hypotheses that BANK2 adopts the reform at the end of the third and of the second quarter 2017 is not significant (see Table 2.16 and 2.17 in the Appendix).

2.5.3.4 Robustness to additional controls

To check the robustness to additional controls, we have identified for each area of interest, a set of additional controls that we have included in the regressions presented in Table 2.1 and Table 2.2 to test H0 and in Table 2.3 to test H1.

For what concerns the additional controls related to macroeconomic, market and lender conditions (M), according to the literature (Angelini et al. 1998), we also control for the lending rates applied in the domestic market to non-financial corporations (*LEND_RATES*). To reflect in the analysis the different competitive power of the two banks, we additionally control for the headquarters location (*HQ_FE*), so to reflect a higher bargaining power when the banks have to deal with the firms located in their HQ areas. We also control for the firms' sector by introducing fixed effects (*SECTOR_FE*) corresponding to the NACE classification, which should show whether the type of production activity of the borrower is taken into consideration in the pricing policies of the banks.

As reported in regression 1, 3, 4, 5 of Table 2.1 and 1, 3, 4 of Table 2.2, the coefficient of *POST_PD* and of *POST_BANK2_PD* are still significant and positive also in case of additional controls. As reported in Table 2.3 (regression 1, 3, 4, 5, 6, 7), the coefficients of *S2* and of *S2_PD* are almost always significant and positive also in case of additional controls.

2.5.5 EXTENSION: IFRS 9 AND CLIMATE RELATED RISK MANAGEMENT

Thus far, we have explored the effects of the IFRS 9 and related staging classification on the relation between corporate loan spread and its traditional determinants identified by the literature. In

this section, we answer to another correlated question: does the IFRS 9 change, in loan loss provisioning method, produce effects on the climate-related risks management practice (i.e., the way banks are considering climate-related risk factors in the determination of their lending standards)?

The question originates from the evidence that a significant stream of the recent literature[47] (Javadi and Masum, 2021; Jiang et al., 2020; Delis et al., 2021) is empirically supporting the evidence that climate-related risks are included in lending decision to firms. With regard to the corporate lending sector, since the effects of climate related risk events may manifest over a reasonably long period of time, it is reasonable to think that such events, if they occur during the lifetime of a medium/long term loan, could have a significant impact on the value of the firm and consequently have a negative contribution on the bank's balance sheet, hence impacting on the lending standards policy. While PD changes from the inception can trigger staging transition, it seems there is not yet interconnection of the IFRS 9 with the way banks are managing the seismic risk in the loan spread determination. This is evident in the recent considerations of the IFRS foundation (2020) that highlight the necessity to include climate-related risk factors in the IFRS 9 provisioning process (see footnote 5).

Consequently, since seismic risk is likely to be an effective credit risk factor[48] not affecting the new LLP model envisaged by IFRS 9 (as opposed to the probability of default), it is interesting to perform additional analyses to investigating potential moderating effects on the relation between climate-related risk factors and credit price, due to the IFRS 9 adoption. These additional analyses

[47] Garmaise and Moskowitz (2009) show evidence that earthquake risk reduced commercial real estate lending in California in the 1990s; and the more recent study of Nguyen et al (2020) shows that financial institutions use the mortgage pricing as lever to handle sea level rise risk (SLR) on prices of residential properties. The authors analyze loans originated in the U.S. between January 1992 and June 2018 and show an "SLR premium" in the mortgage market. Furthermore, Jiang et al. (2020) in their empirical work, highlight that lenders charge a higher cost of credit for firms exposed to higher SLR risk. Further contribution is in Ouazad and Kahn (2021), the authors show that, "*in the aftermath of natural disasters, lenders are more likely to approve mortgages that can be securitized, thereby transferring climate risk".* On the corporate lending side, Javadi and Masum (2021) find empirical evidence that "*firms in locations with higher exposure to climate change pay significantly higher spreads on their bank loans".* The empirical evidence that climate-related risk influence corporate lending decision is also in Delis et al. (2021).

[48] In fact, given the regulatory attention to the management of the climate risk, the literature evidence and the market attention, we expect that banks are including seismic risk factors among the determinants of the credit price.

are particularly important, because they allow us to indirectly assess whether the change in PD pricing is actually driven by the new accounting standard.

To perform the supplementary analyses, we have complemented the dataset with public[49] information related to seismic risk of the municipality (source: local Agency). The seismic risk exposure of the country where the banks operate is significant. In fact, it is one of the countries with the greatest earthquake risk, due to its geographical position in Europe, with 45% of the surface of the national territory (40% of the total population) exposed to high seismic risk.

With the goal to identify the high-risk provinces, we build a specific dummy variable, in two steps: firstly, we aggregate the municipality seismic-risk indicator to a province level, secondly, we assign a value of 1 to provinces that are in the riskiest quartile of the distribution and 0 otherwise. In this way we obtain the dummy variable (*HIGH_SEISMIC RISK*) that indicates that the firm's geographical residence is a province ranked in the first quartile of the seismic risk exposure.

The first additional analysis that we perform is aimed at identifying potential interconnection between the IFRS 9 adoption and the seismic risk premium (if any). In particular, we control the model developed in the equation (1) for the above-mentioned high seismic risk indicator and its interconnection with the variable indicating the post adoption of the IFRS 9 (*POST_HSR=POST*HIGH_SEISMIC_RISK*); accordingly, the equation (1) changes as follow:

$$SPREAD_{it} = \beta_0 + \beta_1 \mathrm{POST_t} + \beta_2(POST_t \times LN\_PD_{it}) + \beta_3 HSR_{it} + \beta_4(POST_t \times HSR_{it}) + \beta_R' R_{it} + \beta_L' L_{it} + \beta_B' B_{it} + \beta_M' M_t + u_{it} \quad (7)$$

The second additional analysis that we perform is aimed at identifying potential interconnections between *S2* variable and the seismic risk premium (if any). In particular we control the model developed in the equation (6) for the high seismic risk indicator (*HIGH_SEISMIC_RISK*), and its

[49] The public dataset allows us to measure the risk magnitude, since it contains detailed information for each municipality in the local territory. Through these risk indicators it is possible to provide a fundamental seismic risk information. To better appreciate the magnitude of these events and consequently the effects for the financial sector, only high-risk indicators are considered in the model. For the Seismic Risk, the basic variable identifies the earthquake risks by assigning a score from 1 to 4 (with decreasing danger) to each municipality in the national territory.

relative *S2* moderating effects (*S2_HIGH_SEISMIC RISK*) on its relation with the credit price. Hence, the equation (4) changes as follow:

$$SPREAD_{it} = \beta_0 + \gamma_0 S2_{it} + \gamma_1 (S2_{it} x HSR_{it}) + \beta_R' R_{it} + \beta_L' L_{it} + \beta_B' B_{it} + \beta_M' M_t + \beta_P' E_t + u_{it} \quad (8)$$

In line with D'Auria and Foglia (1997) and with Angelini et al. (1998), we additionally include, in the list of the control variables for the equations (7) and (8), the fixed effects related to the geo-residence of the client (*PROVINCE_FE*). In fact, since high seismic risk variable is defined at province level, we need to control for the geo-location of the firm, in order to differentiate the risk premium effects of firms located in high seismic risk areas from the risk premium effects of firms located in more developed areas.

As reported in Table 2.11 regression (2) – aimed at performing the first additional analysis - the coefficient of *HIGH_SEISMIC_RISK* is significant and positive and is robust to all the additional controls in the other regressions (1, 3, 4, 5), so providing evidence that there is a seismic risk premium for firms headquartered in geographic areas exposed to higher seismic risk. However, in the same regression the coefficient of *POST_HSR* is not significant, indicating that the post adoption of the IFRS 9 does not produce effects on the relation between seismic risks and the cost of credit. This result is robust to all the additional controls in the other regressions (1, 3, 4, 5).

In terms of magnitude, according to the most conservative results of the Table 2.11, we observe that firms headquartered in high seismic risk areas (*HIGH_SEISMIC*), pay an additional risk premium which amounts to 4.6% of the average *LN_SPREAD*.

As reported in Table 2.12 regression (2) – aimed at performing the first additional analysis - the coefficient of *S2_HIGH_SEISMIC_RISK* is not significant neither robust to the additional controls introduced in the three following regressions, so providing evidence that there is not a significant moderating effect of *S2* on the relation between the cost of credit and the high seismic risk indicator.

This result is robust to all the additional controls in the other regressions (1, 3, 4, 5) in Table 2.12. The evidence arising from the additional analyses suggests that the increased relevance of the

probability of default in determining the spread of a new loan, after the IFRS 9 adoption, is driven by the new accounting rules rather than by an increased banks' sensitivity to clients' risk factors.

This evidence makes also us understand that the increase of the interest rates on those clients with previous S2 transactions is not due to a bank's changed perception of the broader client's risk and profitability profile but is rather the direct effect of the application of the new lifetime expected credit losses mechanism (PD based) and its potential severe burden in terms of provisioning increase to be covered and disclosed in the IFRS 9 new reporting standards.

2.6 CONCLUSIONS

The management of the real effects of the IFRS 9 reform introduced in 2018 is still on top of the banking regulatory agenda and collects concerns among the financial supervisors. This paper follows Leuz and Wysocki's (2016) call for more empirical study on the real effects of accounting rules, by investigating potential moderating effects of the post-IFRS 9 period on the relation between the firm's probability of default and credit price. Despite a significant prior literature (D'Auria and Foglia 1997; Angelini et al., 1998; Bellucci et al., 2013; Wang et al., 2020; Chiu et al., 2021) has investigated and highlighted the main determinants of the credit price in the corporate banking, there is currently no evidence that the change in loan loss provisioning method affects banks loans pricing decisions.

Using a unique dataset of two major banks operating in one European country, we show that the period after the IFRS 9 adoption is characterized by a tightening of the credit price applied to the local corporate clients. We highlight that there is statistical evidence that after IFRS 9 introduction, the lenders charge a higher risk premium ranging from 0.5% to 0.6% of the average *LN_SPREAD*. In terms of spread basis points this interval ranges from 6 to 7 basis points.

Focusing on the post-IFRS 9 adoption, we show that there is statistical evidence that banks charge higher spreads to firms with previous transactions classified in stage 2 and that those *S2* firms pay higher risk premiums. The additional fixed price increase, ranges from 2.4% to 3.2% of the average *LN_SPREAD* (from 32 to 43 in terms of spread basis points). *S2* firms also have higher risk premium, ranging from 0.4% to 0.5% of the average *LN_SPREAD* (from 5 to 6 in terms of spread basis points).

This paper is also the first attempt to estimate the impact of the accounting regulation on the bank's climate risk management practice. In particular, we find that the staging classification and the post adoption of the IFRS 9 are not affecting climate risk premiums. It seems that, while banks have integrated the new accounting risk metrics (i.e., staging) with the prudential risk metrics (i.e., the probability of default, which is actually a trigger of the staging classification), the seismic risk factor

seems to be still an independent component of the pricing framework.[50] This evidence gives further robustness to the hypothesis that the increased PD premium, after the IFRS 9 adoption, is driven by the new accounting regime. All the evidence is robust to a wide range of controls, to a battery of cross-sectional analyses and to additional controls applied to deal with sample heterogeneity and potential endogeneity concerns.

From a policy perspective, this paper adds to the literature on the LLP implication for financial stability. On the one hand, our results on the overall period suggest that the magnitude of the average increase of the risk premium, associated to the accounting reform adoption in the lending standards, is not immaterial. On the other hand, focusing on the post reform adoption, it is evident that new staging classification is a disruptive metric for loan pricing decision. It is likely that lenders change their risk appetite by charging higher spreads to discourage loan origination for clients that became too risky and expensive under the new standard (stage 2). The significant price discrimination associated to the underperforming clients helps understanding the risk of excessive downgrade to stage 2, especially in the geographies and sectors where banks' loans are the prime source of business finance. The EU Authorities statements and interventions, made in the aftermath of the pandemic, to avoid procyclical effects on the industry by promoting adjustments on the staging mechanism, are really consistent with the evidence of this paper.

[50] It seems that there is still a gap on the IFRS expectations that banks consider material climate-related risk on their financial statements.

Table 2.A. Reference literature of the Loan Spread determinants/controls in corporate banking

CATEGORY	VARIABLES[51]	REFERENCE				
		D'Auria Foglia (1997)	Angelini et al. (1998)	Bellucci et al. (2013)	Wang et al. (2020)	Chiu et al. (2021)
LENDING STANDARDS	**Loan Spread:** *difference between the nominal interest paid by the client and the market reference interest rate*	*	*	*	*	*
(R) RISK	**Guarantees:** *presence of collateral or other guarantees*			*	*	*
	PD or other Default risk indicators: *probability of default is the likelihood over one year that a borrower will not be able to repay*	*			*	*
	NPL status: *debtor that missed payments for a period 90 days*		*			
(L) LOAN CHARACTERISTICS	**Loan Amount:** *amount the borrower promises to repay, as in the contract*	*		*	*	*
	Term of loan: *Term of the repayment scheduling*		*		*	*
	Loan purpose: *objective of the loan request*		*			*
(M) MACRO AND MARKET CONDITIONS, LENDER CONDITIONS	**Industrial production growth**		*			
	Credit Market conditions: *competition level and other proxies*	*	*	*		
	Interest rate level and its level changes	*	*		*	
	Average Interest rates non-financial corporations: *average rate applied by the banking industry to non-financial corporations*		*			
	Bank Average NPL on total Loans: *total Bank NPL to total loans*	*	*			
	Bank size: *Total assets under management*	*	*			*
(B) OTHER BORROWER CHARACTERISTICS	**Client segment:** *banks' marketing classification of the client size*	*	*	*		*
	Already client: *number of years the client has relationship with the bank*		*	*		
	Year-end profit & loss: *profit/loss as from the last financial statements*	*	*			
	Residence: *client province or region of residence*	*	*	*		
	Client Sector: *client principal sector of business*		*			*
	Client size: *client turnover as from financial statements*			*	*	*
	Outstanding exposure at industry level: *total credit exposure of the client, as recorded at a central registry at industry level*	*	*	*	*	

[51] In some cases, the mentioned authors adopted proxies of the variables reported. In those cases, the proxy description is not fully consistent with the variables' description.

Table 2.A1. List of variables (at the origination date)

AREA	VARIABLE	NOTES
KEY and TARGET	*BANK*	Bank ID (2 banks)
	ORIG_DATE	Transaction's inception date
	LN_SPREAD	Log of the difference between the nominal interest paid by the client and the reference interest rate observed in the market (Target variable)
LOAN	*FACILITY*	Facility type (Dummy)
	RATE_TYPE	Interest rate type (Dummy)
	MATURITY	Maturity in years
	LN_AMOUNT	Log of the credit extended by the bank at transaction level
	LN_OTHER_LOANS	Log of clients outstanding exposure at banking industry level (National Credit Bureau)
BORROWER	*SECTOR*	Clients NACE (Dummy)
	SEGMENT	Client's size (Dummy)
	PROVINCE	Firm's residence (Dummy)
	REGION	Firm's residence (Dummy)
RISK	*STAGE_2*	1 in case the client has stage 2 transactions in the previous 12 months, 0 otherwise.
	LN_PD	Log of Client's Probability of default
	GUARANTEE	Collateral type. (3 groups)
MACRO MARKET LENDER	*LEND RATES*	Domestic rate applied on average to non-financial firms, quarter
	ASSET GROWTH	Banks total asset growth, quarter
	G_IND PROD	Industrial production domestic growth, quarter
	COVID	1 in case the origination is post state measures to sustain the credit sector, 0 otherwise
	B1_HQ	1 in case the loan is originated in the HQ of Bank1 by Bank1, 0 otherwise
	B2_HQ	1 in case the loan is originated in the HQ of Bank2 by Bank2, 0 otherwise
CLIMATE RISK	*HIGH_SEISMIC RISK*	1 if the seismic risk is high (1st quartile of the provincial ranking in terms of seismic risk), 0 otherwise

Table 2.A1 reports the list of variables collected at origination. Climate risk info are sourced from a local public agency. Within the Macro & Market info: Domestic rate levels *(LEND_RATES)* and the domestic Industrial production growth (*G_IPROD)* are sourced from OECD. Info of the residual areas: Target and Key, Loan, Borrower, Risk is bank-related information.

Table 2.A2. Summary statistics.

The sample comprises 21,634 loans originated in the period 2017-2020 by two banks. Panel A presents variables' description and summary statistics.

Panel A: Summary statistics

Variables Definition *(at origination date)*		**5%**	**25%**	**50%**	**75%**	**95%**
LN_SPREAD	*Log of Loan spread bps*	4.433	5.004	5.374	5.792	6.632
LN_AMOUNT	*Log of Loan amount K€*	9.208	11.090	12.192	13.122	14.509
LN_OTHER_LOANS	*Log of Outstanding exposure at banking industry level €*	11.009	13.115	14.298	15.614	17.356
LN_MATURITY	*Log of Loan term, years*	0.456	0.693	1.094	1.809	2.485
SEGMENT 1	*CORPORATE clients, (firm size 100- 250 € mln), dummy*	0	0	0	0	1
SEGMENT 2	*LARGE Corporate clients, (firm size above 250 € mln), dummy*	0	0	0	0	0
SEGMENT 3	*MID Corporate clients, (firm size 50- 100 € mln), dummy*	0	0	0	1	1
SEGMENT 4	*SMALL Corporate clients, (firm size below 50 € mln), dummy*	0	0	0	1	1
FACILITY 1	*Other Loans, dummy*	0	0	0	1	1
FACILITY 2	*Overdraft Loans, dummy*	0	0	0	0	1
FACILITY 3	*Amortizing Loans, dummy*	0	0	0	1	1
GUARANTEE 1	*Other Guarantees, dummy*	0	0	0	0	1
GUARANTEE 2	*Personal Guarantees, dummy*	0	0	0	0	1
GUARANTEE 3	*Secured, dummy*	0	0	0	0	1
GUARANTEE 4	*Unsecured, dummy*	0	0	1	1	1
COVID	*Post state measures, dummy*	0	0	0	0	1
S2	*Client with stage 2 exposures in last 12 months*	0	0	0	0	1
B1_HQ	*Loan originated by Bank2 in its Headquarters, dummy*	0	0	0	0	0
B2_HQ	*Loan originated by Bank2 in its Headquarters, dummy*	0	0	0	0	0
HIGH SEISMIC RISK	*First quartile risk, dummy*	0	0	0	0	1
PD	*Client Probability of default*	0.001	0.004	0.008	0.025	0.115
LEND RATES	*Average Domestic interest rate on non-fin corp. (%)*	1.480	1.650	1.730	1.790	1.850
ASSET GROWTH	*Total bank's asset growth (quarter)*	-0.040	-0.016	-0.001	0.016	0.040
G_IND_PROD	*Industrial production, domestic growth (quarter)*	-0.006	-0.002	0.001	0.007	0.008

Panel B: *pre- and post-IFRS 9 Distribution, previous stage 2 transactions, seismic risk.*

(1) IFRS 9 reform	**Avg Exposure delta (%)**	**Avg spread delta**
Post vs Pre	+12.3%	-85bps

(2) Previous Stage2 transactions	**Avg Exposure delta (%)**	**Avg spread delta**
Yes vs No	+ 8.8%	+61bps

(3) High Seismic risk	**Avg Exposure delta (%)**	**Avg spread delta**
Yes vs No	-39%	+67 bps

Table 2.1. The effects of the post-IFRS 9 adoption on corporate loan spread

DEPENDENT VARIABLE: LOAN SPREAD (LOG)					
	Panel A (data of Bank1, Bank2, all pre covid period)				
	(1)	(2)	(3)	(4)	(5)
POST	**-0.0483**	**-0.0486**	**-0.0448**	**-0.0320**	**-0.0548**
	(-1.3745)	(-1.4001)	(-1.2873)	(-0.9161)	(-1.6014)
POST_PD	**0.0281*****	**0.0282*****	**0.0287*****	**0.0324*****	**0.0285*****
	(4.3605)	(4.3883)	(4.4549)	(4.9868)	(4.4947)
G_IND_PROD		-1.6734	-1.5033	-0.4854	-0.3987
		(-1.5516)	(-1.3935)	(-0.4490)	(-0.3744)
LN_AMOUNT	-0.0814***	-0.0813***	-0.0810***	-0.0763***	-0.0799***
	(-24.3038)	(-24.1846)	(-24.0692)	(-22.5448)	(-24.2544)
ASSET_GROWTH	-1.5939***	-1.5333***	-1.5160***	-1.1765***	-1.2225***
	(-7.9878)	(-7.5087)	(-7.4206)	(-5.7732)	(-6.0270)
OTHER_LOANS	-0.0121***	-0.0125***	-0.0124***	-0.0089**	-0.0067*
	(-3.1587)	(-3.2304)	(-3.1891)	(-2.2494)	(-1.8016)
LN_PD	0.1523***	0.1522***	0.1524***	0.1631***	0.1634***
	(30.9721)	(30.9732)	(31.0008)	(31.3727)	(32.1993)
LN_MATURITY	0.1176***	0.1177***	0.1170***	0.1082***	0.1028***
	(14.6313)	(14.6495)	(14.5401)	(13.3649)	(12.8774)
LEND_RATES	-0.0541				
	(-1.1221)				
CONSTANT	7.3662***	7.2792***	7.2761***	7.1589***	7.1777***
	(71.4863)	(122.9291)	(122.8281)	(116.8363)	(115.1945)
OBSERVATIONS	17,947	17,947	17,947	17,947	17,783
SEGMENT FE	Yes	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes	Yes
GUARANTEE FE	Yes	Yes	Yes	Yes	Yes
BANK FE	No	No	No	Yes	Yes
SECTOR FE	No	No	No	No	Yes
GEO_HQ FE	No	No	Yes	Yes	Yes
R-SQUARED (ADJ)	0.420	0.420	0.421	0.424	0.450

Table 2.1 reports loan-level regressions which estimate the moderating effect of the variable indicating the post adoption of the IFRS 9 (which is different for the two banks) on the relation between PD and the spread applied to corporate clients. The dependent variable is the natural logarithm of the Loan Spread at transaction level *(LN_SPREAD)*. The main independent variable of interest is the dummy variable identifying loans originated after the adoption of the IFRS 9 *(POST)* and its interaction with the natural logarithm of the probability of default of the client *(POST_PD=POST*LN_PD).* Specification (2) is the focus, while the others aim to check the model robustness by testing the coefficients stability through the inclusion of new control variables within the specification. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* and the bank's Headquarters province *(HQ_FE)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.2. The effects of the post-IFRS 9 adoption on corporate loan spread**.** Difference in difference approach (DID)

DEPENDENT VARIABLE: LOAN SPREAD (LOG)				
	Panel B (data of Bank1, Bank2) pre Bank1 adoption period			
	(1)	(2)	(3)	(4)
POST	-0.0142	0.0088	0.0102	0.0116
	(-0.1778)	(0.1088)	(0.1267)	(0.1485)
POST_BANK2	-0.1060	-0.1110	-0.1097	-0.1066
	(-0.7244)	(-0.7585)	(-0.7468)	(-0.7435)
BANK2_PD	0.1339***	0.1343***	0.1346***	0.1373***
	(11.3280)	(11.4405)	(11.4587)	(11.8912)
POST_PD	-0.0140	-0.0129	-0.0129	-0.0110
	(-1.0558)	(-0.9740)	(-0.9738)	(-0.8439)
POST_BANK2_PD	**0.0728****	**0.0715****	**0.0707****	**0.0695****
	(2.2294)	(2.1930)	(2.1579)	(2.1614)
BANK2	0.5794***	0.5828***	0.5913***	0.6140***
	(9.2243)	(9.2566)	(9.3834)	(10.1913)
G_IND_PROD		-7.1354***	-6.9080***	-6.6443***
		(-3.7947)	(-3.6658)	(-3.5517)
LN_AMOUNT	-0.0530***	-0.0532***	-0.0532***	-0.0585***
	(-9.8350)	(-9.8865)	(-9.8890)	(-11.4202)
ASSET GROWTH	-1.8883***	-1.7011***	-1.7554***	-1.7796***
	(-3.1897)	(-2.8797)	(-2.9716)	(-3.1093)
LN_OTHER_LOANS	-0.0270***	-0.0272***	-0.0274***	-0.0278***
	(-3.9251)	(-3.9582)	(-3.9840)	(-4.5271)
LN_PD	0.1218***	0.1211***	0.1204***	0.1175***
	(16.7968)	(16.6845)	(16.5936)	(16.9831)
LN_MATURITY	0.0340**	0.0329**	0.0333**	0.0343**
	(2.2380)	(2.1672)	(2.1938)	(2.3239)
LEND_RATES	-0.2285*			
	(-1.9447)			
CONSTANT	7.4518***	7.0784***	7.0746***	7.1114***
	(32.7700)	(86.3433)	(86.2866)	(90.1335)
OBSERVATIONS	7,089	7,089	7,089	7,014
FIRM SEGMENT FE	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes	Yes	Yes
BANK FE	Yes	Yes	Yes	Yes
FIRM ATECO FE	No	No	No	Yes
HQ FE	No	No	Yes	Yes
R-SQUARED (ADJ)	0.438	0.439	0.439	0.476

Table 2.2 reports the results of the difference in difference approach. The dependent variable is the natural log of Loan Spread at transaction level *(LN_SPREAD)*. The main independent variable of interest is *(POST_BANK2_PD),* representing the effect of the post introduction of the accounting reform in 2018 *(POST)* on the log of the PD *(LN_PD)* for the bank that firstly adopts IFRS 9 in the managerial processes *(BANK2_PD)*. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT*), facility type *(LOAN TYPE),* guarantee type (*GUARANTEE),* bank *(BANK FE)*, firm's sector *(SECTOR)* and the bank's Headquarters province *(HQ)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significant the 1%, 5%, and 10% levels, respectively.

Table 2.3. The effects of Stage2 classification on corporate loan spread.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)							
	Panel C (data of: Bank1, Bank2, post adoption period)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
S2	**0.1643*** **	**0.1722*** **	**0.1733*** **	**0.1738*** **	**0.1589*** **	**0.1568*** **	**0.1325** **
	(2.9126)	(3.0573)	(3.0674)	(3.0793)	(2.8158)	(2.8046)	(2.3417)
S2_PD	**0.0331** **	**0.0343** **	**0.0343** **	**0.0344** **	**0.0291***	**0.0256***	**0.0143**
	(2.1334)	(2.2112)	(2.2055)	(2.2137)	(1.8648)	(1.6802)	(0.9295)
LN_AMOUNT	-0.1059***	-0.1050***	-0.1046***	-0.1047***	-0.0998***	-0.1024***	-0.0947***
	(-24.5415)	(-24.3003)	(-24.1520)	(-24.3823)	(-23.0050)	(-23.9072)	(-21.7109)
LN_OTHER_LOANS	-0.0232***	-0.0228***	-0.0228***	-0.0227***	-0.0067	-0.0029	-0.0054
	(-4.8123)	(-4.7262)	(-4.7260)	(-4.8045)	(-1.2012)	(-0.5320)	(-0.9813)
LN_PD	0.1684***	0.1688***	0.1692***	0.1692***	0.1759***	0.1713***	0.1892***
	(35.5602)	(35.6066)	(35.5998)	(35.6533)	(37.3430)	(36.1737)	(35.4215)
LN_MATURITY	0.1814***	0.1833***	0.1828***	0.1834***	0.1760***	0.1673***	0.1709***
	(19.4366)	(19.5902)	(19.5039)	(19.5305)	(18.7155)	(17.9281)	(18.3322)
G_IND PROD	-2.8968**	-0.7365	-0.6844		0.7206	1.0744	1.9986
	(-2.3590)	(-0.5843)	(-0.5428)		(0.5646)	(0.8410)	(1.5713)
ASSET_GROWTH		-1.6230***	-1.6084***	-1.5762***	-1.7217***	-1.7080***	-1.4865***
		(-7.0324)	(-6.9703)	(-6.9039)	(-7.3761)	(-7.3096)	(-6.3652)
LEND_RATES				-0.0996*			
				(-1.9408)			
CONSTANT	7.4303***	7.4106***	7.4105***	7.5787***	7.2763***	7.2608***	7.1539***
	(99.9912)	(99.4943)	(99.4921)	(69.7499)	(89.1781)	(83.0271)	(82.7532)
OBSERVATIONS	11,185	11,185	11,185	11,185	11,185	11,096	11,096
FIRM SEGMENT FE	No	No	No	No	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BANK FE	No	No	No	No	No	No	Yes
FIRM ATECO FE	No	No	No	No	No	Yes	Yes
HQ FE	No	No	Yes	Yes	Yes	Yes	Yes
R-SQUARED (ADJ)	0.413	0.416	0.416	0.416	0.427	0.446	0.452

Table 2.3 reports loan-level regressions which estimate the moderating effect of staging classification, together with other control or independent variables, on the relation between the client probability of default and the spread applied to corporate clients. The dependent variable is the natural logarithm of the Loan Spread at transaction level. The main independent variables of interest are *S2* - dummy identifying clients with previous stage2 exposures within the 12 months prior to the loan origination - and its interactions with the probability of default of the client *(S2_PD= S2 *LN_PD),* Specification (1) is the focus, while the others aim to check the model robustness by testing the coefficients stability through the inclusion of new control variables within the specification. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* and the bank's Headquarters province *(GEO HQ_FE)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.4. Cross-sectional analysis. The effects of the post-IFRS 9 adoption on corporate loan spread. By segment.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)		
	Panel A (data of Bank1, Bank2, all pre covid period)	
	(MID CORP)	(SMALL CORP)
POST	**-0.0446**	**-0.0608**
	(-0.7447)	(-1.2510)
POST_PD	**0.0319*****	**0.0163***
	(3.0457)	(1.7989)
G_IND_PROD	-1.1873	-1.3741
	(-0.7065)	(-0.9022)
LN_AMOUNT	-1.8752***	-1.8571***
	(-6.0059)	(-6.1047)
ASSET_GROWTH	-0.0943***	-0.0549***
	(-15.5126)	(-12.9603)
OTHER_LOANS	-0.0144**	-0.0253***
	(-2.0214)	(-5.1569)
LN_PD	0.1665***	0.1435***
	(18.5923)	(24.4451)
LN_MATURITY	0.1886***	0.0249*
	(16.2033)	(1.9368)
CONSTANT	7.3232***	7.1334***
	(58.9187)	(103.2739)
OBSERVATIONS	7,463	8,511
SEGMENT FE	Yes	Yes
LOAN TYPE FE	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes
BANK FE	No	No
SECTOR FE	No	No
HQ FE	No	No
R-SQUARED (ADJ)	0.366	0.425

Table 2.4. reports the same results of regression (1) of Table 2.1 split by segment. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* and the bank's Headquarters province *(GEO HQ_FE)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.5 Cross-sectional analysis. Moderating effects of Stage2 classification on the relation between risk & loan spread. Split by segment.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)		
	Panel C (data of: Bank1, Bank2,post adoption period)	
	(MID CORP)	(SMALL CORP)
S2_	**0.3659*** **	**-0.0286**
	(5.0164)	(-0.3064)
S2_PD	**0.0752*** **	**-0.0048**
	(3.5785)	(-0.1842)
LN_AMOUNT	-0.1161***	-0.0665***
	(-16.6812)	(-10.9864)
LN_OTHER LOANS	-0.0156*	-0.0189**
	(-1.9180)	(-2.3604)
LN_PD	0.1806***	0.1621***
	(27.6371)	(21.6531)
LN_MATURITY	0.2320***	-0.0340*
	(19.4151)	(-1.6513)
G_IND_PROD	-2.4601	-0.1238
	(-1.4251)	(-0.0597)
CONSTANT	7.4418***	7.1351***
	(53.7022)	(66.3020)
OBSERVATIONS	5,528	4,189
SEGMENT FE	No	No
LOAN TYPE FE	Yes	Yes
GUARANTEE FE	Yes	Yes
BANK FE	No	No
SECTOR FE	No	No
HQ FE	No	No
R-SQUARED (ADJ)	0.393	0.422

Table2. 5. reports the same results of regression (1) of Table3 split by segment. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* and the bank's Headquarters province *(GEO HQ_FE)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.6. Pairwise comparisons of means with equal variances (PD over S2)

PD	Contrast	Std. Err.	t	P>|t|
S2				
1 vs 0	.0507232	.0013933	36.40	0.000

Table 6 reports the T test results of the pairwise comparison of the *PD* average value observed on *S2* clients with the mean observed on non *S2* clients.

Table 2.7. Pairwise comparisons of means with equal variances (PD below and above its median)

If PD below average	**Contrast**	**Std. Err.**	**t**	**P>|t|**
S2				
1 vs 0	.0032903	.0002372	13.87	0.000
If PD above average	**Contrast**	**Std. Err.**	**t**	**P>|t|**
S2				
1 vs 0	.032518	.0032719	9.94	0.000

Table 2.7 reports the T test results – below and above the PD average - of the pairwise comparison of the *PD* average value observed on *S2* clients and on non *S2* clients.

Table 2.8. Cross-sectional analysis. Loan spread regression estimated below/above average (1,2)

DEPENDENT VARIABLE: LOAN SPREAD (LOG)		
	Panel D (data of Bank1, Bank2 post-IFRS 9)	
	(1)	(2)
	Below PD Average	Above PD Average
S2	**0.4227****	**0.1632***
	(2.0682)	(1.7655)
S2_PD	**0.0814***	**0.0280**
	(1.9090)	(0.8673)
LN_AMOUNT	-0.1024***	-0.0911***
	(-21.6645)	(-13.6697)
LN_OTHER LOANS	-0.0289***	-0.0053
	(-6.2645)	(-0.7279)
LN_PD	0.1422***	0.1373***
	(25.7960)	(6.8256)
LN_MATURITY	0.1702***	0.0532***
	(16.7831)	(3.8504)
G_IND_PROD	-3.8311***	-2.1490
	(-3.1836)	(-0.9219)
CONSTANT	7.3262***	7.0436***
	(100.8910)	(58.7607)
OBSERVATIONS	11,210	3,652
SEGMENT FE	no	no
LOAN TYPE FE	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes
BANK FE	no	no
SECTOR FE	no	no
HQ FE	no	no
R-SQUARED (ADJ)	0.333	0.294

Table 2.8. reports the same results of regression (1) of Table 2.3 below and above the average PD. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* and the bank's Headquarters province *(HQ_FE)*. Refer to Table A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.9 Endogeneity. Simultaneous equation model of *LN_AMOUNT* and *LN_SPREAD*

DEPENDENT VARIABLE: LOAN SPREAD (LOG)		
	Panel A (data of: Bank1, Bank2, all pre covid period	
	LN SPREAD	LN AMOUNT
LN_SPREAD		0.4340
		(1.6295)
LN_AMOUNT	-0.1070***	
	(-6.9094)	
POST	**-0.0358**	
	(-0.9379)	
POST_PD	**0.0308*****	
	(4.3371)	
LEND_RATES	-0.0423	0.3367
	(-0.8599)	(1.6263)
ASSET_GROWTH	-1.3823***	9.3193***
	(-5.7909)	(9.0903)
LN_OTHER_LOANS	0.0021	0.5832***
	(0.2288)	(31.9034)
LN_PD	0.1471***	-0.2283***
	(23.0941)	(-4.6775)
LN_MATURITY	0.1291***	0.4313***
	(12.8566)	(13.6496)
CONSTANT	7.4031***	-1.1360
	(72.2609)	(-0.6559)
OBSERVATIONS	17,497	17,497
SEGMENT FE	Yes	Yes
LOAN TYPE FE	Yes	Yes
GUARANTEE FE	Yes	Yes
BANK FE	No	No
SECTOR FE	No	No
HQ FE	No	No

Table 2.9 reports the results of a SEM that includes the log of the mortgage interest rate *(LN_INT_RATE)* and Loan-to-Value *(LTV)*. The SEM is estimated with quasi maximum likelihood (QML) that uses maximum likelihood to fit the model but relaxes the conditional normality assumptions when estimating the standard errors. QML handles nonnormality by adjusting standard errors. The main independent variable of interest is the dummy variable identifying loans originated after the adoption of the IFRS 9 *(POST)* and its interaction with the natural logarithm of the probability of default of the client *(POST_PD=POST*LN_PD)*. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* and the bank's Headquarters province *(HQ_FE)*. Robust z-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.10. The effects of the post-IFRS 9 adoption on corporate loan spread**.** Difference in difference approach (DID). Propensity score matching.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)				
	Panel B (data of Bank1, Bank2) pre Bank1 adoption period			
	(1)	(2)	(3)	(4)
POST	-0.0625	-0.0175	-0.0196	-0.0179
	(-0.9538)	(-0.2678)	(-0.2989)	(-0.2772)
POST_BANK2	0.0148	-0.0053	-0.0035	-0.0166
	(0.1746)	(-0.0624)	(-0.0419)	(-0.1976)
BANK2_PD	0.1144***	0.1158***	0.1159***	0.1177***
	(12.8936)	(13.1631)	(13.1723)	(13.5681)
POST_PD	-0.0053	-0.0025	-0.0028	-0.0048
	(-0.5064)	(-0.2432)	(-0.2676)	(-0.4698)
POST_BANK2_PD	0.0927***	0.0904***	0.0906***	0.0922***
	(5.7323)	(5.6099)	(5.6236)	(5.7606)
BANK2	0.5295***	0.5428***	0.5432***	0.6007***
	(11.0858)	(11.3837)	(11.3925)	(12.7147)
G_IND_PROD		-8.7796***	-8.7752***	-8.9043***
		(-6.7157)	(-6.7118)	(-6.8340)
LN_AMOUNT	-0.0785***	-0.0785***	-0.0785***	-0.0781***
	(-18.5375)	(-18.5629)	(-18.5724)	(-18.4806)
ASSET GROWTH	-0.3366	-0.4125	-0.4093	-0.5639
	(-0.7856)	(-0.9673)	(-0.9599)	(-1.3307)
LN_OTHER_LOANS	-0.0169***	-0.0175***	-0.0175***	-0.0184***
	(-3.4603)	(-3.5795)	(-3.5700)	(-3.7958)
LN_PD	0.1269***	0.1247***	0.1247***	0.1190***
	(23.2562)	(22.9042)	(22.8929)	(22.1273)
LN_MATURITY	0.0851***	0.0830***	0.0832***	0.0847***
	(9.9885)	(9.8089)	(9.8344)	(9.9736)
LEND_RATES	-0.4138***			
	(-4.7935)			
CONSTANT	7.9195***	7.2142***	7.2137***	7.1141***
	(46.3222)	(110.3415)	(110.3420)	(106.5039)
OBSERVATIONS	14,082	14,082	14,082	14,082
FIRM SEGMENT FE	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes
GUARANTEE FE	no	no	no	Yes
BANK FE	Yes	Yes	Yes	Yes
FIRM ATECO FE	yes	yes	yes	Yes
HQ FE	No	No	Yes	Yes
R-SQUARED (ADJ)	0.525	0.525	0.525	0.530

Table 2.10. reports the results of the regressions performed in Table 2.2 where the sample has been matched by banks based on a propensity score exact matching procedure. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT*), facility type *(LOAN TYPE),* guarantee type (*GUARANTEE),* bank *(BANK FE)*, firm's sector *(SECTOR)* and the bank's Headquarters province *(HQ)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significant the 1%, 5%, and 10% levels, respectively.

Table 2.11. Effects of climate risk on loan spread.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)					
	Panel A (data of Bank1, Bank2, all pre covid period)				
	(1)	(2)	(3)	(4)	(5)
HIGH SEISMIC RISK	**0.2481*** **	**0.2485*** **	**0.2485*** **	**0.5127*** **	**0.5240*** **
	(5.1632)	(5.1787)	(5.1787)	(10.5165)	(10.7166)
POST	-0.0186	-0.0198	-0.0198	-0.0462	-0.0363
	(-0.5344)	(-0.5724)	(-0.5724)	(-1.3615)	(-1.0683)
POST_HSR	**-0.0228**	**-0.0226**	**-0.0226**	**-0.0202**	**-0.0247**
	(-1.2312)	(-1.2182)	(-1.2182)	(-1.1063)	(-1.3576)
POST_PD	0.0288***	0.0288***	0.0288***	0.0253***	0.0275***
	(4.5332)	(4.5375)	(4.5375)	(4.0527)	(4.3969)
G_IND PROD		-0.2251	-0.2251	-0.3216	0.3313
		(-0.2096)	(-0.2096)	(-0.3036)	(0.3134)
LN_AMOUNT	-0.0795***	-0.0795***	-0.0795***	-0.0826***	-0.0797***
	(-23.8834)	(-23.8214)	(-23.8214)	(-25.4717)	(-24.4438)
ASSET GROWTH	-1.4190***	-1.4061***	-1.4061***	-1.4130***	-1.2104***
	(-7.2059)	(-6.9749)	(-6.9749)	(-7.0300)	(-6.0286)
LN_OTHER LOANS	-0.0083**	-0.0084**	-0.0084**	-0.0069*	-0.0044
	(-2.1534)	(-2.1476)	(-2.1476)	(-1.8516)	(-1.1881)
LN_PD	0.1550***	0.1549***	0.1549***	0.1554***	0.1613***
	(30.9334)	(30.9484)	(30.9484)	(31.7660)	(32.3651)
LN_MATURITY	0.1127***	0.1127***	0.1127***	0.1071***	0.1023***
	(14.2012)	(14.2192)	(14.2192)	(13.6745)	(13.0348)
LEND_RATES	0.0016				
	(0.0327)				
CONSTANT	7.1716***	7.1757***	7.1757***	7.1889***	7.0149***
	(64.7207)	(99.8046)	(99.8046)	(98.4024)	(92.1076)
OBSERVATIONS	17,947	17,947	17,947	17,783	17,783
FIRM SEGMENT FE	Yes	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes	Yes	Yes	Yes
BANK FE	No	No	No	No	Yes
FIRM ATECO FE	No	No	No	Yes	Yes
PROVINCE FE	Yes	Yes	Yes	Yes	Yes
R-SQUARED (ADJ)	0.448	0.448	0.448	0.469	0.472

Table 2.11 reports loan-level regressions which estimate the effect of climate risk indicators (seismic risk) and other control or independent variables on the spread applied to corporate clients. The dependent variable is the natural logarithm of the Loan Spread at transaction level. The main independent variable of interest is the climate risk indicator: high seismic risk indicator *(HIGH_SEISMIC_RISK)* and its interaction with the post adoption dummy *(POST_HSR)*. Specification (1) is the focus, while the other regressions aim to check the model robustness by testing the coefficients stability through the inclusion of new control variables within the specification Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* the firm's residence province *(PROVINCE_FE)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.12. Moderating effects of Stage 2 on the relation between high seismic risk and loan spread.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)							
	Panel C (data of: Bank1, Bank2,post adoption period)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
S2	**0.0686*** **	**0.0700*** **	**0.0700*** **	**0.0699*** **	**0.0724*** **	**0.0821*** **	**0.0898*** **
	(3.3644)	(3.4375)	(3.4375)	(3.4322)	(3.5374)	(4.1032)	(4.4921)
HIGH SESIMIC RISK	**0.3563*** **	**0.3403*** **	**0.3403*** **	**0.3397*** **	**0.4680*** **	**0.5113*** **	**0.4972*** **
	(6.4817)	(6.1777)	(6.1777)	(6.1847)	(8.1376)	(8.7108)	(8.4599)
S2_HSR	**0.0016**	**0.0045**	**0.0045**	**0.0042**	**0.0027**	**-0.0003**	**0.0005**
	(0.0297)	(0.0807)	(0.0807)	(0.0765)	(0.0498)	(-0.0057)	(0.0090)
LN_AMOUNT	-0.1002***	-0.0998***	-0.0998***	-0.0996***	-0.0972***	-0.0994***	-0.0944***
	(-22.8317)	(-22.7114)	(-22.7114)	(-22.8295)	(-22.1927)	(-22.8108)	(-21.5045)
LN_OTHER_LOANS	-0.0192***	-0.0189***	-0.0189***	-0.0193***	-0.0039	-0.0005	-0.0022
	(-3.9511)	(-3.8823)	(-3.8823)	(-4.0206)	(-0.6734)	(-0.0818)	(-0.3780)
LN_PD	0.1808***	0.1808***	0.1808***	0.1807***	0.1808***	0.1775***	0.1871***
	(36.4401)	(36.4293)	(36.4293)	(36.4072)	(35.7280)	(35.0316)	(35.4932)
LN_MATURITY	0.1754***	0.1770***	0.1770***	0.1774***	0.1717***	0.1639***	0.1667***
	(18.5916)	(18.7436)	(18.7436)	(18.7494)	(18.1737)	(17.3902)	(17.7608)
G_IND PROD	-1.1071	0.6885	0.6885		1.5243	1.7773	2.3688*
	(-0.8987)	(0.5446)	(0.5446)		(1.1976)	(1.3940)	(1.8713)
ASSET_GROWTH		-1.3470***	-1.3470***	-1.3006***	-1.5042***	-1.4502***	-1.3447***
		(-5.8806)	(-5.8806)	(-5.7377)	(-6.4951)	(-6.2589)	(-5.8098)
LEND_RATES				-0.0258			
				(-0.5077)			
CONSTANT	7.3506***	7.3399***	7.3399***	7.3850***	7.1827***	7.1835***	6.9729***
	(82.5650)	(82.4019)	(82.4019)	(61.2625)	(74.5743)	(71.0317)	(68.9385)
OBSERVATIONS	11,185	11,185	11,185	11,185	11,185	11,061	11,061
FIRM SEGMENT FE	No	No	No	No	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BANK FE	No	No	No	No	No	No	Yes
FIRM ATECO FE	No	No	No	No	No	Yes	Yes
PROVINCE FE	No	No	Yes	Yes	Yes	Yes	Yes
R-SQUARED (ADJ)	0.438	0.440	0.440	0.440	0.449	0.465	0.470

Table 2.12 reports loan-level regressions which estimate the moderating effect of the staging classification, together with other control or independent variables, on the spread applied to corporate clients. The dependent variable is the natural logarithm of the Loan Spread at transaction level. The main independent variables of interest are the interactions between *S2* - dummy identifying clients with previous stage2 exposures within the 12 months prior to the loan origination - and the presence of high seismic risk dummy *(S2_HSR)*. Specification (1) is the focus, while the others aim to check the model robustness by testing the coefficients stability through the inclusion of new control variables within the specification. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT_FE*), facility type *(LOAN TYPE FE),* guarantee type (*GUARANTEE FE),* bank *(BANK FE)*, firm's sector *(SECTOR_FE)* and the firm's residence province *(PROVINCE_FE)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2.7 APPENDIX

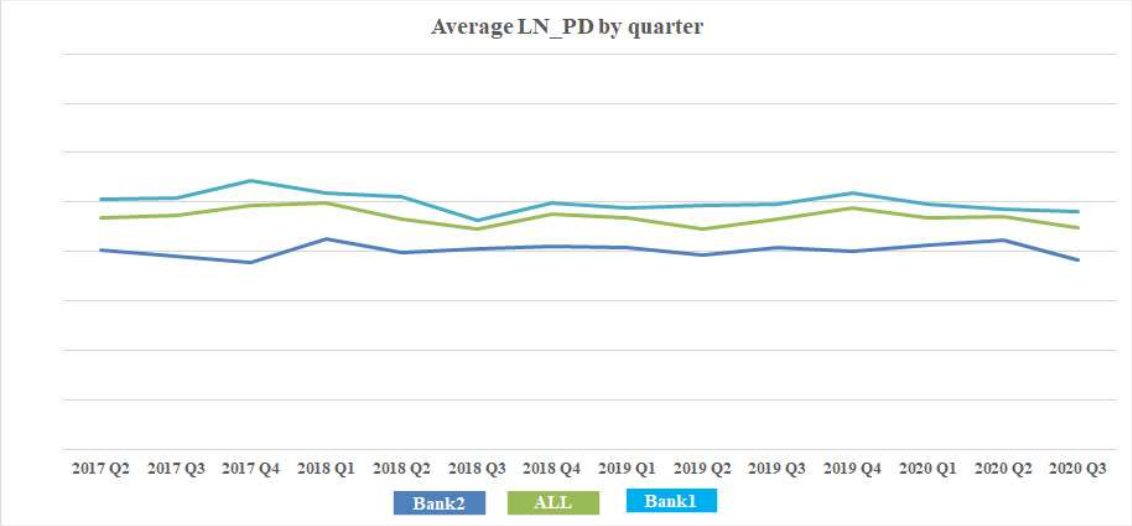

Figure 2.1 Average LN_PD evolution by quarter and by Bank and in total

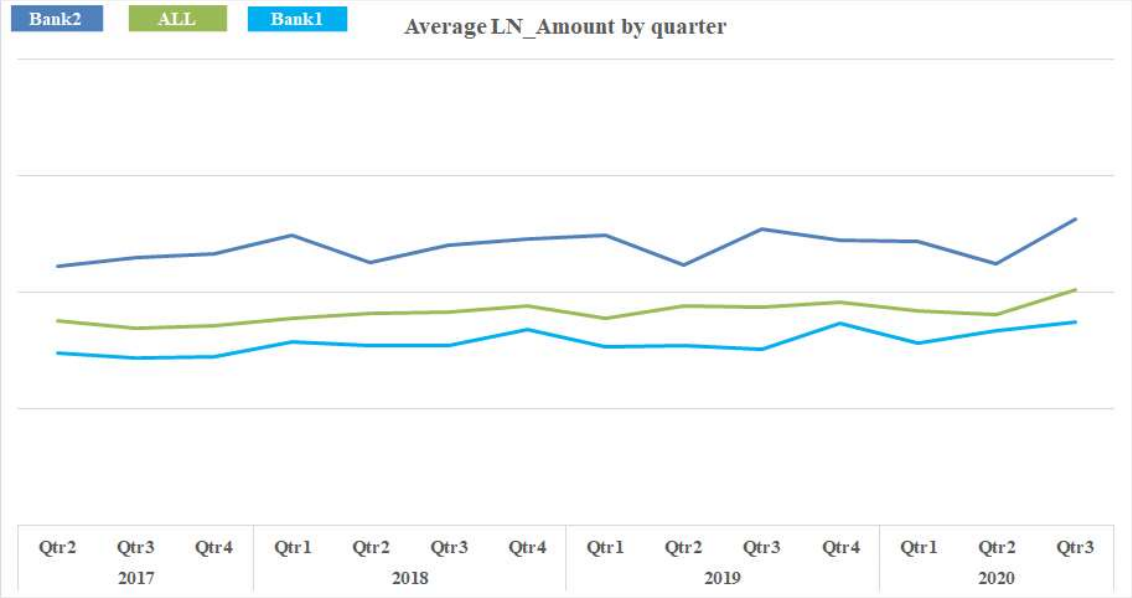

Figure 2.2 Average LN_Amount evolution by quarter and by Bank and in total

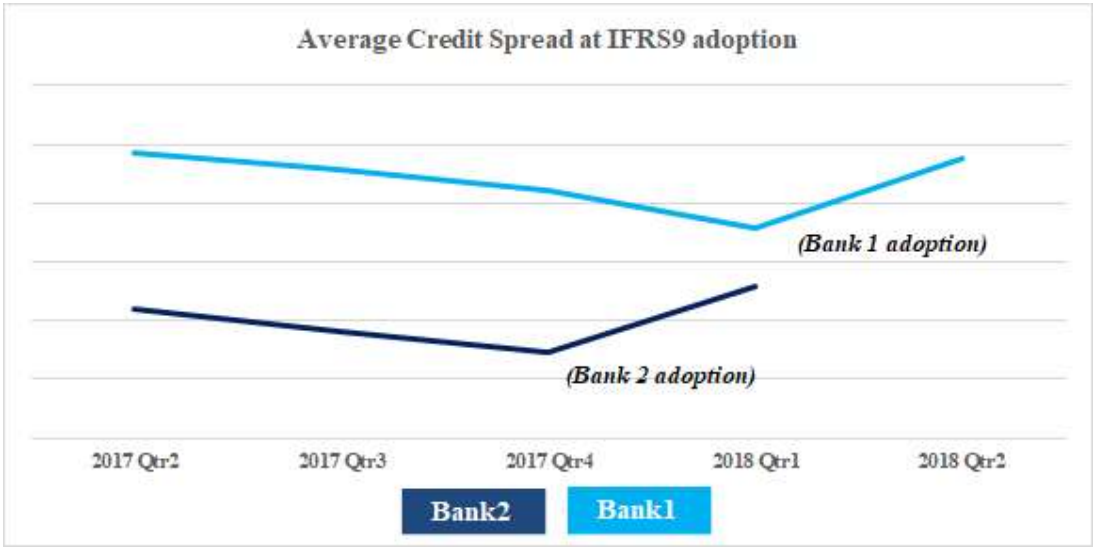

Figure 2.3 Average credit spread evolution by quarter and by Bank in proximity of the IFRS 9 managerial adoption. Unsecured Loans to non-investment grade clients (PD higher than 5.8%)

Table 2.14 The effects of the post-IFRS 9 adoption on corporate loan spread**.** Difference in difference approach (DID). In the hypothesis that BANK2 adopts the reform at the end of the third quarter 2017.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)				
	Panel B (data of Bank1, Bank2) pre Bank1 adoption period			
	(1)	(2)	(3)	(4)
POST	0.1996***	0.2450***	0.2454***	0.2273***
	(2.7985)	(3.3636)	(3.3689)	(3.3289)
POST_BANK2	-0.1951*	-0.2164**	-0.2174**	-0.2067**
	(-1.8432)	(-2.0324)	(-2.0414)	(-2.0062)
BANK2_PD	0.1702***	0.1682***	0.1684***	0.1697***
	(11.4184)	(11.3187)	(11.3279)	(11.5551)
POST_PD	0.0485***	0.0487***	0.0486***	0.0455***
	(4.1083)	(4.1296)	(4.1249)	(4.0293)
POST_BANK2_PD	**-0.0308**	**-0.0293**	**-0.0292**	**-0.0273**
	(-1.3920)	(-1.3280)	(-1.3255)	(-1.2559)
BANK2	0.6282***	0.6442***	0.6468***	0.6662***
	(7.9462)	(8.0883)	(8.1185)	(8.5353)
G_IND_PROD		-7.2104***	-7.2317***	-6.4706***
		(-3.3562)	(-3.3658)	(-2.9889)
LN_AMOUNT	-0.0566***	-0.0567***	-0.0568***	-0.0620***
	(-10.5773)	(-10.5982)	(-10.6121)	(-12.1670)
ASSET GROWTH	-0.0839	-0.3237	-0.3489	-0.4982
	(-0.1180)	(-0.4501)	(-0.4852)	(-0.7216)
LN_OTHER_LOANS	-0.0208***	-0.0207***	-0.0207***	-0.0211***
	(-3.0898)	(-3.0775)	(-3.0693)	(-3.5004)
LN_PD	0.0963***	0.0962***	0.0960***	0.0949***
	(10.5786)	(10.5628)	(10.5418)	(10.8772)
LN_MATURITY	0.0017	0.0036	0.0041	0.0040
	(0.1157)	(0.2514)	(0.2867)	(0.2847)
LEND_RATES	-0.2158*			
	(-1.7634)			
CONSTANT	7.3693***	6.9897***	6.9874***	7.0498***
	(30.2978)	(76.9814)	(76.9478)	(81.9989)
OBSERVATIONS	7,089	7,089	7,089	7,014
FIRM SEGMENT FE	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes	Yes	Yes
BANK FE	Yes	Yes	Yes	Yes
FIRM ATECO FE	No	No	No	Yes
HQ FE	No	No	Yes	Yes
R-SQUARED (ADJ)	0.432	0.433	0.433	0.470

Table 2.14 reports the results of the difference in difference approach. The dependent variable is the natural log of Loan Spread at transaction level *(LN_SPREAD)*. The main independent variable of interest is *(POST_BANK2_PD),* representing the effect of the post introduction of the accounting reform in 2018 *(POST)* on the log of the PD *(LN_PD)* for the bank that firstly adopts IFRS 9 in the managerial processes *(BANK2_PD)*. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT*), facility type *(LOAN TYPE),* guarantee type (*GUARANTEE),* bank *(BANK FE)*, firm's sector *(SECTOR)* and the bank's Headquarters province *(HQ)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significant the 1%, 5%, and 10% levels, respectively.

Table 2.15 The effects of the post-IFRS 9 adoption on corporate loan spread**.** Difference in difference approach (DID). In the hypothesis that BANK2 adopts the reform at the end of the second quarter 2017.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)				
	Panel B (data of Bank1, Bank2) pre Bank1 adoption period			
	(1)	(2)	(3)	(4)
POST	-0.0129	0.0841	0.0854	0.1066
	(-0.1671)	(1.1003)	(1.1167)	(1.4542)
POST_BANK2	-0.1057	-0.1157	-0.1173	-0.1574
	(-0.9721)	(-1.0637)	(-1.0790)	(-1.4878)
BANK2_PD	0.1621***	0.1629***	0.1632***	0.1697***
	(8.6294)	(8.6787)	(8.6931)	(9.0490)
POST_PD	0.0173	0.0174	0.0175	0.0205
	(1.3289)	(1.3338)	(1.3422)	(1.6192)
POST_BANK2_PD	**-0.0125**	**-0.0131**	**-0.0132**	**-0.0196**
	(-0.5455)	(-0.5705)	(-0.5757)	(-0.8720)
BANK2	0.6127***	0.6238***	0.6271***	0.6804***
	(6.3907)	(6.5081)	(6.5402)	(7.1009)
G_IND_PROD		-8.2945***	-8.3135***	-7.8604***
		(-4.2113)	(-4.2205)	(-3.9815)
LN_AMOUNT	-0.0568***	-0.0568***	-0.0569***	-0.0621***
	(-10.5638)	(-10.5768)	(-10.5912)	(-12.1232)
ASSET GROWTH	-0.0386	-0.2700	-0.2887	-0.5571
	(-0.0775)	(-0.5455)	(-0.5835)	(-1.1520)
LN_OTHER_LOANS	-0.0213***	-0.0212***	-0.0211***	-0.0215***
	(-3.1741)	(-3.1575)	(-3.1491)	(-3.5696)
LN_PD	0.1071***	0.1071***	0.1068***	0.1020***
	(9.4472)	(9.4457)	(9.4186)	(9.0187)
LN_MATURITY	0.0038	0.0037	0.0042	0.0043
	(0.2653)	(0.2593)	(0.2937)	(0.3114)
LEND_RATES	-0.8775***			
	(-4.5831)			
CONSTANT	8.6635***	7.0534***	7.0505***	7.0919***
	(23.0925)	(74.0543)	(74.0061)	(79.4561)
OBSERVATIONS	7,089	7,089	7,089	7,014
FIRM SEGMENT FE	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	Yes	Yes	Yes	Yes
BANK FE	Yes	Yes	Yes	Yes
FIRM ATECO FE	No	No	No	Yes
HQ FE	No	No	Yes	Yes
R-SQUARED (ADJ)	0.431	0.431	0.431	0.468

Table 2.15 reports the results of the difference in difference approach. The dependent variable is the natural log of Loan Spread at transaction level *(LN_SPREAD)*. The main independent variable of interest is *(POST_BANK2_PD),* representing the effect of the post introduction of the accounting reform in 2018 *(POST)* on the log of the PD *(LN_PD)* for the bank that firstly adopts IFRS 9 in the managerial processes *(BANK2_PD)*. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT*), facility type *(LOAN TYPE),* guarantee type (*GUARANTEE),* bank *(BANK FE)*, firm's sector *(SECTOR)* and the bank's Headquarters province *(HQ)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significant the 1%, 5%, and 10% levels, respectively.

Table 2.16 The effects of the post-IFRS 9 adoption on corporate loan spread**.** Difference in difference approach (DID). Propensity score matching. In the hypothesis that BANK2 adopts the reform at the end of the third quarter 2017.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)				
	Panel B (data of Bank1, Bank2) pre Bank1 adoption period			
	(1)	(2)	(3)	(4)
POST	0.1825***	0.2821***	0.2823***	0.2782***
	(3.3966)	(5.2338)	(5.2388)	(5.2352)
POST_BANK2	-0.2129***	-0.2549***	-0.2554***	-0.2304***
	(-2.7590)	(-3.2902)	(-3.2974)	(-3.0099)
BANK2_PD	0.1428***	0.1408***	0.1409***	0.1410***
	(11.6038)	(11.4082)	(11.4176)	(11.5946)
POST_PD	0.0356***	0.0369***	0.0368***	0.0370***
	(3.9721)	(4.1155)	(4.1132)	(4.1991)
POST_BANK2_PD	**0.0119**	**0.0127**	**0.0127**	**0.0157**
	(0.7740)	(0.8257)	(0.8268)	(1.0362)
BANK2	0.6528***	0.6813***	0.6827***	0.7088***
	(10.1885)	(10.5650)	(10.5857)	(11.1257)
G_IND_PROD		-14.443***	-14.459***	-14.444***
		(-9.5807)	(-9.5917)	(-9.6028)
LN_AMOUNT	-0.0871***	-0.0869***	-0.0869***	-0.0865***
	(-20.7536)	(-20.7084)	(-20.7175)	(-20.6121)
ASSET GROWTH	-1.5435***	-2.1680***	-2.1832***	-1.9989***
	(-2.9900)	(-4.1072)	(-4.1369)	(-3.8146)
LN_OTHER_LOANS	0.0003	-0.0000	0.0000	-0.0002
	(0.0731)	(-0.0057)	(0.0046)	(-0.0490)
LN_PD	0.1059***	0.1051***	0.1050***	0.0999***
	(15.3327)	(15.1786)	(15.1651)	(14.6176)
LN_MATURITY	0.0410***	0.0456***	0.0458***	0.0485***
	(5.0708)	(5.6094)	(5.6355)	(5.8925)
LEND_RATES	-0.7761***			
	(-7.9267)			
CONSTANT	8.4325***	7.0569***	7.0557***	6.9653***
	(43.6148)	(100.8589)	(100.8471)	(97.1198)
OBSERVATIONS	14,082	14,082	14,082	14,082
FIRM SEGMENT FE	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	no	no	no	Yes
BANK FE	Yes	Yes	Yes	Yes
FIRM ATECO FE	Yes	Yes	Yes	Yes
HQ FE	No	No	Yes	Yes
R-SQUARED (ADJ)	0.510	0.511	0.511	0.515

Table 2.16 reports the results of the regressions performed in Table2.10 where the sample has been matched by banks based on a propensity score exact matching procedure. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT*), facility type *(LOAN TYPE),* guarantee type (*GUARANTEE),* bank *(BANK FE)*, firm's sector *(SECTOR)* and the bank's Headquarters province *(HQ)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significant the 1%, 5%, and 10% levels, respectively.

Table 2.17 The effects of the post-IFRS 9 adoption on corporate loan spread**.** Difference in difference approach (DID). Propensity score matching. In the hypothesis that BANK2 adopts the reform at the end of the second quarter 2017.

DEPENDENT VARIABLE: LOAN SPREAD (LOG)				
	Panel B (data of Bank1, Bank2) pre Bank1 adoption period			
	(1)	(2)	(3)	(4)
POST	-0.1684***	0.0327	0.0335	0.0336
	(-2.9264)	(0.5666)	(0.5811)	(0.5915)
POST_BANK2	-0.0362	-0.1448*	-0.1460*	-0.1297
	(-0.4273)	(-1.6964)	(-1.7102)	(-1.5268)
BANK2_PD	0.1605***	0.1561***	0.1563***	0.1543***
	(9.4841)	(9.1563)	(9.1691)	(9.1770)
POST_PD	0.0055	0.0053	0.0054	0.0048
	(0.5558)	(0.5414)	(0.5500)	(0.4893)
POST_BANK2_PD	**-0.0003**	**0.0022**	**0.0021**	**0.0070**
	(-0.0192)	(0.1213)	(0.1146)	(0.3885)
BANK2	0.5957***	0.6760***	0.6778***	0.7096***
	(7.1768)	(8.0992)	(8.1215)	(8.6199)
G_IND_PROD		-17.8536***	-17.8722***	-18.0891***
		(-11.4928)	(-11.5043)	(-11.6920)
LN_AMOUNT	-0.0888***	-0.0880***	-0.0881***	-0.0875***
	(-21.0893)	(-20.9083)	(-20.9173)	(-20.7866)
ASSET GROWTH	1.8287***	0.4159	0.4052	0.4153
	(5.0372)	(1.1631)	(1.1334)	(1.1690)
LN_OTHER_LOANS	0.0022	0.0003	0.0004	-0.0000
	(0.4753)	(0.0737)	(0.0845)	(-0.0037)
LN_PD	0.1166***	0.1169***	0.1167***	0.1120***
	(13.5449)	(13.5363)	(13.5211)	(13.2063)
LN_MATURITY	0.0316***	0.0404***	0.0406***	0.0435***
	(3.9465)	(5.0302)	(5.0542)	(5.3558)
LEND_RATES	-1.4627***			
	(-10.2605)			
CONSTANT	9.8904***	7.2064***	7.2048***	7.1094***
	(35.9329)	(99.5773)	(99.5691)	(96.8829)
OBSERVATIONS	14,082	14,082	14,082	14,082
FIRM SEGMENT FE	Yes	Yes	Yes	Yes
LOAN TYPE FE	Yes	Yes	Yes	Yes
GUARANTEE TYPE FE	no	no	no	Yes
BANK FE	Yes	Yes	Yes	Yes
FIRM ATECO FE	Yes	Yes	Yes	Yes
HQ FE	No	No	Yes	Yes
R-SQUARED (ADJ)	0.507	0.508	0.508	0.512

Table 2.17 reports the results of the regressions performed in Table2.10 where the sample has been matched by banks based on a propensity score exact matching procedure. Fixed effects are used to control for: the firm's size based on the turnover segments *(SEGMENT*), facility type *(LOAN TYPE),* guarantee type (*GUARANTEE),* bank *(BANK FE)*, firm's sector *(SECTOR)* and the bank's Headquarters province *(HQ)*. Refer to Table 2.A1 for definitions of variables. Robust *t*-statistics are reported in brackets. ***, **, and * indicate significant the 1%, 5%, and 10% levels, respectively.

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CHAPTER THREE:

IFRS 9 AND LOAN-TO-VALUE: EVIDENCE FROM RETAIL BANKING

ABSTRACT

We investigate the nexus between the interest rates charged to bank borrowers and loan-to-value (LTV). Using a unique dataset on mortgage applications from a major European bank (2017-2020), we test whether reporting entities change resource allocation in response to a new accounting rule (*real effect hypothesis*) by exploiting the mandatory IFRS 9 adoption in 2018 as a laboratory setup. We first find evidence of a tightening of loan-to-value in retail banking, suggesting that its introduction increases the LTV-related costs compared to its predecessor (IAS 39). Second, we demonstrate that the staging classification drives the tightening in LTV. For bank borrowers with previous underperforming exposures, increasing LTVs might become proportionally more expensive. Finally, we show that underperforming borrowers are exposed to further LTV reductions when they apply for mortgages with higher maturity and higher climate-related risks. Our findings provide important implications since the extensive staging downgrades create the conditions for credit crunch phenomena.

Keywords: Accounting for financial instruments; Real effects of accounting; IFRS 9; Loan Loss Provisioning, Loan-to-Value, Mortgage Loans, Climate risk, Seismic Risk, Flood Risk, Landslide risk

3.1 INTRODUCTION

Within the mortgage banking sector, Loan-to-Value (calculated as the ratio between the amount of the loan and the appraisal value of the property at origination) has a pivotal role. It is the most widely used indicator for measuring financial leverage in the USA and around the world (Bian et al. 2018). By accepting a certain LTV level, commercial banks define the amount of leverage permitted for a client.

From an academic perspective, LTV is highly relevant to a number of significant fields. Firstly, it is a central parameter for financial risk management and capital requirements calculation (Calem and LaCour-Little, 2004), and consequently it has direct impact on the growth of the mortgage market. Secondly, as Lang et al. (2020) recall in their study of trends in residential real estate lending standards, LTV has relevant implications for financial stability. In fact, regulators often adopt LTV as a macroprudential policy tool to increase the resilience of households and banks and to reduce systemic risk. Lastly, LTV is a central parameter in investment decisions by homeowners, such as refinancing or reducing investments (see Campbell 2006, Melzer 2010). A recent literature[52]: Kinghan & al. (2019), Allen et al. (2017), Lang et al. (2020), Cunha et al. (2009) has contributed to explain the main drivers of the LTV. The determinants highlighted by the authors are generally linked to the following factors: loan and property characteristics, macroeconomic and lender conditions, and other borrower and risk characteristics.

In our work, we empirically analyze the mortgage data of a major European bank at the origination date in the period from 2017 to 2020 and we show that, besides the determinants

[52] See Table A2 in the appendix

already identified by the recent literature, the new IFRS 9 accounting risk classification[53] adopted in 2018 has a significant impact on mortgage LTV levels. In fact, the IFRS 9 reform represents a disruptive event for the banking industry with evident impacts on retail credit risk management practices, particularly evident in the circumstances of the Covid-19 global pandemic.[54]

The sample adopted to conduct the analysis comprises 24,247 mortgage exposures. The dataset contains the following lender information: risk characteristics (individual and transaction specific), loan characteristics (transaction specific), and borrower characteristics (individual specific). The dataset has been complemented with public information related to macroeconomic, market and lender variables (country, industry, or bank specific). Leveraging on this dataset, we performed analyses to shed light on the role of fundamental features explaining the level of LTV over the entire period, as well as post the IFRS 9 reform.

Our empirical analysis on the entire period shows that in the post-reform period, the lender tightened LTV standards thus increasing costs compared with the previous accounting regime (IAS 39). Our evidence is consistent with the hypothesis that European banks may have tightened their lending standards in response to the higher cost of lending (especially for high-risk clients) due to the introduction of the new accounting requirements.

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[53] The general approach of the IFRS 9 reform that entered into force in 2018 is to recognize loan loss provisions (LLPs) based on a three-stage process where the deterioration in credit quality of a loan is properly reflected as follows: stage 1 covers performing loans for which LLPs are calculated as 12 months expected credit losses. Stage 2 covers underperforming loans for which LLPs are calculated as lifetime expected credit losses, stage 3 covers impaired loans for which LLPs are calculated as lifetime expected credit losses.

[54] In 2020, potential real effects of IFRS 9 attracted the attention of capital markets and banking regulators. Considering the Covid-19 emergency, EU Authorities (EBA, ESMA, ECB) made statements urging the avoidance of procyclical effects of the IFRS 9 reform on the industry. ECB (2020) stated: *"In order to mitigate volatility in institutions' regulatory capital and financial statements stemming from IFRS 9 accounting practices in the current context of extraordinary uncertainty, we recommended that banks ii) avoid excessively procyclical assumptions in their IFRS 9 models to determine their provisions."*

In this sense we expect banks to incorporate the new accounting risk classification in their credit risk management policies and to allocate capital consistently with the new risk profile of their clients.

Our empirical analyses focused on the post-IFRS 9 reform period (2018-2020) suggest that the tightening (LTV reduction) has been driven by the accounting risk classification. In fact, LTV reduction is associated with clients having previously underperforming exposures (stage 2) applying for mortgages with higher maturity. Furthermore, we also observe that, in the post-reform period, increasing the LTV is proportionally more expensive for clients with previously underperforming exposures. These conclusions support the thesis that banks, in response to the reform adoption, consistently modified their risk appetite and adopted mechanisms to discourage mortgage origination for clients, properties and durations, that became too risky and expensive in light of the new standard.

We also performed additional analyses with the goal of understanding how and to what extent the adoption of the IFRS 9 reform produces effects on the management of climate-related risks. In fact, in the recent years both regulators[55] and supervisors[56] recently pushed to enhance the consideration of climate-related risk factors in all relevant stages of the credit process from the

[55] From a European perspective, on December 2019 the EBA released an action plan that will require banks to include ESG factors in their risk management policies. As set out in the following *EBA Guidelines on loan origination and monitoring* (May 2020 final report and June 2019 the consultative version) *"Institutions should take into account the risks associated with ESG factors on the financial conditions of borrowers, and in particular the potential impact of environmental factors and climate change, in their credit risk appetite, policies and procedures"*. In the same guidelines the regulator highlights the importance of including accounting allowances measures in banks' credit risk policies and procedures determination: *"Institutions should set out, in their credit risk policies and procedures, the criteria for identifying, assessing, approving, monitoring, reporting and mitigating credit risk, and the criteria for measuring allowances for both accounting and capital adequacy purposes. Institutions should document the framework and update it regularly"*.

[56] In May 2020, the ECB issued a guide for banks on climate-related and environmental risk management. The guidance included assessing the potential impact of climate-related and environmental factors on market risk positions and future investments, developing stress testing scenarios and evaluating the benefit of including stress testing into baseline and adverse scenarios for those institutions with material climate-related and environmental risks.

origination to the accounting classification and it is particularly interesting to investigate potential moderating effects on the relation between climate-related risk factors and LTV due to IFRS 9 adoption. In this context we performed additional analyses covering the interconnection of the IFRS 9 reform with climate-related risks in explaining LTV levels: the first analysis refers to the entire period, and the second focuses on the post-IFRS 9 reform period. To perform the above-mentioned analyses, we have complemented the dataset with public information related to three main categories of physical risks within the broader category of climate risk: landslide and flood risk of the property (source: local public Agency[57]), seismic risk of the property (source: local public Agency).

Our additional analysis conducted on the entire period (2017-2020), that includes both pre- and post-IFRS 9 reform data, suggests that a higher climate risk exposure of the property (i.e. seismic, landslide and flood risk) negatively affects LTV levels in line with the thesis that climate risk factors are included in the lending decision process (Nguyen et al., 2020; Jiang et al., 2020; Ouazad and Kahn 2021). Our additional analysis of the post-IFRS 9 reform period (2018-2020) shows that lower LTV levels are associated to clients with previously underperforming exposures (stage 2) applying for mortgages originated to purchase properties in areas exposed to higher climate risk and that the staging classification has moderating effects on the relation between LTV levels and physical risks.

The first basic and immediate contribution of this work is towards the debate on the real effects of accounting. In fact, it contributes to the question of whether considerations related to the reporting of financial statements do affect real corporate decisions (Kanodia 2007). This empirical

[57] A public entity mainly dedicated to research in the field of environmental protection.

work can contribute to the literature on the impact of the accounting regulation on the lending decisions of retail banks. This research can also contribute to the modern debate, present in literature, on the role of accounting as messenger or contributor to the economic cycle, with particular emphasis on the behavior of the banking industry.

The second contribution, related to the policy implications, is twofold. On the one hand, this work can have micro-prudential policy implications on the determination of regulatory capital. On the other hand, this study can have macroprudential policy implications given the use (by many jurisdictions all over the world) of LTV limits in the mortgage market, aimed at increasing the resilience of households and banks and at reducing systemic risk. On the macroprudential policy implications, it is worth noting that the analysis of the effectiveness of the accounting rules on LTV levels is of fundamental importance for regulators. Knowing the interconnection between staging classification and LTV levels can help authorities to set up new macroprudential tools in the jurisdictions where LTV limits are missing or to better recalibrate existing ones. The micro-prudential policy implications relate to the impacts of LTV levels on financial risk management metrics and therefore on the amount of economic capital that banks require to cover their credit risk (Calem and LaCour-Little, 2004). In this context, it is interesting to understand whether the IFRS 9 accounting regulation, through its interconnection with lending standards and particularly with LTV, can play a role in determining the capital requirement and in assessing the riskiness of the credit portfolio[58].

The third contribution relates to the role of LTV as a significant element in the investment decisions making of homeowners. Knowing the interconnection between staging classification and

[58] This paper can also contribute to understand if the staging classification is a credit risk relevant information (i.e., banks are using staging information to determine LTV levels to clients).

the amount of leverage in the mortgage market can reveal the implications of accounting on household finance decision making. In fact, by influencing the leverage level of the mortgage market, the accounting regulation could exacerbate the collateral-based approach of retail banking, with relevant and significant business implications.

Finally, the paper contributes to the recent literature on the climate-related risk management practice and explores potential interconnections with the new accounting regulation. We add to this literature by showing that banks attempt to include climate-related risks in their lending practices and that the staging classification has moderating effects on the relation between LTV levels and physical risks.

The rest of the paper is organized as follows. In Section 3.2, we provide the institutional background of the IFRS 9 reform, we review the literature that inspires this research, and we present the research question and the hypotheses development, in Section 3.3 we present the mortgage dataset and the empirical models used to perform the research. Section 3.4 reports the results of the regressions performed to test the target hypotheses and the robustness checks with the additional analyses on climate risk. Conclusions are provided in Section 3.5.

3.2 INSTITUTIONAL BACKGROUND, RELATED LITERATURE, AND HYPOTHESES DEVELOPMENT

3.2.1 INSTITUTIONAL BACKGROUND

In response to the subprime crisis of 2007-2009, the International Accounting Standards Board (IASB)[59] invested in developing rules for financial instrument valuation. The transition from IAS 39 (*"Financial Instruments: Recognition and Measurement",* old standard) to IFRS 9 ("*Financial Instruments*", new standard) has been a radical change for the banking industry. For commercial banks, the new Loan Loss Provisioning[60] (LLP) mechanism under IFRS 9 is a revolutionary approach to measuring and recognizing expected losses with potential real effects on banks' credit price and non-price terms. The IFRS 9 project is initially part of the IASB's and FASB's joint initiative. Eventually, the Boards agreed to common principles for measuring the impairment of loans and receivables but diverged on the timing[61] of their recognition. The IASB issued the first exposure draft of a new accounting principle on financial instruments (Exposure Draft ED/2009/7 Financial Instruments: Classification and Measurement) in July 2009, but the final version of IFRS 9 was released only in July 2014.[62] IFRS 9 replaced IAS 39 "*Financial Instruments: Recognition and Measurement"* and was effective for annual periods beginning on or after January 1, 2018. Earlier application was permitted. The new standard aimed to simplify the accounting for financial

[59] International Accounting Standards Board (IASB) is the body responsible for issuing international accounting standards.
[60] Loan loss provisions (or credit provisions) are those that banks set aside to take account of the likelihood that some loans may not be repaid in full.
[61] The FASB's new impairment standard is effective for SEC filers for years beginning on or after December 2019 (with early adoption permitted one year earlier), and one year later for other entities.
[62] IASB issued two preceding versions of IFRS 9 (2009 and 2010) that should have been effective on 1 January 2013 and on 1 January 2015, respectively. Given the critiques and the intense debate on some of the new rules, the IASB decided to postpone the effective dates of both IFRS 9 (2009) and IFRS 9 (2010), and then it made some further changes to the standard that resulted in the IFRS 9 (2014 version).

instruments and address perceived deficiencies that were highlighted by the financial crisis. The IFRS 9 reform simplifies most of the elements of IAS 39, particularly those related to LLP calculations, by introducing a staging classification based on credit quality.

The general approach of IFRS 9 is to recognize loan loss provisions based on a three-stage process where the deterioration in credit quality of loan is properly reflected as follows: (i) **Stage 1** covers loans that have not deteriorated significantly in credit quality since initial recognition or (where the optional low credit risk simplification is applied) that have low credit risk. LLPs are calculated as 12 months expected credit losses. (ii) **Stage 2** covers loans that have deteriorated significantly in credit quality since initial recognition (unless the low credit risk simplification has been applied and is relevant), but that do not have objective evidence of a credit loss event. LLPs are calculated as lifetime expected credit losses. (iii) **Stage 3** covers loans that have objective evidence of loss at the reporting date.[63] LLPs are calculated as lifetime expected credit losses.

3.2.2 RELATED LITERATURE

The paper is related to the literature around the debate over whether accounting choices and disclosures have a real effect on the decision-making process of the firms. Kanodia and Sapra (2016) sustain that measurement and disclosure have a significant effect on the real decisions that firms make (i.e., the real effects hypothesis[64]). While according to Kanodia (2007) a part of the literature is convinced that accounting measurement and disclosure do not actually affect capital market pricing and corporate decisions, a relevant literature supports the real effects hypothesis. Specifically, Graham et al. (2005) indicate that financial statement reporting considerations do

[63] Unlike clients with previous exposure in stage 2, retail clients with prior exposures in stage 3 are unlikely to access to additional loans from banks.

affect real corporate decisions. Biddle and Hilary (2006) report evidence that investment efficiency is improved by the accounting quality, since it reduces information asymmetry between managers and capital providers. Bird et al. (2020) in their empirical research on the real effects of accounting standards provide evidence that standard setting matters and has economically significant real effects. However, with regard to the banking industry, the empirical evidence of such effects is not conclusive (Leuz and Wysocki, 2016).

3.2.2.1 Determinants on Loan-to-value

The study of the main determinants of the LTV is the goal of a recent literature aimed at exploring the implications of macroprudential policies on residential real estate lending standards and relevant implications for financial stability. According to Kingham et al. (2019) most of the research around LTV determinants is aimed at assessing the effectiveness of macroprudential policies based on LTV limits and is generally adopting macro data for the goal (Allen et al. 2017). This is particularly evident in Lang et al. (2020) who propose there to be a significant relationship between lending standards, macro-financial indicators and macroprudential policy action for euro area banks between 2016 and 2018. Within the stream of the literature that is examining the household behavior including micro[65] data, we highlight Cunha et al. (2009) who show, in their study of the Dutch mortgage industry, that outstanding LTVs are driven by borrower characteristics, life-cycle effects, and loan characteristics.

[65] Kingham et al. (2019) select employee status, income quartiles, borrower age, property type, property region, the interest rate and loan term applying to the loan at origination as well as controls for the month of origination to explain the LTV origination.

3.2.2.2 LTV and investments decisions

In his study on investment decisions in the household sector, Campbell (2006) illustrates how Loan-to-Value at origination is a significant element in investment decision making. The author refers to the option to refinance a fixed rate mortgage that can occur when households must pay a fixed rate that greatly exceeds the current level of mortgage rates. The author observes that when interest rates fall, the LTV level can influence the decision to refinance the mortgage. Refinancing may consist of reductions in the monthly installment with the same residual debt or maintaining the same installment but increasing the residual debt. According to Greenspan and Kennedy (2005), this practice could have impacts on consumer spending. Melzer (2010), in his empirical work on the effects of mortgage debt overhang, explains how LTV levels and in particular those levels that can generate debt overhang (which occurs in case of negative equity, i.e., the property value drops below the mortgage balance, or the minimum equity value) can reduce investments by homeowners. High LTVs expose homeowners to default risk, since they are facing a debt overhang that reduces their incentive to invest in their property. The author shows that debt overhang as represented by LTV levels plays an important role in household financial decisions[66]. According to the author, the decrease in home investments starts at loan-to-value of 80-100% and continues as loan-to-value rises. Empirical literature (Foote et al., 2008; Campbell and Cocco 2011) shows that the likelihood of future default begins to rise around 80% loan-to-value and accelerates from there.

[66] Melzer (2010): "as negative equity homeowners cut back substantially on home improvements and mortgage principal payments. At the same time, these households do not reduce spending on physical assets that the homeowner may retain in default, including vehicles and home-related durables (appliances and furnishings). Even higher income and wealthier homeowners, who appear financially unconstrained, reduce improvements and principal payments when they are in a negative equity position.".

3.2.2.3. LTV and credit risk

Calem and LaCour-Lit (2004) explain that, in their simulation on capital requirement for mortgage loans (for a portfolio composed of geo-diversified and prime loans), a loan with an LTV of 95% requires three times as much capital as a loan with an LTV of 80%. In terms of probability of default, for mortgages with a high LTV ratio, mortgage default is more sensitive to changes in collateral values (Stroebel 2016). According to Melzer (2010) a homeowner's probability of default should accelerate at or around the point where combined mortgage balances exceed the home value, a fact that is roughly confirmed by Foote et al. (2008), who shows that default rates rise when equity falls below 15% of the mortgage balance (corresponding to an 87% loan-to-value)". Bian et al. (2018) in their empirical work explain that, as the LTV ratio increases, credit risk escalates. Both in terms of probability of default and in terms of loss given default (LGD). A higher LTV increases the probability of negative equity so that defaults become more likely. Qi and Yang (2009) find that loss given default is positively related to the LTV ratio (see also Bang and Park, 2013). Cowan and Cowan (2004) explain that the type and the level of collateralization has impacts on default correlation. In their empirical study on the determinants of the LGD, Qi and Yang (2009) have studied a large set of historical loan-level default and recovery data of high Loan-to-Value residential mortgages. They show that within the list of the characteristics associated with higher LGD there is the loan amount and the property value. In line with this conclusion, it is worth mentioning that most studies find a strong relation between LTV and recovery rates (Calem and LaCour-Little, 2004; Pennington-Cross, 2003). Moreover, many empirical works recognize that high LTV levels generate significant risk of default (Melzer 2010; Foote et al 2008; Bian et al. 2018). Furthermore, in relation to the type of property, high LTV levels have impacts on the default correlation (Cowan and Cowan 2004).

3.2.2.4 LTV and Macro-prudential policies

In recent years, policy makers have adopted macroprudential tools to enhance the resilience of the financial system (Lim et al., 2013). Given the riskiness of the mortgage market during the subprime crisis, the adoption of macroprudential limits on mortgage lending has become more frequent. As highlighted by Kinghan et al. (2019), limits on borrower leverage are introduced through loan-to-value, loan-to-income, or debt service ratio restrictions (Cerutti et al., 2017; Lim et al., 2013). The goal of these measures is to enhance the ability of banks and borrowers to resist shocks and adverse scenarios. Kinghan et al. (2019) analyze whether macroprudential limits on LTV recently introduced in Ireland had effects on the borrowing behavior of first time-homebuyers. They find that *"LTVs fell by approximately 1.4 percentage points after the measures, with larger reductions recorded for high income borrowers"*. Allen et al. (2017) studied macroprudential policies introduction in Canada using a microsimulation model of mortgage demand of first-time homebuyers. The authors find that policies limiting Loan-to-Value ratio have a larger impact on demand than policies limiting the debt-service ratio. Furthermore, LTV policies more successfully reduce default compared with income-based policies. In their theoretical work, Armstrong et al. (2019) simulate the introduction in New Zealand of macroprudential policies. They find that LTV policy is effective at reducing house price inflation by limiting the credit-fueled housing demand channel. In line with the previous authors, Ho and Zu (2016) develop a theoretical study to simulate the introduction in Canada of macroprudential policies. They find that LTV limits can produce different distributional consequences compared with loan to income limits.

3.2.3 TESTABLE RESEARCH QUESTIONS

Within the general topic of the real effects of accounting regulation, accounting impact on banks is a highly debated topic. The literature on the real effects of accounting is significant in the investment banking and capital market sector. Nevertheless, considering the recent introduction of the IFRS 9 reform, a research gap on the impacts of accounting on commercial banking seems to have appeared. With respect to the relation between accounting and commercial banking, research seems concentrated on financial stability and on procyclicality of provisioning and earnings management. However, the effects of accounting changes on banks' Loan-to-Value levels applied to mortgage clients appears to be insufficiently researched. In particular, the recent adoption of IFRS 9 principles in 2018 represents a substantial area of study to check the potential real effects of accounting on commercial banking. Within the broader question of the real effects hypothesis of accounting (see Kanodia 2007), we assess if the IFRS 9 reform is affecting the behavior of commercial banks by producing real effects on the mortgage credit market in terms of Loan-to-Value allowed to clients. Following Leuz and Wysocki's (2016) call for more empirical study on the real effects of accounting rules, and given the change imposed by IFRS 9 on the LLP model, we pose the following research question:

RQ: Does the IFRS 9 change in loan loss provisioning method affects commercial banks' lending decisions?

The recent adoption of IFRS 9 principle in 2018 represents a major change in accounting rules and offers the opportunity to investigate empirically the real effects of accounting and the commercial banking sector is, in our opinion, an interesting setting. To cope with the complexity of the empirical analysis and the institutional differences of the banking businesses, in answering RQ1, we focus on the lending decisions related to the retail segment and particularly to the

mortgage loans. Furthermore, we would like to assess if IFRS 9 accounting reform is affecting lending decisions by changing the conditions (Loan-to-Value) to access credit for mortgage applicants. The implementation of the IFRS 9 reform has been complex for the European banking industry. The post-reform timeframe and particularly the post Covid period has been characterized by a growing cost of credit and by uncertainty in the application of the staging classification standards. In this context, it is reasonable to suppose that European banks may have increased the cost of LTV, in response to the higher cost of lending due to the introduction of the new accounting requirements. On the other hand, we tend to exclude significant changes in the lending standards prior to the reform introduction due to anticipation effects of the IFRS 9. This is particularly evident by considering that the SSM in its thematic review on IFRS 9 of November 2017 (very close to the deadline for the first-time adoption) explain that: *"As expected, the implementation of the new standard is a major challenge and institutions are making a considerable effort to be adequately prepared for the first application date".* At that time, according to the Supervisor, the most challenging aspects of the IFRS 9 implementation, within the european banking industry, was the implementation of the new ECL framework. In fact, the major difficulties originated from the application of the significant increase of credit risk mechanism that requested a new role of risk management, data availability and expert judgement for accounting purposes, for which strong governance and clear internal processes would have to be in place. In the case of the LTV determination, we make the following hypothesis:

(H0): after the adoption of the IFRS 9 reform there is a tightening of the Loan-to-Value levels allowed to clients. Particularly, in the post-IFRS 9 period, the effect of the interest rate on LTV is less strong than in the pre-IFRS 9 period. Ceteris paribus, increasing the LTV

becomes proportionally more expensive in comparison to the previous accounting regime (IAS 39).

Testing H0 is important to preliminary explore if the accounting reform introduction is associated with a period of structural changes in the bank's credit practice, that we are going to analyze in the following hypothesis H1, where we directly test if the new parameters introduced with IFRS 9 (stage 2) are affecting the lending standards. If the reform is having real effects on the credit market, we expect that the clients affected by the reform are those classified in stage 2 (for loan loss provisioning purposes, stage 2 exposures require the estimation of the entire residual life expected credit loss). More broadly, we refer to the clients that experienced at least one exposure classified in stage 2 in the 12 months preceding the origination. In fact, under the new accounting classification rules, these underperforming borrowers are reasonably considered to be riskier and more expensive exposures. It is worth emphasizing that, under the new IFRS 9 regime, banking practices have also adopted some "significant increase of credit risk" triggers (determining the stage 2 classification) at a client level, with the effect of potential stage 2 contamination to all client-related exposures. In this context it is likely that previous stage 2 exposures could attract newly originated transactions in the following reporting periods. This is in line with the thesis that banks, in response to the reform adoption, coherently modified their risk appetite and adopted mechanisms to discourage mortgage origination for clients, properties and durations, too risky and too expensive in light of the new standard (McKinsey 2017). In this sense we expect banks to incorporate the new accounting risk classification in their credit risk

management policies and to allocate capital according[67] to the new risk profile of their clients. Consistent with these considerations we formulate the following hypothesis:

(H1): within the post-reform period, clients with previous stage 2 transactions, in the 12 months preceding the origination, are penalized in terms of LTV. For these clients, there is a tightening (LTV reduction) proportional to the mortgage maturity. For these underperforming borrowers the effect of the interest rate on LTV is less strong and, ceteris paribus, increasing the LTV becomes proportionally more expensive in comparison to the performing borrowers.

Of course, the two hypotheses are connected and not mutually exclusive: we suppose that the LTV tightening, associated to the post-IFRS 9 reform, is due to the adoption of tighter leverage levels (LTVs reduced and more expensive) to the new transactions originated by clients that already experienced previous stage 2 exposures.

[67] On an aggregate perspective, recent literature on the IFRS 9 impacts on the economic cycle (Gaffney and McCann, 2018; Ertan, 2019; Loew et al. 2019) give evidence that the adoption of the ECL accounting models can increase the stock of provisions and reduce the credit amount.

3.3 DATA AND METHODS

3.3.1 DATA

Our analysis is developed on a unique dataset that covers the lending of a significant European bank in a recent period (2017 - 2020). The Bank's data refer to the microeconomic characteristics of the new mortgages originated in the target period. In particular, the bank's data include information related to four areas: (1) loan characteristics: loan purpose, loan interest rate, property value, property location, loan maturity, etc. (2) borrower characteristics: residence, occupation, etc. (3) risk characteristics: accounting risk indicators (e.g., presence of previous stage 2 transactions), borrower income, other loans outstanding, borrower's age, number of the borrower's family members, etc. Furthermore, information on a fourth area of analysis has been retrieved from public sources, i.e. (4) Macroeconomic, mortgage market and lender conditions: Euribor, inflation rate, local mortgage interest rate, etc. With the goal of performing additional analyses on the relation between accounting classification and climate risk, this dataset has been complemented with public information regarding physical risk exposure of the property (see 5.4.3). The final dataset that collects the private and public data is presented in the Table 3.A1. In the following paragraph we present more details on the information collected for the IFRS 9 accounting risk classification.

3.3.1.1 Key variables of interest: staging classification

The accounting risk indicators analyzed in this paper are relevant to the adoption of the IFRS 9 reform. As already mentioned, the general approach of the IFRS 9 reform that entered into force in FY 2018 is to recognize loan loss provisions based on a three-stage process reflecting a deterioration in credit quality. According to the reform, each new performing loan originates in

stage 1 and only after breaching some specific underperforming triggers, the transaction can be classified as stage 2. The deterioration of the exposure to stage 3 derives from the emergence of impairment losses. The rationale is to correlate the loan loss provisions to the staging classification, since stage 2 and stage 3 require higher provisions compared with stage 1 loans.

To analyze the lending standards applied by the bank at the granting phase, we are interested in understanding if the client originating the new mortgage has at least one prior exposure classified in stage 2. In fact, under the new accounting classification rules, stage 2 transactions have a higher cost of credit provisions, hence clients with previous transactions in stage 2 at the time of application are considered riskier by the lenders. For our research, we recognize those situations based on a dummy variable (*S2*) that identifies clients with previous stage 2 exposures in the 12 months before the origination date.

3.3.1.2 Determinants of LTV in the pre-adoption period

We developed a baseline OLS regression model to explain the leverage levels (in terms of LTV) of the mortgage market following the literature that examines the household behavior using micro data (Kinghan et al. 2019). In fact, the baseline model explains Loan-to-Value levels based on information related to creditworthiness, loan, and borrower characteristics, while controlling for market conditions, macroeconomic and lender conditions. Within the baseline analysis we explore the potential relationship between mortgage Loan-to-Value and climate-related risk indicators.

The baseline model is defined as follows:

$$LTV_{it} = \beta_0 + \beta_R' R_{it} + \beta_L' L_{it} + \beta_B' B_{it} + \beta_M' M_t + u_{it} \quad (1)$$

In equation (1) the dependent variable is the Loan-to-Value (*LTV*), which is the ratio between the amount of the loan and the appraisal value of the property granted to a client at time t of origination,

while the regressors can be grouped in the following set: i) R is the set of risk variables, including accounting risk indicators (individual and transaction specific); ii)

- L is the set of loan characteristics variables (transaction specific);
- B is the set of borrower characteristics variables (individual specific); and
- M is the set of macroeconomic, market and lender condition variables (country, industry, or bank specific variables).

Within the set of risk variables (R) explaining the *LTV* levels of equation (1), we include the log of the borrower income *(LN_INCOME)* and his age *(AGE)* to reflect the repayment capacity of the debtor (Kinghan & al., 2019; Allen et al., 2017; Cunha et al., 2009). Furthermore, in line with credit risk management practice and with the pertinent literature, we also control for the presence of other credit exposures as recorded at a central registry level (*OTHER_LOANS*) and with the number of the borrower's family members (*NUM_FAMILY*). The presence of additional debt at industry level is potentially worsening the debt affordability (Varetto, 1999) and negatively relates with the LTV levels; on the other hand, a high number of family members generally corresponds to higher levels of family indebtedness (Cosma, 2016) and so it is supposed to negatively relate with LTV levels.

Within the set of loan characteristics (L), in line with the literature (Kinghan & al., 2019; Lang et al., 2020; Cunha et al., 2009), the main variables of interest are: the log of the interest rate paid by the client (*LN_INT_RATE*) and the term of the loan (*MATURITY*), both expected to have positive relation with LTV. In fact, higher LTVs are more expensive and require longer durations to be affordable for borrowers. Furthermore, following Cunha et al. (2009) we also include the log of the appraisal value of the property (*LN_VAL_PROP*), because financing high values properties generally relates, in credit risk management practice, with lower LTV ratios. According to the

literature, we also control for the fixed effects of the Loan purpose (*LOAN_PURPOSE FE*), since we expect different association with the LTV of the possible objectives of the mortgage request (e.g., refinancing, advance, first mortgage etc.).

On the set of other borrower characteristics (B) that explain the LTV levels, according to the literature (Kinghan & al., 2019; Cunha et al., 2009), we have included the fixed effects related to the type of occupation of the primary borrower (*BORROWER JOB FE*).

For macroeconomic, market and lender condition variables (M), according to the literature (Allen et al. 2017), we control for the log of the 3 months Euribor (*LN_EURIBOR*), and for the variation of the property price index (one quarter lag) in the local market (*G_HPI_L1*). We expect market interest rate levels to negatively relate to the amount of leverage in the credit market, while the growth of the house price index has the opposite relation.

Table 3.1 – Panel A presents summary standardized statistics for our key variables. Our sample includes 24,247 originated mortgages for properties located in all the national territory. The average borrower in the sample borrows 67% of the property's appraisal value.

In our sample, almost 80% of the mortgages are issued after the introduction of the IFRS 9 reform, which came into effect from January 2018. Table 3.1 – Panel B provides a detailed breakdown of the average exposure, the average Loan-to-Value and the average interest rate for the periods before and after the introduction of the IFRS 9 reform. We note that, on average, in the post-reform period sample, the LTV granted by the lender to its clients increases in absolute value (see Table 3.1, Panel B) by 3.8%, the interest rate charged to clients reduces by 30 basis points, while the average loan amount remains substantially stable.

If we focus on the statistics of the post-reform period, we note that the bank charges higher interest rates to clients with stage 2 loans in the previous 12 months. Table 3.1 – Panel C provides further information regarding this breakdown.

Regarding climate-related risks, it is worth noting that 45% of the mortgages in the sample are granted to applicants buying or renovating real estate located in provinces with a non-zero physical risk exposure. Table 3.1 - Panel D provides a detailed breakdown. We note that the bank grants below-average LTV levels in higher landslide risk areas and charges higher interest rates in higher seismic risk areas.

3.3.2 INTEREST RATES, LOAN-TO-VALUE, AND IFRS 9 ADOPTION

With the objective to test (H0), we define an indicator variable, dummy period *(DT_t),* that is adopted to test the potential moderating effect of the dummy in question on the relation between the interest rate paid by the client and the LTV. The dummy in question is defined as:

$$DT_t = \begin{cases} 1 & if\ the\ application\ time\ t\ falls\ under\ the\ period\ after\ the\ IFRS\ 9\ reform\ (Jan\ 18) \\ 0 & if\ the\ application\ time\ t\ falls\ under\ the\ period\ preceding\ the\ IFRS\ 9\ reform\ (Jan\ 18) \end{cases} \quad (2)$$

By introducing the dummy period variable under the (H0) hypothesis, the regression (1) changes as follows:

$$LTV_{it} = \beta_0 + \beta_R' R_{it} + \beta_L' L_{it} + \gamma_L' (L_{it} dt_t) + \beta_B' B_{it} + \beta_M' M_t + u_{it} \quad (3)$$

To test the above-mentioned hypothesis (H0) we analyze the sign and the significance of the coefficients associated to the interest rate applied to the borrowers within the group of variables (L) in the equation (3). Given the hypothesis that banks, after the accounting reform, charge higher interest rates to provide the same LTV levels allowed, ceteris paribus, in the previous accounting regime, we expect a negative sign of the variable coefficient indicating the interaction between the

interest rate paid by the client and IFRS 9 introduction *(DT_LN_INT).* We deem as unrealistic the hypothesis that the post-IFRS 9 reform tightening is applied regardless of the transaction characteristics.

It is worth noting that the change of the lending standards represents a regime effect[68], which is not indicating itself a nexus of causality with the IFRS 9 adoption. However, testing H0 is important to preliminary explore if the accounting reform introduction is associated with a period of structural changes in the bank's credit practice, that we are going to analyze in the following hypothesis H1, where we directly test if the new parameters introduced with IFRS 9 (stage 2) are affecting the lending standards.

3.3.3 THE IMPLICATIONS OF THE STAGING CLASSIFICATION ON BANK BORROWERS

In order to test (H1), we define a new dummy stage variable (*S2*), in the sample after the reform period (2018-2020) as:

$$S2_t = \begin{cases} 1 & if\ the\ clien\ \ has\ transactions\ in\ stage\ 2\ in\ the\ 12\ month\ \ \ before\ the\ origination \\ 0 & if\ the\ client\ does\ not\ have\ transactions\ in\ stage\ 2\ in\ the\ 12\ mont\ \ \ \ before\ the\ origination \end{cases} \quad (4)$$

By introducing the dummy stage variable under (H1) hypothesis, the baseline regression (1) changes as follows:

$$LTV_{it} = \beta_0 + \beta_R' R_{it} + \beta_L' L_{it} + \gamma_L' (L_{it} S2_t) + \beta_B' B_{it} + \beta_M' M_t + u_{it} \quad (5)$$

We suppose that the introduction of $S2_t$, that indicates this group of underperforming clients, can moderate the relation of the loan characteristics variable with the LTV. In fact, the new equation (5) presents potential interaction coefficients of *S2* with the loan characteristics variables (γ_L'). Given the hypothesis of more expensive LTV for underperforming clients (*S2*) and of an LTV

[68] i.e., a set of structural economic conditions that exist for a certain period (Verbeek, 2012)

reduction for those *S2* clients exposed to long-term maturities, we expect that the interactions of (S2) with the term of loan (*S2_MATURITY*) and with log of the interest rate (*S2_LN_INT*) are both significant and negative. It is worth noting that the reduction of the LTV due to (*S2*) represents an IFRS 9 reform treatment.

3.4 RESULTS

3.4.1 MAIN RESULTS: THE DETERMINANTS OF THE LOAN-TO-VALUE IN THE PRE-ADOPTION PERIOD AND THE IMPLICATIONS OF THE IFRS 9 INTRODUCTION ON BANK BORROWERS

Following the model in equation (3), Table 3.2 reports the results of the baseline regressions of the Loan-to-Value levels for the sample of the mortgages originated. The choice of the regressors is inspired by the recent literature (Kinghan & al., 2019; Allen et al., 2017; Lang et al., 2020; Cunha et al., 2009). The dependent variable is the Loan-to-Value and the main independent variable of interest is *DT_LN_INT* which is defined as the interaction between the interest rate applied to the loan transformed into logarithmic form (*LN_INT*) and the dummy variable identifying loans originated after the introduction of IFRS 9 (*DT*). In Table 3.2, the specification in the first column is the baseline model regression, while the other columns are used to evaluate the significance of the main independent variable and its robustness to a wide range of controls.

The most relevant evidence observed in the regression (2) is that the coefficient of the interaction variable, between the post-reform period and the natural logarithm of the interest rate charged by the bank (*DT_LN_INT*), has a negative sign and is statistically significant. This coefficient estimates the moderating effect of the post-IFRS 9 period on the relation between LTV and Interest rate paid by the client.

With regard to (H0), we cannot reject the relevant hypothesis since we find significant relation between LTV and interest rate paid by the client in the post-reform period. In the post-reform period, there is statistical evidence that the lender charges, ceteris paribus, proportionally higher

interest rates for the same Loan-to-Value increase allowed in the previous accounting regime (IAS 39).

In relation to the other independent or control variables, our results in regression (1) are broadly in line with what the recent literature observes, more specifically the sign of the coefficients of the variables are in line with those reported in prior literature. Specifically, we estimate negative relation of the LTV with the age of the borrower, the number of borrower's family members, the presence of other loans outstanding for the borrower, the level of the market interest rates and the value of the property. We estimate positive relations of the LTV with: the contractual interest rate, the borrower's annual income, the maturity of the loan and the growth of house price index (one quarter lag). As represented in the robustness checks chapter (5.1.2), these relations are robust to a wide range of additional controls, including macroeconomic and market conditions, other loan and borrower characteristics and other fixed effects (see Table 3.2, columns: 2, 3). In terms of magnitude, according to the results in regression (2) Table 3.2, we observe that the coefficient *LN_INT_RATE* which applies in the pre-reform period (0.0350) is 1.09 times the coefficient that applies in the post-reform period (0.0350-0.0029); which means that the increase of LTV associated to a unit increase of interest rate in the post-reform period produces 0.92 times the increase associated with the pre-reform period. In terms of magnitude, according to the most conservative results of Table 3.2, we observe that a one standard deviation increase in the property value (on the average value), is associated with a 5.7% reduction on the average LTV. Marginal effects on the linear prediction of LTV of the variables of interest are reported in Figure 3.1 in the Appendix.

3.4.2. ROBUSTNESS CHECKS

To check the robustness to additional controls, we identify for each area of interest a set of additional controls that we include in the regressions presented in Table 3.2 to test H0.

Within the set of additional controls on the borrower characteristics (B), we also control for the flag indicating if the borrower deposits his salary on a current account of the lender (*SALARY_DEPOSIT*). In fact, this circumstance enhances the commercial relationship lender-borrower and positively relates with LTV levels allowed to clients. We also control for the flag indicating that the client is new, according to the commercial segmentation of the bank (*NEW_CLIENT*). That is due to the fact that, given the level of the competition in the retail banking market, banks often offer more favorable lending conditions to attract new clients.

Within the set of risk characteristics of the transaction (R), we also control for the duration of the borrower's working experience (*YEARS_WORKING*). Within retail banking, a longer working history correlates to an improved client default risk scoring.

Within the set of additional controls related to the characteristics of the loan (L), we also control for the flag indicating if the contractual rate of the loan is variable (*VARIABLE_RATE*), since such loans are generally more suitable to receive higher LTV. In this set of additional controls, according to the literature (Cunha et al., 2009), we also include the macro geographical area of the client residence (*GEO_FE*).

On the additional controls related to macroeconomic, market and lender conditions (M), we also control for the quarterly growth of the total assets of the bank (*G_ASSET*) which normally correlates with growth in the bank's overall leverage. In this set of additional controls, according to the literature (Allen et al., 2017; Lang et al., 2020), we also include the average spread applied

in the mortgage domestic market (*AVERAGE_SPREAD*). We expect the average domestic spread to positively relate to the leverage level allowed by the bank. We also control for the variable *COVID* which is the flag indicating the period after the adoption of the state credit measures introduced to tackle the Covid emergency, even if the public measures were mainly dedicated to sustaining the actual debtors rather than the origination of new mortgages.

As reported in Table 3.2, the coefficient of *DT_LN INT* is still significant and negative also in case of additional controls as in regressions (3) and (4). It is evident that the moderating effect of the post-reform period on the relation between LTV and Interest rate paid by the client is robust to a wide range of controls.[69]

3.4.2.1 Sensitivity analysis

We perform sensitivity analyses with the aim to test the robustness of our findings, particularly to check whether the heterogeneity of the sample, pre- and post-reform, drives the results of our model in accepting H0 (*DT_LN_INT_RATE* coefficient is positive and significant). In particular, we apply the two-sample t-test and the Wilcoxon signed rank test to check the significance of possible differences in the means and ranked medians of each independent variable in the sample pre- and post-IFRS 9. The t-test and Wilcoxon signed rank test reject the null hypothesis of equality in the means and in the ranked medians of the two populations, for some of the variables under consideration (see, respectively, Table 3.3 and Table 3.4). For each independent variables that failed the test (*AGE, LN_INT_RATE, MATURITY*), we estimate the same LTV regression adopted to check H0 (regression 2,Table 3.2) on two sub-samples: the one

[69] It is worth mentioning that in a specification containing both moderating effects (*DT_LN_INT*) and fixed effects (*DT*), the mean VIF goes above 10 and the marginal VIF of the two variables both go above 70, owing to collinearity. Thus, we are unable to test whether, in the post-IFRS 9 period, there are also fixed time effects on LTV levels.

comprising only the values above and the other comprising only the values below the median. The regressions of the LTV estimated on the samples below and above the median value, produces very comparable[70] parameters (see Table 3.5) and the interaction coefficient *DT_LN_INT_RATE* is always positive and significant.

To check the model stability, we re-perform the baseline model of equation (1) on the sample before the IFRS 9 introduction (see Table 6). We also perform a sensitivity analysis to isolate possible effects due to uncertainty on the IFRS 9 application in the aftermath of the pandemic. Even if public emergency measures were mainly dedicated to sustaining the actual debtors rather than the origination of new mortgages, we repeat our analysis on a subsample that excludes the Covid period (i.e., the period after the introduction of the extraordinary state measures of credit support, see Table 3.7). We also exclude observations of mortgages originated for purposes other than the acquisition of real estate (i.e., cash or investment purposes, see Table 3.8). In all cases we find consistent results after excluding these data.

3.4.2.2 Endogeneity, Reverse causality and simultaneity concerns

As reported in the previous pages, we provide empirical evidence that bank mortgages attract higher interest rates in the post-reform period. In this section, we use a simultaneous equation model (SEM) approach to address potential concerns[71] about reverse causality and simultaneous determination of mortgage interest rates and Loan-to-Value.

For Loan-to-Value, we use equation (3) where the leverage level is explained via the Log of the Interest rate and the other control variables. For Mortgage interest rate we develop a new equation,

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[70] There are only one out of 39 cases of sign inconsistency, where statistically significant parameters estimated above the median have statistically different signs if estimated below.

[71] We follow Chiu et al (2021) that adopt a SEM approach to test simultaneous determination between loan interest rate and debt maturity dispersion in the mortgage banking sector.

with a regression specification in which we include the Loan-to-Value as the explanatory variable and other control variables that are expected to influence the loan price as suggested in the literature. Specifically, Magri & Pico (2010) propose a model that links Mortgage interest rates to the probability of mortgage delinquency and to the value of the mortgaged property. Nevertheless, even if mortgage pricing models usually control for default likelihood (Al-Bahrani & Su, 2015), default risk is not the only information that explains mortgage pricing. This is evident in several authors (Al-Baharani & Su 2015; Chiang et al., 2002; Zhang 2013; Titman et al., 2005; Black et al., 2001) that explain the pricing premium related to credit risk score but also to loan maturity, Loan-to-Value, state unemployment rate and other control variables.

Therefore, our proposed mortgage interest rate equation includes the following variables: loan term (*MATURITY*), Loan-to-Value (*LTV*), credit risk components (*PD, LGD;* respectively the probability of default of the client and the loss given default of the facility), and the log of the property value (*LN_PROP_VALUE*). We also include other control variables in the literature: local occupation rate (*PROV_ OCC*), the flag identifying if the contractual interest rate is variable (*VARIABLE_RATE*), the log of the short-term interest rate level (*LN_EURIBOR*), and the macro geographical area of the client residence (*GEO_FE*).

To estimate the SEM, we use quasi maximum likelihood (QML) with uses maximum likelihood to fit the model but relaxes the conditional normality assumptions when estimating the standard errors. QML handles nonnormality by adjusting standard errors. The technique adopted is robust to heteroskedasticity of the errors. In our SEM approach, all inputs and outputs are observed.

Table 3.15 in the Appendix shows the results of the SEM. We find that for Loan-to-Value and the log of the mortgage interest rates there is no evidence of a bidirectional relation: the LTV coefficient in the *LN_INT_RATE* equation is not significant, while the *LN_INT_RATE* coefficient

in the *LTV* equation is positive and significant. With regard to the control variables in the Log Interest rate equation, we find that most of the control variables are statistically significant, and their signs are consistent with our expectations. Overall, we find that within the LTV equation, the pre-IFRS 9 (*LN_INT_RATE*) effects and the moderating effects of the post-IFRS 9 period in the relation between Interest rate and *LTV* (*DT_LN_INT_RATE*) remain robust, with consistent signs, when we address the endogeneity concerns about reverse causality and simultaneous determination.

3.4.2.3 Selection bias

It is worth explaining that, since the regressions adopted to test our hypotheses are run on households granted with a mortgage, there could be a sample selection problem and the results could be biased. In fact, the sample adopted to test the hypotheses may be a non-random sample if there are variables which also affect the mortgage approval.

In order to handle the potential selection bias, we run a Heckman regression, where we use a dummy for mortgage granted as exclusion restriction. If selectivity exists, then coefficients may not be applicable to all the applicants (granted and non-granted) and need to be corrected.

Firstly, we estimate the select model i.e. the probability of being approved a mortgage (by including in the analysis also the sample of the rejected applications[72] in the same period) as a function of one of the original control variables (*OLD:* dummy that takes value 1 if the age of the client is above 65 years) and one additional identifying variable (*INSTALLMENT_ON_INCOME:* dummy that takes value 1 if the ratio installment/income is above 50%). Subsequently, we correct the outcome regression model on the basis of the results of the select model.

[72] The rejected applications are, in number, approximately 10% of the approved loans.

According to the result of the Heckman regression reported in Table 3.16 in Appendix, the coefficients of the variables in the select model, as expected, have negative sign in the selection equation and so are negatively affecting the probability of being granted a mortgage. Furthermore, the significance and positivity of the lambda term - which suggests that the error terms in the selection and outcome equations are positively correlated - means that factors that make mortgage granting more likely (lower inception/income ratio and lower age) tend to be associated with higher LTV. However, lambda is little and, as evident in Table 3.16, the coefficients of interest in the regression in column (1) (*DT_LN_INT_RATE* and *LN_INT_RATE)* are substantially unchanged if compared with those reported in the regression in column (2) of Table 3.2 (reported for convenience in Table 3.16).

3.4.3 IMPLICATIONS OF THE STAGING CLASSIFICATION AND OTHER TESTS

Following the model in equation (5), the analyses reported in Table 3.9 are aimed at evaluating potential interactions of the stage 2 dummy variable with key characteristics of the exposure. The table reports the result of the regression of the Loan-to-Value levels for all the mortgages originated in the period 2018Q1-2020Q4. The dependent variable is the Loan-to-Value, while the main independent variables of interest are: *S2_MATURITY* and *S2_LN_INT.* These variables are the interactions between *S2* and respectively: the maturity in years (*MATURITY*), and the LN of the interest rate applied to the transaction (*LN_INT_RATE*).

The statistically significant and negative coefficients of *S2_MATURITY* and *S2_LN_INT_RATE* in column (1) suggest that both the loan term and the charged interest rate interact with (*S2*), reducing LTV. These coefficients estimate the moderating effects of the stage 2 variable on the relation between LTV, interest rate paid by the client and loan term.

With regard to (H1), we cannot reject the relevant hypothesis since we find that clients with previous stage 2 transactions, in the 12 months prior to the origination, are penalized in terms of LTV. For these clients the tightening is associated with long-term maturities. For these underperforming borrowers increasing LTVs become proportionally more expensive. As represented in the following part, this *S2* moderating effect is robust to a wide range of additional controls.

In terms of magnitude, according to the results in regression (1) Table 3.9, we observe that every additional year of maturity is associated with an increase in the average LTV by approximately 1.4%, while for *S2* clients the increase in the average LTV associated with every additional year of maturity is 0.9%. We also observe that the coefficient *LN_INT_RATE* which applies for non *S2* clients (0.0474) is 1.65 times the same coefficient that applies for *S2* clients (0.0286). This means that the increase of LTV associated with a unit increase of *LN_INT_RATE* for non *S2* clients produces 1.65 times the increase associated to *S2* clients. Marginal effects on the linear prediction of LTV of the variables of interest are reported in Figure 3.2 in the Appendix.

In order to check the robustness of the test results with regard to H1, we adopt the same set of additional controls to check the robustness of H0 (see 5.1.3). As reported in Table 3.9, the coefficients of *S2_MATURITY* and of *S2_LN INT_RATE* are still significant and negative also in case of additional controls as in the regression (2), (3), (4) and (5) where we also control for S2 potential fixed effects. This means that the moderating effects of the stage 2 variable on the relation between LTV, interest rate paid by the client and loan term are robust to a wide range of controls, encompassing macroeconomic and market conditions, other loan and borrower characteristics and other fixed effects.

We also performed sensitivity analyses to test if the heterogeneity of the sample for S2 and non S2 clients can drive the results of our model in accepting (H1) (*S2_MATURITY* and *S2_LN_INT_RATE* coefficients are negative and significant). We apply the two-sample t-test to check the significance of possible differences in the means of each independent variable. The null hypothesis of equality in the means of the two samples is not rejected for all the variables under consideration (see Table 3.10 and 3.11).

As for testing (H0), we performed a sensitivity analysis by excluding observations of the mortgages originated for purposes other than the acquisition of real estate (i.e., cash or investment purposes, see Table 3.12). In all cases we find consistent results after excluding these data.

As already reported in paragraph 3.4.2.3, since the regressions adopted to test our hypotheses are run on households granted with a mortgage, there could be a sample selection issue and the results could be biased. In fact, the sample adopted to test the hypotheses may be a non-random sample if there are variables which affect the mortgage approval. In order to handle[73] the potential selection bias, we run a Heckman regression, where we use a dummy for mortgage granted as exclusion restriction that we explain with the same variables[74] adopted in 3.4.2.3.

According to the result of the Heckman regression reported in Table 3.17 in Appendix, the coefficients of the variables in the select model, as expected, have negative sign in the selection equation and so are negatively affecting the probability of being granted a mortgage. Furthermore, the significance and positivity of the lambda term - which suggests that the error terms in the selection and outcome equations are positively correlated - means that factors that make mortgage

[73] We follow Magri and Pico (2010) that confronted with a similar situation in their analysis of an Italian portfolio of mortgages granted between 2000 and 2007.

[74] The variables are: *OLD* (dummy that takes value 1 if the age of the client is above 65 years) and *INSTALLMENT_ON_INCOME* (dummy that takes value 1 if the ratio installment/income is above 50%).

granting more likely (lower inception/income ration and lower age) tend to be associated with higher LTV. However, lambda is little and as evident in Table 3.17, the coefficients of interest in the regression in column (1) (*S2_MATURITY* and *S2_LN_INT_RATE*) are substantially unchanged if compared with those reported in the regression in column (1) of Table 3.9 (reported for convenience in Table 3.17).

3.4.4 CLIMATE RISK INCLUSION AND LTV

Thus far, we have explored the effects of the IFRS 9 reform and related staging classification on the relationship between LTV and its traditional determinants identified by the recent literature. In this section, we answer another correlated question: do the changes in the loan loss provisioning method under IFRS 9 produce effects on the management of climate-related risks, i.e., the way banks are considering climate-related risk factors in the determination of their lending standards?

The question originates from the evidence in a significant stream of recent literature[75] (Nguyen et al., 2020; Jiang et al., 2020; Ouazad and Kahn 2021) which empirically supports the claim that climate-related risks are included in lending decisions. With regard to the mortgage sector, if the effects of climate-related risk events manifest over a reasonably long period of time, it is reasonable to think that such events occurring during the lifetime of a mortgage could have a sudden and significant impact on the value of the collateral and consequently have a negative

[75] Garmaise and Moskowitz (2009) show evidence that earthquake risk reduced commercial real estate lending in California in the 1990s; and the more recent study of Nguyen et al. (2020) shows that financial institutions use mortgage pricing as lever to handle sea level rise risk (SLR) on prices of residential properties. The authors analyze loans originated in the U.S. between January 1992 and June 2018 and show an "SLR premium" in the mortgage market. Furthermore, Jiang et al. (2020) in their empirical work, highlight the fact that lenders charge a higher cost of credit for firms exposed to higher SLR risk. Further contribution from Ouazad and Kahn (2021) shows that, "*in the aftermath of natural disasters, lenders are more likely to approve mortgages that can be securitized, thereby transferring climate risk".* On the corporate lending side, Javadi and Masum (2021) find empirical evidence that "*firms in locations with higher exposure to climate change pay significantly higher spreads on their bank loans".* The empirical evidence that climate-related risk influences corporate lending decisions is also in Delis et al. (2021).

contribution on the bank's balance sheet. This would, in turn, impact on lending standards policies. In this context, it is interesting to explore the potential interconnection of the IFRS 9 reform with the way banks are managing climate-related risks in the determination of LTV.

To answer this question, we need to test two additional hypotheses: **(H2) banks include climate-related risks in the LTV determination; (H3) stage 2 classification has moderating effects on the relation between climate-related risks and LTV.**

To perform the supplementary analyses, we have complemented the dataset with public[76] information related to three main categories of climate-related risk at the municipality level: landslide risk, flood risk, and seismic risk.

It is worth emphasizing that the lender and borrowers' country of residence is one of the European countries most affected by landslides[77] where the total area of landslide hazard zones and landslide attention zones is around 20% of the national territory. With respect to flood risk, defined as the risk of temporary covering by water of land not normally covered by water (this includes floods from rivers, mountain torrents, ephemeral water courses, and floods from the sea in coastal areas; Flood Directive 2007/60/EC), the total area of flood hazard zones (medium, low, high probability) is substantial at around 23.3% of the national territory. The seismic risk exposure of the country is also significant. In fact, it is one of the countries with the greatest earthquake risk

[76] The public dataset allows us to measure the risk magnitude, since it contains detailed information for each municipality in the local territory. In particular, through these risk indicators it is possible to provide a fundamental risk information for flood, landslide and earthquakes. To better appreciate the magnitude of these events and consequently the effects for the financial sector, only high-risk indicators are considered in the model. For Landslide Risk, the variable represents the size of the municipality area, expressed in square kilometers, exposed to high landslide hazard. For Flood Risk, the variable represents the size of the municipality area, expressed in square kilometers, exposed to high flood hazard. For the Seismic Risk, the variable identifies the seismic risks by assigning a score from 1 to 4 (with decreasing danger) to each municipality in the national territory.

[77] Herrera et al. 2018; Spizzichino et al. 2013; Van Den Eeckhaut & Hervás, 2012.

due to its geographical position in Europe, with 45% of the surface of the national territory (40% of the total population) exposed to high seismic risk.

With the goal to identify the high-risk provinces, we build specific dummy variables, in two steps: firstly, we aggregate the municipality risk indicators to a province-level; secondly, we assign a value of 1 to provinces that are in the riskiest quartile of the distribution and 0 otherwise. In this way we obtain three dummy variables: *HIGH_LANDSLIDE RISK, HIGH_FLOOD_RISK, HIGH_SEISMIC RISK;* indicating that the location of the mortgaged property is a province ranked in the first quartile of the climate-related risk exposure.

To test (H2) we control the model in equation (3) for the above-mentioned set of climate-related risk indicators to estimate the climate-related risk practice of the bank in the determination of the leverage levels. In fact, given the regulatory attention paid to the management of climate risk and the evidence found in the literature, we expect that the bank is including the climate-related risk factors among the determinants of the LTV. By controlling for the set (E) of the environmental physical risk variables, under (H2) hypothesis, equation (3) changes as follow:

$$LTV_{it} = \beta_0 + \beta_R' R_{it} + \beta_L' L_{it} + \gamma_L'(L_{it} dt_t) + \beta_B' B_{it} + \beta_M' M_t + \beta_P' E_t + u_{it} \quad (6)$$

In order to accept (H2), we expect significant and negative coefficients of the climate risk variables: *HIGH_LANDSLIDE RISK, HIGH_FLOOD_RISK, HIGH_SEISMIC RISK*. We also expect that, by controlling for these variables, the coefficient of *DT_LN INT* remain significant and negative.

To test (H3), we control the model developed in the equation (5) for the set (E) of the environmental physical risk variables: *HIGH_LANDSLIDE_RISK, HIGH_FLOOD_RISK, HIGH_SEISMIC_RISK,* and their related *S2* moderating effects (*S2_HIGH_LANDSLIDE RISK,*

S2_HIGH_FLOOD_RISK, S2_HIGH_SEISMIC RISK). Hence, equation (5) under the (H3) hypothesis changes as follow:

$$LTV_{it} = \beta_0 + \beta_R' R_{it} + \beta_L' L_{it} + \gamma_L'(L_{it} S2_t) + \beta_B' B_{it} + \beta_M' M_t + \beta_P' E_t + \gamma_E'(E_{it} S2_t) + u_{it} \qquad (7)$$

In order to accept hypothesis (H3) we expect significant and negative coefficients of: *S2_HIGH_LANDSLIDE RISK, S2_HIGH_FLOOD_RISK, S2_HIGH_SEISMIC RISK.* We also expect that by controlling for these variables, the coefficients of *S2_MATURITY* and of *S2_LN_INT* remain significant and negative.

As reported in Table 3.13 regression (1), aimed at testing (H2), the coefficients of *HIGH_LANDSLIDE RISK, FLOOD_RISK, SEISMIC RISK* are significant and negative and are robust to all the additional controls in the following regressions (2, 3, 4, 5).

With regard to (H2), we cannot reject the relevant hypothesis since we find significant relation between the LTV and climate-related risk indicators. We find that the bank grants lower LTV levels in geographic areas exposed to higher landslide and seismic risk, while little or no significant relation has been found with the flood risk**.**

In terms of magnitude, according to the results of regression (1) in Table 3.13, we observe that clients, applying for mortgages to buy properties located in areas with high flood risk, are associated with a haircut on LTV of 1.7% that becomes 2.1% in case the property is located in areas exposed to high seismic risk and 1.7% for high landslide risk areas.

As reported in regression (1) Table 3.14, the coefficient of *S2_HIGH_FLOOD RISK,* is significant and negative and is always robust to additional controls (regression 4), while the coefficients of *S2_HIGH_LANDSLIDE _RISK* and *S2_HIGH_SEISMIC RISK* are not significant in the set of reported regressions. Consequently, with regard to (H3), we cannot reject the relevant

hypothesis since we find evidence that lower LTVs are associated with underperforming clients (*S2*) applying for mortgages originated to purchase properties in areas exposed to higher flood risk. The new provisioning method has impacts on the climate risk management practice.

In terms of magnitude, according to the most prudent results of Table 3.14 (regression 4), we estimate that, in the post-reform period, clients with previous stage 2 exposures that apply for mortgages to buy properties located in areas with high flood risk, are associated with a haircut on LTV of 19%. Marginal effects on the linear prediction of LTV of the variables of interest are reported in Figure 3.3 in the Appendix.

3.5 CONCLUSIONS

This paper follows Leuz and Wysocki's (2016) call for more empirical study on the real effects of accounting rules by investigating potential moderating effects of the post-IFRS 9 period on the relation between LTV and its determinants. Despite recent literature (Kinghan & al., 2019; Allen et al., 2017; Lang et al., 2020; Cunha et al., 2009) highlights the main determinants of the leverage level in the mortgage market (LTV), there is currently no evidence that the change in loan loss provisioning method affects commercial banks' lending decisions on LTV.

Using a unique dataset of a major European bank, we show that the post-IFRS 9 reform period, compared with the IAS 39 tenure, is characterized by a tightening of the LTV applied to the local mortgage market. In the post-IFRS 9 reform period, we show that there is statistical evidence that , in comparison to the previous accounting regime, increasing the LTV becomes proportionally more expensive.

Focusing on the post-IFRS 9 reform period, we show that the accounting risk classification drives a targeted LTV tightening. For underperforming clients (*S2*), ceteris paribus, increasing LTVs is more expensive. Furthermore, an LTV reduction is associated with these underperforming clients (*S2*) applying for mortgages with higher maturity. These effects are robust to a wide range of controls, encompassing additional macroeconomic and market conditions, other loan and borrower characteristics.

This paper sheds light on the real effects of the accounting legislation and its interconnection with the prudential supervision of the banking sector. This paper also contributes to testing the real

effect hypothesis in a highly regulated sector where supervisory expectations[78] on climate-related and environmental risks overlap with accounting legislation.

This paper is also the first attempt to estimate the impact of accounting regulation on climate-related risk management practices of banks. We find that the bank grants lower LTV levels in geographic areas exposed to higher landslide, flood and seismic risk, and that, focusing on the post-reform period, lower LTVs are associated to underperforming clients (*S2*) applying for mortgages originated to purchase properties in areas exposed to higher flood risk. In terms of magnitude, all the mentioned effects seem to be material.

This study has important micro- and macro-implications referred to customers, banks, and policymakers. First, the introduction of the IFRS 9 and the related staging classification makes more expensive access to bank loans for underperforming clients (stage 2). Second, as well as becoming a key factor in determining the bank lending policies and risk measurement, such an IFRS 9 adoption smooths the bank risk appetite for underperforming clients, ensuring consistency between credit risk practices and loan loss provisioning. Finally, extensive staging downgrades might create the conditions for credit rationing in more bank-based economies by impairing access to finance for underperforming clients. Overall, our findings highlight the existence of a trade-off between the accuracy of bank risk assessment and access to finance, potentially leading to a higher discretion in loss recognition processes.

[78] ECB, "Guide on climate-related and environmental risks", November 2020

Table 3.A1. List of variables

AREA	VARIABLE	NOTES
TARGET & KEY	*LTV*	Loan amount / property appraisal value (%)
	ORIGIN_DATE	Transaction inception date
	TRANSACTION ID	Transaction ID
	ID	Counterparty ID
LOAN & PROPERTY INFO	*VARIABLE_RATE*	1 if the contractual interest rate is variable, 0 otherwise
	LN_INT_RATE	Log of the contractual interest rate applied to the transaction
	MATURITY	Mortgage maturity measured in years
	PROP LOCATION	Location of the property, province level (dummy)
	LOAN PURPOSE	Mortgage purpose, 3 groups (dummy)
	LN_PROP_VALUE	Log of property value measured in €
RISK INFO	*S2*	1 in case the client has stage 2 transactions in the previous 12 months, 0 otherwise
	AGE	Age of the primary borrower at the origination measured in years
	OTHER LOANS	1 if the borrower has debts in other banks, 0 otherwise
	LN_INCOME	Log of the annual income of the primary borrower measured in €
	NUM FAMILY	Number of borrower's family members
	YEARS WORKING	Borrower's working experience (years)
MACRO, MARKET & LENDER INFO	*LN_EURIBOR*	Log of the 3 months Euribor levels, monthly
	AVERAGE SPREAD	Average mortgage spread in local market, monthly
	G_HPI_L1	House price index local growth, quarterly (1 lag)
	G_ASSET	Bank's total asset growth
	COVID	1 if origin is after Covid public support measures, 0 otherwise
	PROV_OCC	Annual occupation rate at province level
BORROWER INFO	*SALRY_DEPOSIT*	1 if the borrower deposits his salary at the bank, 0 otherwise
	NEW_CLIENT	1 if the client is segmented new, 0 otherwise
	GEO_AREA	Borrower residence, 3 groups (dummy)
	BORROWER_JOB	Borrower occupation, 5 groups (dummy)
CLIMATE RISK INFO	*HIGH_LAND_RISK*	1 if the landslide risk of the province is high (4^{th} quartile), 0 otherwise
	HIGH_SEISM_RISK	1 if the seismic risk of the province is high (4^{th} quartile), 0 otherwise
	HIGH_FLOOD_RISK	1 if the flood risk of the province is high (4^{th} quartile), 0 otherwise

Table 3.A1 reports the list of variables collected at origination. Climate risk info are sourced from local public agencies. Within the Macro & Market info: Euribor levels *(EURIBOR)* and average mortgage spread in local market (*AVERAGE_SPREAD)* are sourced from ECB, lender's asset growth *(G_ASSET)* is a bank-related information, house price index growth in the local market *(G_HPI)* is sourced from OECD, annual occupation rate is sourced from Eurostat. Info of the residual areas: Target and Key, Loan and Property, Risk, Borrower, are bank-related information.

Table 3.A2. Literature of the main LTV determinants/controls in the Mortgage Market

CATEGORY	PROPOSED VARIABLES[79]	PRIOR LITERATURE			
		Cunha et al. (2009)	Allen et al. (2017)	Kinghan & al. (2019)	Lang et al. (2020)
TARGET	*Loan-to-Value*	*	*	*	*
RISK (R)	*Borrower Income*	*	*	*	
	Borrower age	*	*	*	
LOAN & PROPERTY (L)	*Property type*	*	*	*	
	Term of loan	*		*	*
	Property location	*	*	*	
	Loan purpose	*			
	Interest rate paid at origination	*		*	*
	Property value	*			
MACRO, MARKET, LENDER CONDITIONS (M)	*Unemployment/employment rate and its level changes*		*		
	Interest rate level and its level changes				
	Credit market conditions: competition level			*	
	Inflation rate and its level changes				*
	Average interest rates applied by local industry		*		*
	Property price index levels and its variations		*		*
	Bank size		*		
	Bank Capital ratio		*		
BORROWER (B)	*Borrower occupation*	*		*	

[79] In some cases, the mentioned authors adopt proxies of the variables reported.

Table 3.1. Summary Statistics

Panel A: the sample comprises 24,247 mortgages originated during 2017-2020. Panel A presents a short description of the variables used in the main analyses and the summary statistics in terms of standardized quantiles. Panel B provides key statistics of the pre- and post-IFRS 9 period. Panel C provides key statistics of the clients with or without previous stage transactions in the previous 12 months. Panel D provides key statistics of the geo areas with high physical risks. Table A1 provides descriptions of the variables.

Variables		5%	25%	50%	75%	95%
LTV	Loan amount /property value, %	-1.33	-0.83	0.03	0.77	1.54
LN EURIBOR	Log of 3 months Euribor, %	-2.29	-0.49	0.50	0.64	0.77
AGE	Age of the primary borrower, years	-1.47	-0.77	-0.74	-0.70	1.76
NUM_FAMILY	Number of the borrower's family members	-0.76	-0.76	-0.76	0.58	1.91
OTHER_LOANS	1 if the borrower has debts with other banks, 0 otherwise	-0.41	-0.41	-0.41	-0.41	2.42
SALARY_DEPOSIT	1 if borrower deposits his salary at the bank, 0 otherwise	-0.70	-0.70	-0.70	1.43	1.43
LN INCOME	Log of the income of the primary borrower, EUR	-0.38	-0.10	0.11	0.30	0.70
LN INT_RATE	Log of the contractual interest rate	-1.87	-0.56	0.03	0.56	1.49
MATURITY	Loan term, years	-1.64	-0.89	-0.14	0.60	1.35
LN PROP_VALUE	Log of the Value of the property, K EUR	-1.49	-0.66	-0.06	0.57	1.72
G_HPI_L1	House price index growth, one quarter lag	-1.94	-0.39	-0.14	0.50	2.52
NEW_CLIENT	1 if the borrower is a new client, 0 otherwise	-1.14	-1.14	0.87	0.87	0.87
VARIABLE_RATE	1 if the contractual rate is floating, 0 otherwise	-0.83	-0.83	-0.83	1.20	1.20
YEARS WORKING	Borrower's working experience, years	-1.53	-0.22	-0.05	0.27	2.07
G ASSET	Bank's total asset quarterly growth	-1.78	-0.56	0.05	0.80	1.71
AVERAGE_SPREAD	Domestic average spread on mortgages, %)	-1.52	-0.91	0.46	0.82	1.24
HIGH LANDSLIDE_RISK	1 if landslide risk is high (4^{tn} quartile) 0 otherwise	-0.33	-0.33	-0.33	-0.33	2.98
HIGH SEISMIC_RISK	1 if the seismic risk is high (4th quartile) 0 otherwise	-0.63	-0.63	-0.63	1.58	1.58
HIGH FLOOD_RISK	1 if the flood risk is high (4th quartile) 0 otherwise	-0.22	-0.22	-0.22	-0.22	-0.22
PROVINCE OCC	Occupation rate at Province level	-1.85	-0.50	0.46	0.68	0.96
COVID	1 if the origination is after State Covid measures, 0 otherwise	-0.51	-0.51	-0.51	-0.51	1.94

Panel B: *pre- and post-IFRS 9 Distribution*

	Avg Exposure delta (Eur)	Avg LTV delta	Avg Interest Rate delta
Post-IFRS 9 - Pre-IFRS 9	1,503	3.8%	-0.3%

Panel C*: post-IFRS 9 introduction - Clients with stage2 transactions in 12 months prior to origination*

Previous Stage2 transactions	Avg Exposure delta (Eur)	Avg LTV delta	Avg Interest Rate delta
Yes - NO	-3,537	0.0%	0.1%

Panel D: *Physical Risk Distribution*

Physical Risk	Delta vs Avg. Exposure (Eur)	Delta vs Avg. LTV	Delta vs Avg. Interest Rate
SEISMIC RISK	-11,878	-1%	0.13%
LANDSLIDE RISK	7,407	-5%	-0.41%
FLOOD RISK	-1,943	-2%	-0.15%

Table 3.2. The effects of Interest rates on mortgage LTV, pre- and post-IFRS 9 reform

Dependent variable: *Loan-to-value (LTV)*					
	(1)	(2)	(3)	(4)	(5)
DT_LN INT RATE		**-0.0029*** **	**-0.0029*** **	**-0.0031*** **	**-0.0030*** **
		(-5.4718)	(-5.2654)	(-4.9557)	(-5.3888)
LN_INT_RATE	**0.0353*** **	**0.0350*** **	**0.0354*** **	**0.0376*** **	**0.0370*** **
	(16.0527)	(15.5203)	(15.6563)	(15.9920)	(15.5841)
AGE	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(-3.4700)	(-3.3942)	(-3.4494)	(-3.3735)	(-3.3819)
NUM_FAMILY	-0.0077***	-0.0070***	-0.0071***	-0.0067***	-0.0027***
	(-15.1762)	(-13.6000)	(-13.8464)	(-13.2476)	(-3.3081)
OTHER LOANS	-0.0091***	-0.0073***	-0.0080***	-0.0089***	-0.0081***
	(-3.8484)	(-2.9849)	(-3.2399)	(-3.6397)	(-3.2864)
SALARY DEPOSIT			0.0096***	0.0096***	0.0098***
			(5.8190)	(5.8745)	(5.9185)
LN_INCOME	0.0058***	0.0058***	0.0056***	0.0055***	0.0056***
	(10.6797)	(10.6957)	(10.4104)	(10.2006)	(10.3863)
MATURITY	0.0097***	0.0094***	0.0093***	0.0092***	0.0092***
	(62.1390)	(58.6109)	(58.1898)	(57.5043)	(57.3976)
LN PROP VALUE	-0.0758***	-0.0739***	-0.0731***	-0.0724***	-0.0735***
	(-40.1481)	(-38.6751)	(-38.1566)	(-37.8778)	(-37.7455)
G_HPI_L1	0.2743***	0.1990***	0.2141***	0.1750***	0.2040***
	(4.5591)	(3.2917)	(3.3421)	(2.7361)	(3.1225)
VARIABLE RATE				0.0136***	0.0135***
				(7.9923)	(8.0285)
YEARS WORKING				0.0004***	0.0003**
				(2.7488)	(2.3753)
G ASSET			0.0288	0.0191	0.0156
			(0.6540)	(0.4190)	(0.3560)
AVERAGE SPREAD				-0.0014	
				(-0.4011)	
NEW CLIENT		0.0175***	0.0187***	0.0201***	0.0190***
		(10.2834)	(10.8925)	(11.7078)	(10.8225)
COVID				0.0047**	0.0025
				(1.9618)	(0.9279)
PROV OCCUPATION	0.0008***	0.0007***	0.0007***	0.0009***	0.0010***
	(11.8789)	(10.3234)	(10.1643)	(3.7122)	(3.9830)
LN EURIBOR	-0.0613***	-0.0371**	-0.0332*		-0.0385
	(-3.3909)	(-1.9965)	(-1.7849)		(-1.5817)
CONSTANT	1.4301***	1.3885***	1.3786***	1.3204***	1.3481***
	(65.4616)	(61.6925)	(61.0745)	(52.3083)	(48.3091)
OBSERAVTIONS	24,247	24,247	24,247	24,247	24,247
GEO FE	No	No	No	Yes	Yes
BORROWER JOB FE	No	No	No	No	Yes
LOAN PURPOSE FE	yes	yes	Yes	Yes	Yes
R^2 adjusted	0.330	0.334	0.335	0.344	0.346

Table 3.2 reports loan-level regressions which estimate the effect of the selected independent variables on mortgage Loan-to-Value. The dependent variable is *LTV*, which is the ratio between the amount of the loan and the appraisal value of the property at the origination. The main independent variable of interest is *DT_LN_INT RATE* which is the interaction between the interest rate applied to the loan transformed into logarithmic form (*LN_INT RATE)* and the dummy variable identifying loans originated after the introduction of IFRS 9 *(DT).* Refer to Table 3.A1 for variables definition. Fixed effects are used to control for: the borrower's macro-area of residence *(GEO_FE*), the borrower job *(BORROWER JOB_FE)* and loan purpose *(LOAN_PURPOSE FE).* Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.3. Pairwise comparisons of means, pre- and post-IFRS 9, t-test.

Variable	Contrast	p-value
LN INT RATE	0.0797	0.000
AGE	1.1661	0.000
LN INCOME	-0.1718	0.000
MATURITY	-2.0489	0.000
LN PROP VALUE	0.0109	0.212

Table 3.3 reports the results - for each independent variable - of the parametric two-sample t-test to observe any difference between the mean estimated in the sample pre-IFRS 9 reform with the mean estimated in the post-IFRS 9 reform sample. H0 the two-population means are equal.

Table 3.4. Pairwise comparisons of means, pre- and post-IFRS 9, Wilcoxon signed rank test.

Variable	z_statistic	p-value
LN INT RATE	16.194	0.000
AGE	6.270	0.000
LN INCOME	1.049	0.294
MATURITY	-19.25	0.000
LN PROP VALUE	1.017	0.309

Table 3.4 reports the results for each independent variable of the non-parametric Wilcoxon signed rank test to observe any differences in the ranked medians in the two samples: pre- and post-IFRS 9 reform. H0: median of the population of differences between the paired data is zero.

Table 3.5 Sensitivity analysis. The effects of Interest rates on mortgage LTV, pre- and post-IFRS 9 reform. Reported estimates are below and above the median of selected independent variables *(LN_INT_RATE, AGE, MATURITY)*.

Dependent variable: *Loan-to-value (LTV)*						
	Below Log Interest rate Median (1)	Above Log Interest rate Median (2)	Below Age Median (1)	Above Age Median (2)	Below Maturity Median (1)	Above Maturity Median (2)
DT_LN INT RATE	**-0.0017****	**-0.0042*****	**-0.0029*****	**-0.0026*****	**-0.0019*****	**-0.0039*****
	(-2.3034)	(-5.2767)	(-3.7609)	(-3.5146)	(-2.6951)	(-4.6801)
LN EURIBOR	-0.0102	-0.1514***	-0.0006	-0.0680**	0.0153	-0.0693***
	(-0.4366)	(-4.8617)	(-0.0246)	(-2.4203)	(0.5369)	(-2.8436)
AGE	-0.0002*	-0.0004***	-0.0013***	0.0006***	0.0001	-0.0010***
	(-1.9115)	(-3.2215)	(-6.6811)	(3.3499)	(1.3843)	(-7.2087)
NUM FAMILY	-0.0062***	-0.0082***	-0.0085***	-0.0056***	-0.0061***	-0.0080***
	(-9.0311)	(-11.0472)	(-11.9904)	(-7.5465)	(-8.5195)	(-11.1081)
OTHER LOANS	-0.0091***	-0.0007	-0.0153***	-0.0010	0.0033	-0.0195***
	(-3.1167)	(-0.1549)	(-4.1943)	(-0.2976)	(0.9821)	(-5.6210)
LN INCOME	0.0047***	0.0062***	0.0065***	0.0049***	0.0048***	0.0070***
	(5.9296)	(8.6884)	(7.6877)	(7.0460)	(6.8415)	(8.4451)
LN INT RATE	0.0207***	0.0223***	0.0391***	0.0284***	0.0150***	0.0536***
	(5.8206)	(3.7726)	(11.6827)	(9.2623)	(5.0863)	(15.3199)
MATURITY	0.0082***	0.0103***	0.0098***	0.0093***	0.0107***	0.0062***
	(38.0889)	(42.1373)	(45.0178)	(37.0996)	(33.2148)	(18.1665)
LN PROP VALUE	-0.0588***	-0.0911***	-0.0882***	-0.0638***	-0.0664***	-0.0845***
	(-23.7369)	(-30.1545)	(-28.8871)	(-26.3218)	(-28.5920)	(-26.4624)
G HPI L1	0.0468	0.3319***	0.2278***	0.1589*	0.2541***	0.1522*
	(0.6341)	(3.2503)	(2.9213)	(1.7114)	(2.7956)	(1.9001)
NEW CLIENT	0.0180***	0.0143***	0.0157***	0.0174***	0.0173***	0.0151***
	(8.0223)	(5.5371)	(6.4939)	(7.2689)	(7.4869)	(6.1175)
PROV OCCUPATION	0.0001	0.0011***	0.0009***	0.0006***	0.0005***	0.0009***
	(1.4186)	(12.0770)	(9.6444)	(5.8093)	(4.5601)	(9.6543)
CONSTANT	1.2081***	1.5568***	1.5537***	1.2298***	1.1900***	1.6634***
	(39.1267)	(40.5401)	(46.5541)	(38.9683)	(39.1068)	(45.9015)
OBSERAVTIONS	12,613	11,634	12,134	12,113	12,072	12,175
LOAN PURPOSE FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2 adjusted	0.231	0.359	0.347	0.247	0.192	0.269

Table 3.5 reports the results of the same LTV regression (2 of table 2) applied into two sub-samples. For each independent variable, we estimated the same LTV regression on the sample comprising only the values above the median and (2) on the sample comprising only the values below the median (1). Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Refer to Table 3.A1 for definitions of variables. Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.6 Sensitivity analysis. The effects of Interest rates on mortgage LTV in the pre-IFRS 9 reform period.

Dependent variable: *Loan-to-value (LTV)*				
	(1)	(2)	(3)	(4)
LN_INT_RATE	**0.0090****	**0.0071***	**0.0074***	**0.0066**
	(2.1985)	(1.7313)	(1.7982)	(1.6101)
AGE	-0.0006***	-0.0005***	-0.0005***	-0.0005***
	(-3.1598)	(-2.9544)	(-2.6688)	(-2.7184)
NUM_FAMILY	-0.0070***	-0.0061***	-0.0060***	-0.0031
	(-5.9282)	(-5.0915)	(-4.9381)	(-1.6242)
OTHER_LOANS	-0.1241**	-0.1187**	-0.1251**	-0.1289**
	(-2.0686)	(-2.0758)	(-2.1902)	(-2.2856)
SALARY DEPOSIT		0.0097***	0.0090**	0.0094**
		(2.5900)	(2.3902)	(2.4710)
LN_INCOME	0.0053***	0.0051***	0.0051***	0.0052***
	(6.0556)	(5.8479)	(5.7974)	(5.8454)
MATURITY	0.0098***	0.0095***	0.0096***	0.0096***
	(25.8846)	(24.7377)	(24.9676)	(24.9602)
LN_PROP_VALUE	-0.0631***	-0.0619***	-0.0621***	-0.0623***
	(-13.5843)	(-13.3289)	(-13.3275)	(-13.2075)
G_HPI_L1	0.2392	-0.0975	-0.0849	-0.0843
	(0.7878)	(-0.2950)	(-0.2567)	(-0.2546)
VARIABLE_RATE			-0.0022	-0.0022
			(-0.6263)	(-0.6312)
YEARS_WORKING			0.0002	0.0002
			(0.6629)	(0.7469)
G ASSET		0.8550**	0.8468**	0.8339**
		(2.2941)	(2.2823)	(2.2503)
AVERAGE SPREAD	0.0583**	-0.0322	-0.0305	-0.0305
	(2.4580)	(-0.6692)	(-0.6354)	(-0.6347)
NEW CLIENT		0.0200***	0.0211***	0.0208***
		(5.3887)	(5.6809)	(5.3159)
PROV OCCUPATION	0.0010***	0.0010***	0.0004	0.0004
	(6.4372)	(6.3528)	(0.6386)	(0.6700)
CONSTANT	1.0786***	1.1756***	1.1952***	1.1948***
	(19.1769)	(15.3538)	(14.6139)	(14.5124)
OBSERVATIONS	4,912	4,912	4,912	4,912
GEO FE	No	No	Yes	Yes
BORROWER JOB FE	No	No	No	yes
LOAN PURPOSE FE	Yes	Yes	Yes	Yes
R^2 adjusted	0.268	0.274	0.277	0.278

Table 3.6 reports loan-level regressions performed in order to study the baseline model to explain mortgage Loan-to-Value prior to the introduction of the IFRS 9. The dependent variable is *Loan-to-Value*, which is the ratio between the amount of the loan and the appraisal value of the property at the origination. Refer to Table 3.A1 for definitions of variables. Fixed effects are used to control for: the borrower's macro-area of residence *(GEO_FE*), the borrower job *(BORROWER JOB_FE)* and loan purpose *(LOAN_PURPOSE FE).* Robust *t*-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.7 Sensitivity analysis. Pre- and post-IFRS 9 reform. The effects of Interest rates on mortgage LTV for mortgages in the pre-covid period.

Dependent variable: *Loan-to-value (LTV)*					
	(1)	(2)	(3)	(4)	(5)
DT_LN INT RATE		**-0.0031*** **	**-0.0031*** **	**-0.0033*** **	**-0.0033*** **
		(-5.6793)	(-5.5127)	(-5.1908)	(-5.8032)
AGE	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***
	(-4.5118)	(-4.4324)	(-4.4894)	(-4.3798)	(-4.3810)
NUM_FAMILY	-0.0077***	-0.0069***	-0.0070***	-0.0066***	-0.0031***
	(-13.4259)	(-11.9321)	(-12.0891)	(-11.5317)	(-3.2614)
OTHER_LOANS	-0.0098***	-0.0087***	-0.0095***	-0.0102***	-0.0096***
	(-3.6125)	(-3.0778)	(-3.3133)	(-3.5726)	(-3.3425)
SALARY DEPOSIT			0.0083***	0.0082***	0.0084***
			(4.4347)	(4.3882)	(4.4371)
LN_INCOME	0.0057***	0.0057***	0.0055***	0.0055***	0.0056***
	(9.8077)	(9.8139)	(9.6012)	(9.5250)	(9.6978)
LN_INT_RATE	0.0318***	0.0315***	0.0318***	0.0349***	0.0339***
	(13.3633)	(13.0238)	(13.1492)	(13.8653)	(13.3601)
MATURITY	0.0095***	0.0091***	0.0091***	0.0090***	0.0090***
	(55.0804)	(51.7195)	(51.3635)	(50.6091)	(50.5716)
LN_PROP_VALUE	-0.0727***	-0.0710***	-0.0703***	-0.0693***	-0.0705***
	(-35.2196)	(-34.0416)	(-33.6075)	(-33.1264)	(-33.1691)
G_HPI_L1	0.6076***	0.4858***	0.5071***	0.3895***	0.4394***
	(4.3166)	(3.4572)	(3.5036)	(2.8851)	(3.0518)
VARIABLE RATE				0.0141***	0.0138***
				(7.8929)	(7.7055)
YEARS_WORKING				0.0004**	0.0003**
				(2.2654)	(2.0729)
G ASSET			0.0233	0.0095	0.0087
			(0.5201)	(0.2067)	(0.1958)
AVERAGE SPREAD				0.0001	
				(0.0179)	
NEW_CLIENT		0.0169***	0.0180***	0.0196***	0.0186***
		(8.7694)	(9.2382)	(10.1005)	(9.3032)
PROV_OCCUPATION	0.0009***	0.0008***	0.0008***	0.0008***	0.0008***
	(11.5433)	(9.9621)	(9.8491)	(2.9483)	(3.1038)
LN EURIBOR	0.0064	0.0537	0.0605		0.0486
	(0.1516)	(1.2686)	(1.4278)		(1.1411)
CONSTANT	1.3508***	1.3012***	1.2909***	1.2881***	1.2736***
	(43.6513)	(41.0296)	(40.5589)	(46.8493)	(35.9638)
OBSERVATIONS	19,162	19,162	19,162	19,162	19,162
GEO FE	No	No	No	Yes	Yes
BORROWER JOB FE	No	No	No	No	yes
LOAN PURPOSE FE	Yes	Yes	Yes	Yes	Yes
R^2 adjusted	0.322	0.326	0.327	0.337	0.339

Table 3.7 reports loan-level regressions as in table 4, but on a different panel since data are here limited to the period before the starting of COVID state aid measures (i.e., Apr 20). Refer to Table 3.A1 for definitions of variables. Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.8 Sensitivity analysis. Pre- and post-IFRS 9 reform. The effects of Interest rates on mortgage LTV for mortgages originated to buy only real estates (excluding cash or investment purposes).

Dependent variable: *Loan-to-value (LTV)*					
	(1)	(2)	(3)	(4)	(5)
DT_LN INT RATE		**-0.0030*** **	**-0.0030*** **	**-0.0031*** **	**-0.0030*** **
		(-5.6780)	(-5.4589)	(-5.0008)	(-5.5177)
AGE	-0.0003***	-0.0004***	-0.0004***	-0.0004***	-0.0004***
	(-3.2315)	(-4.8220)	(-4.8713)	(-4.5224)	(-4.5562)
NUM_FAMILY	-0.0082***	-0.0071***	-0.0073***	-0.0069***	-0.0030***
	(-15.1325)	(-13.9313)	(-14.1899)	(-13.5998)	(-3.6656)
OTHER_LOANS	-0.0107***	-0.0089***	-0.0095***	-0.0105***	-0.0097***
	(-3.9752)	(-3.6523)	(-3.8646)	(-4.2759)	(-3.9315)
SALARY DEPOSIT			0.0095***	0.0095***	0.0097***
			(5.7339)	(5.7814)	(5.8179)
LN_INCOME	0.0056***	0.0058***	0.0056***	0.0055***	0.0056***
	(9.0948)	(10.6555)	(10.3721)	(10.1648)	(10.3551)
LN_INT_RATE	0.0342***	0.0328***	0.0333***	0.0348***	0.0342***
	(14.3485)	(14.8396)	(15.0313)	(15.2264)	(14.7565)
MATURITY	0.0103***	0.0095***	0.0095***	0.0094***	0.0094***
	(63.5784)	(63.0255)	(62.3856)	(61.8703)	(61.4616)
LN_PROP_VALUE	-0.0832***	-0.0753***	-0.0745***	-0.0738***	-0.0748***
	(-41.8829)	(-40.0082)	(-39.4325)	(-39.1040)	(-38.9580)
G_HPI_L1	0.2967***	0.2038***	0.2189***	0.1788***	0.2082***
	(4.7931)	(3.3651)	(3.4085)	(2.7901)	(3.1785)
VARIABLE_RATE				0.0118***	0.0117***
				(6.9956)	(6.9985)
YEARS_WORKING				0.0003**	0.0003**
				(2.3971)	(2.0423)
G ASSET			0.0292	0.0255	0.0200
			(0.6585)	(0.5566)	(0.4535)
AVERAGE_SPREAD				-0.0020	
				(-0.5528)	
NEW_CLIENT		0.0183***	0.0194***	0.0208***	0.0198***
		(10.6542)	(11.2307)	(12.0505)	(11.1937)
COVID				0.0047**	0.0025
				(1.9626)	(0.9441)
PROV_OCCUPATION	0.0009***	0.0007***	0.0007***	0.0010***	0.0011***
	(11.9445)	(10.0686)	(9.8999)	(4.1191)	(4.3811)
LN_EURIBOR	-0.0521***	-0.0450**	-0.0411**		-0.0407*
	(-2.7734)	(-2.4180)	(-2.2072)		(-1.6659)
CONSTANT	1.5220***	1.4262***	1.4165***	1.3429***	1.3708***
	(66.4988)	(64.5263)	(63.8923)	(53.5257)	(49.3437)
OBSERVATIONS	21,097	24,247	24,247	24,247	24,247
GEO_FE	No	No	No	Yes	Yes
BORROWER_JOB FE	No	No	No	No	Yes
LOAN PURPOSE FE	Yes	No	No	No	No
R^2 adjusted	0.341	0.330	0.331	0.341	0.342

Table 3.8 reports loan-level regressions as in table 4, but on a different panel since data are here limited to the mortgages originated to buy real estates (Excluding cash or investment purposes). Refer to Table 3.A1 for definitions of variables. Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.9. Focus on post-reform. The Effects of Staging classification on Mortgage LTV

Dependent variable: *Loan-to-value (LTV)*					
	(1)	(2)	(3)	(4)	(5)
LN INT RATE	**0.0474*** **	**0.0449*** **	**0.0450*** **	**0.0499*** **	**0.0498*** **
	(17.9585)	(16.9432)	(17.0009)	(17.4052)	(17.2228)
MATURITY	**0.0094*** **	**0.0092*** **	**0.0091*** **	**0.0090*** **	**0.0090*** **
	(55.0810)	(53.1252)	(52.6613)	(51.5500)	(51.3353)
S2 MATURITY	**-0.0034** **	**-0.0034** **	**-0.0034** **	**-0.0038** **	**-0.0038** **
	(-1.9814)	(-1.9763)	(-1.9828)	(-2.1449)	(-2.2063)
S2 LN INT RATE	**-0.0188***	**-0.0184***	**-0.0184***	**-0.0202** **	**-0.0221** **
	(-1.9163)	(-1.8829)	(-1.8745)	(-2.0095)	(-2.1795)
S2					-0.0053
					(-0.6414)
AGE	-0.0002***	-0.0002**	-0.0002**	-0.0002**	-0.0002**
	(-2.5769)	(-2.4702)	(-2.4970)	(-2.4502)	(-2.4183)
NUM FAMILY	-0.0077***	-0.0071***	-0.0073***	-0.0068***	-0.0026***
	(-13.8379)	(-12.6661)	(-12.9229)	(-12.0952)	(-2.8682)
OTHER LOANS	-0.0100***	-0.0051**	-0.0061**	-0.0074***	-0.0061**
	(-4.1105)	(-2.0711)	(-2.4693)	(-2.9861)	(-2.4352)
SALARY DEPOSIT			0.0093***	0.0097***	0.0096***
			(5.0879)	(5.3302)	(5.2338)
LN INCOME	0.0060***	0.0060***	0.0059***	0.0056***	0.0058***
	(8.8153)	(8.8846)	(8.6446)	(8.4182)	(8.6084)
LN PROP VALUE	-0.0776***	-0.0760***	-0.0752***	-0.0738***	-0.0751***
	(-37.8353)	(-36.7924)	(-36.2433)	(-35.7155)	(-35.6286)
G HPI L1	0.2098***	0.1857***	0.1758***	0.1147*	0.1538**
	(3.4081)	(3.0176)	(2.6703)	(1.7450)	(2.2873)
VARIABLE RATE				0.0203***	0.0204***
				(10.2328)	(10.3763)
YEARS WORKING				0.0004***	0.0003**
				(2.6958)	(2.1751)
G ASSET			-0.0231	-0.0450	-0.0506
			(-0.5051)	(-0.9566)	(-1.1117)
AVERAGE SPREAD				-0.0031	
				(-0.8683)	
NEW CLIENT		0.0171***	0.0180***	0.0196***	0.0183***
		(8.9512)	(9.3630)	(10.2066)	(9.3698)
COVID				0.0087***	0.0061**
				(3.5492)	(2.2684)
PROV OCCUPATION	0.0006***	0.0005***	0.0005***	0.0009***	0.0010***
	(7.7815)	(7.0810)	(6.8471)	(3.4692)	(3.7285)
LN EURIBOR	-0.0434**	-0.0499***	-0.0461**		-0.0532**
	(-2.3202)	(-2.6735)	(-2.4700)		(-2.1800)
CONSTANT	1.5034***	1.4746***	1.4645***	1.3882***	1.4263***
	(63.2327)	(60.7936)	(60.0862)	(49.8413)	(46.9619)
OBSERVATIONS	19,335	19,335	19,335	19,335	19,335
GEO FE	No	No	No	Yes	Yes
BORROWER JOB FE	No	No	No	No	Yes
LOAN PURPOSE FE	Yes	Yes	Yes	Yes	Yes
R^2 adjusted	0.343	0.346	0.347	0.359	0.361

Table 3.9 reports loan-level regressions which estimate the effect of the staging classification on Mortgage LTV. The dependent variable is *LTV*, which is the ratio between Loan amount and property appraisal value at the origination. Main independent variables of interest are *S2_MATURITY* and *S2_LN_INT_RATE* which are the interactions between the variable identifying clients with previous stage 2 exposures on the 12 months prior to the origination *(S2)* and respectively: the term of loan *(MATURITY)* and the log of the interest rate paid by the client *(LN_INT_RATE)*. Fixed effects are used to control for: the borrower's macro-area of residence *(GEO_FE*), the borrower job *(BORROWER_JOB_FE)* and loan purpose *(LOAN_PURPOSE FE)*. Refer to Table 3.A1 for definitions of variables. Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.10. Pairwise comparisons of means, stage 2 vs non-stage 2 clients, t-test

Variable	Contrast	p-value
LN INT RATE	0.038	0.068
AGE	- 0.254	0.667
LN INCOME	- 0.020	0.820
MATURITY	0.285	0.438
LN PROP VALUE	- 0.029	0.299
HIGH_LAND_RISK	- 0.010	0.527
HIGH_SEISM_RISK	- 0.009	0.708
HIGH FLOOD RISK	- 0.002	0.852

Table 3.10 reports the results for each independent variable of the parametric two-sample t-test to observe any difference between the mean estimated for S2 clients with the mean estimated for non-S2 clients. H0: two-population means are equal.

Table 3.11 Pairwise comparisons of means, stage 2 vs non-stage 2 clients**.** Wilcoxon signed rank test

Variable	Contrast	p-value
LN INT RATE	-1.294	0.196
AGE	0.449	0.654
LN INCOME	-0.081	0.936
MATURITY	-0.703	0.482
LN PROP VALUE	1.200	0.230
HIGH_LAND_RISK	0.606	0.544
HIGH_SEISM_RISK	0.371	0.710
HIGH FLOOD RISK	0.183	0.855

Table 3.11 reports the results for each independent variable of the non-parametric Wilcoxon signed rank test to observe any differences in the ranked medians in the two samples: pre- and post-IFRS 9 reform. H0: median of the population of differences between the paired data is zero.

Table 3.12. Sensitivity analysis. Focus on post reform. The Effects of the Staging classification on Mortgage Loan-to-Value, for mortgages originated to buy only real estates (excluding cash or investment purposes).

Dependent variable: *Loan-to-value (LTV)*					
	(1)	(2)	(3)	(4)	(5)
LN INT RATE	**0.0474*** **	**0.0449*** **	**0.0450*** **	**0.0499*** **	**0.0498*** **
	(17.9585)	(16.9432)	(17.0009)	(17.4052)	(17.2228)
MATURITY	**0.0094*** **	**0.0092*** **	**0.0091*** **	**0.0090*** **	**0.0090*** **
	(55.0810)	(53.1252)	(52.6613)	(51.5500)	(51.3353)
S2 MATURITY	**-0.0034** **	**-0.0034** **	**-0.0034** **	**-0.0038** **	**-0.0038** **
	(-1.9814)	(-1.9763)	(-1.9828)	(-2.1449)	(-2.2063)
S2 LN INT RATE	**-0.0188***	**-0.0184***	**-0.0184***	**-0.0202** **	**-0.0221** **
	(-1.9163)	(-1.8829)	(-1.8745)	(-2.0095)	(-2.1795)
S2					-0.0053
					(-0.6414)
AGE	-0.0002***	-0.0002**	-0.0002**	-0.0002**	-0.0002**
	(-2.5769)	(-2.4702)	(-2.4970)	(-2.4502)	(-2.4183)
NUM FAMILY	-0.0077***	-0.0071***	-0.0073***	-0.0068***	-0.0026***
	(-13.8379)	(-12.6661)	(-12.9229)	(-12.0952)	(-2.8682)
OTHER LOANS	-0.0100***	-0.0051**	-0.0061**	-0.0074***	-0.0061**
	(-4.1105)	(-2.0711)	(-2.4693)	(-2.9861)	(-2.4352)
SALARY DEPOSIT			0.0093***	0.0097***	0.0096***
			(5.0879)	(5.3302)	(5.2338)
LN INCOME	0.0060***	0.0060***	0.0059***	0.0056***	0.0058***
	(8.8153)	(8.8846)	(8.6446)	(8.4182)	(8.6084)
LN PROP VALUE	-0.0776***	-0.0760***	-0.0752***	-0.0738***	-0.0751***
	(-37.8353)	(-36.7924)	(-36.2433)	(-35.7155)	(-35.6286)
G HPI L1	0.2098***	0.1857***	0.1758***	0.1147*	0.1538**
	(3.4081)	(3.0176)	(2.6703)	(1.7450)	(2.2873)
VARIABLE RATE				0.0203***	0.0204***
				(10.2328)	(10.3763)
YEARS WORKING				0.0004***	0.0003**
				(2.6958)	(2.1751)
G ASSET			-0.0231	-0.0450	-0.0506
			(-0.5051)	(-0.9566)	(-1.1117)
AVERAGE SPREAD				-0.0031	
				(-0.8683)	
NEW CLIENT		0.0171***	0.0180***	0.0196***	0.0183***
		(8.9512)	(9.3630)	(10.2066)	(9.3698)
COVID				0.0087***	0.0061**
				(3.5492)	(2.2684)
PROV OCCUPATION	0.0006***	0.0005***	0.0005***	0.0009***	0.0010***
	(7.7815)	(7.0810)	(6.8471)	(3.4692)	(3.7285)
LN EURIBOR	-0.0434**	-0.0499***	-0.0461**		-0.0532**
	(-2.3202)	(-2.6735)	(-2.4700)		(-2.1800)
CONSTANT	1.5034***	1.4746***	1.4645***	1.3882***	1.4263***
	(63.2327)	(60.7936)	(60.0862)	(49.8413)	(46.9619)
OBSERVATIONS	19,335	19,335	19,335	19,335	19,335
GEO FE	No	No	No	Yes	Yes
BORROWER JOB FE	No	No	No	No	Yes
LOAN PURPOSE FE	No	No	No	No	No
R^2 adjusted	0.343	0.346	0.347	0.359	0.361

Table 3.12 reports loan-level regressions as in table 9, but on a different panel since data are here limited to the mortgages originated to buy real estates (Excluding cash or investment purposes). Refer to Table 3.A1 for definitions of variables. Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.13. The role of climate-related risks in the determination of LTV

Dependent variable: *Loan-to-value (LTV)*					
	(1)	(2)	(3)	(4)	(5)
DT_LN INT RATE	**-0.0034*** **	**-0.0029*** **	**-0.0029*** **	**-0.0026*** **	**-0.0029*** **
	(-6.3633)	(-5.4757)	(-5.2595)	(-4.3092)	(-5.2590)
HIGH LANDSLIDE RISK	**-0.0146*** **	**-0.0119*** **	**-0.0122*** **	**-0.0122*** **	**-0.0121*** **
	(-5.1777)	(-4.1806)	(-4.2979)	(-4.2900)	(-4.2379)
HIGH FLOOD RISK	**-0.0112*** **	**-0.0133*** **	**-0.0128*** **	**-0.0132*** **	**-0.0131*** **
	(-2.8850)	(-3.4509)	(-3.3122)	(-3.4128)	(-3.4028)
HIGH SEISMIC RISK	**-0.0071*** **	**-0.0059** **	**-0.0061** **	**-0.0063** **	**-0.0064** **
	(-2.7816)	(-2.3245)	(-2.3711)	(-2.4897)	(-2.5288)
AGE	-0.0003***	-0.0003***	-0.0003***	-0.0004***	-0.0004***
	(-3.7957)	(-3.5473)	(-3.6108)	(-4.2926)	(-4.2797)
NUM_FAMILY	-0.0076***	-0.0069***	-0.0070***	-0.0068***	-0.0028***
	(-14.9069)	(-13.5408)	(-13.7869)	(-13.4296)	(-3.3866)
OTHER_LOANS	-0.0116***	-0.0069***	-0.0076***	-0.0080***	-0.0071***
	(-4.7934)	(-2.8268)	(-3.0785)	(-3.2459)	(-2.8614)
SALARY DEPOSIT			0.0096***	0.0102***	0.0104***
			(5.8442)	(6.2191)	(6.2519)
LN_INCOME	0.0057***	0.0057***	0.0056***	0.0055***	0.0056***
	(10.5352)	(10.6499)	(10.3631)	(10.2772)	(10.4756)
LN_INT_RATE	0.0360***	0.0335***	0.0338***	0.0374***	0.0375***
	(15.8600)	(14.7252)	(14.8535)	(16.0144)	(15.7006)
MATURITY	0.0095***	0.0093***	0.0093***	0.0092***	0.0092***
	(60.8355)	(58.5015)	(58.0730)	(57.1358)	(56.8136)
LN_PROP_VALUE	-0.0750***	-0.0738***	-0.0730***	-0.0728***	-0.0738***
	(-39.6407)	(-38.6671)	(-38.1438)	(-38.0354)	(-37.8523)
G_HPI_L1	0.2169***	0.1936***	0.2095***	0.1899***	0.2002***
	(3.5865)	(3.2051)	(3.2734)	(2.9889)	(3.0567)
VARIABLE_RATE				0.0156***	0.0161***
				(9.3866)	(9.5705)
YEARS_WORKING				0.0003**	0.0003*
				(2.1534)	(1.7813)
G ASSET			0.0305	0.0362	-0.0022
			(0.6925)	(0.8134)	(-0.0509)
AVERAGE_SPREAD				-0.0083***	
				(-2.6567)	
NEW_CLIENT		0.0169***	0.0181***	0.0183***	0.0175***
		(9.8488)	(10.4462)	(10.5867)	(9.8584)
PROV_OCCUPATION	0.0006***	0.0006***	0.0006***	0.0006***	0.0006***
	(5.7540)	(5.5801)	(5.4563)	(5.4020)	(5.7236)
LN_EURIBOR	-0.0222	-0.0296	-0.0256		-0.0483**
	(-1.1871)	(-1.5915)	(-1.3760)		(-1.9854)
COVID					0.0033
					(1.2536)
CONSTANT	1.4171***	1.3908***	1.3809***	1.3825***	1.4094***
	(62.4519)	(60.1266)	(59.5114)	(63.0126)	(56.4055)
OBSERVATIONS	24,247	24,247	24,247	24,247	24,247
GEO_FE	No	No	No	No	No
BORROWER_JOB FE	No	No	No	No	yes
LOAN PURPOSE FE	yes	yes	Yes	Yes	Yes
R^2 adjusted	0.333	0.336	0.337	0.339	0.341

Table 3.13 reports loan-level regressions which estimate the effect of climate risk and other control or independent variables on Mortgage Loan-to-Value. The dependent variable is *Loan-to-Value*, which is the ratio between the amount of the loan and the appraisal value of the property at the origination. The main independent variables of interest are: *HIGH LANDSLIDE_RISK, HIGH FLOOD_RISK* and *HIGH SEISMIC RISK* which are the dummy representing high exposure to the climate-related risks. Fixed effects are used to control for: the borrower's macro-area of residence *(GEO_FE*), the borrower job *(BORROWER JOB_FE)* and loan purpose *(LOAN_PURPOSE FE).* Refer to Table 3.A1 for variables definition. Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.14. The Effects of the Staging classification on Mortgage Loan-to-Value – Focus climate

Dependent variable: *Loan-to-value (LTV)*				
	(1)	(2)	(3)	(4)
HIGH_LANDSLIDE_RISK	**-0.0142*** **	**-0.0141*** **	**-0.0141*** **	**-0.0141*** **
	(-4.3985)	(-4.3574)	(-4.3920)	(-4.3853)
HIGH_FLOOD_RISK	**-0.0115*** **	**-0.0118*** **	**-0.0118*** **	**-0.0115*** **
	(-2.6874)	(-2.7682)	(-2.7611)	(-2.6913)
HIGH_SEISMIC_RISK	**-0.0072** **	**-0.0072** **	**-0.0072** **	**-0.0072** **
	(-2.4890)	(-2.4895)	(-2.4698)	(-2.4731)
S2_HIGH_FLOOD_RISK	**-0.1329*** **			**-0.1311** **
	(-2.7216)			(-2.3514)
S2_HIGH_LANDSLIDE_RISK		**-0.0201**		**-0.0037**
		(-0.4409)		(-0.0751)
S2_HIGH_SEISMIC_RISK			**-0.0131**	**-0.0131**
			(-0.6419)	(-0.6417)
LN_EURIBOR	-0.0333	-0.0333	-0.0333	-0.0333
	(-1.3651)	(-1.3615)	(-1.3650)	(-1.3652)
AGE	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(-2.8031)	(-2.8107)	(-2.8097)	(-2.8047)
NUM_FAMILY	-0.0028***	-0.0029***	-0.0029***	-0.0028***
	(-3.1289)	(-3.1416)	(-3.1475)	(-3.1329)
OTHER_LOANS	-0.0073***	-0.0073***	-0.0073***	-0.0073***
	(-2.9592)	(-2.9540)	(-2.9540)	(-2.9590)
LN_INCOME	0.0061***	0.0061***	0.0061***	0.0061***
	(8.9784)	(8.9789)	(8.9753)	(8.9750)
LN_INT_RATE	0.0448***	0.0448***	0.0448***	0.0448***
	(16.6245)	(16.6152)	(16.6134)	(16.6260)
MATURITY	0.0093***	0.0093***	0.0093***	0.0093***
	(54.0071)	(54.0049)	(54.0079)	(54.0070)
LN_PROP_VALUE	-0.0788***	-0.0788***	-0.0788***	-0.0788***
	(-37.7452)	(-37.7481)	(-37.7543)	(-37.7419)
G_HPI_L1	0.2042***	0.2051***	0.2051***	0.2039***
	(3.2520)	(3.2663)	(3.2657)	(3.2472)
PROV_OCCUPATION	0.0005***	0.0005***	0.0005***	0.0005***
	(4.0700)	(4.0645)	(4.0636)	(4.0644)
COVID	0.0000	0.0000	-0.0000	0.0000
	(0.0093)	(0.0019)	(-0.0037)	(0.0073)
CONSTANT	1.5203***	1.5203***	1.5205***	1.5203***
	(58.8340)	(58.8367)	(58.8393)	(58.8314)
OBSERVATIONS	19,335	19,335	19,335	19,335
GEO_FE	No	No	No	No
BORROWER_JOB FE	Yes	Yes	Yes	Yes
LOAN PURPOSE FE	Yes	Yes	Yes	Yes
R^2 adjusted	0.346	0.346	0.346	0.346

Table 3.14 reports loan-level regressions which estimate the effect of the staging classification on Mortgage LTV. The dependent variable is Loan-to-Value, which is the ratio between Loan amount and property appraisal value at the origination. The main independent variables of interest are the dummies *S2_HIGH_LANDSLIDE_RISK*, *S2_HIGH_SEISMIC_RISK, S2_HIGH_FLOOD_RISK,* which identify the interaction of clients with previous stage2 transactions, in the 12 months prior the origination *(S2),* with high exposure to climate risk, respectively: landslide, earthquake, and flood risk. Fixed effects are used to control for: the borrower's macro-area of residence *(GEO_FE*), the borrower job *(BORROWER JOB_FE)* and loan purpose *(LOAN_PURPOSE FE).*Refer to Table 3.A1 for definitions of variables. Robust t-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

3.6 APPENDIX

Table 3.15. Endogeneity. Simultaneous equation model.

Dependent Variable	*(LTV)*	*(LN_INT_RATE)*
LN_INT_RATE	**1.1227****	
	(2.4572)	
LTV		-16.1762
		(-1.5381)
DT_LN_INT	**-0.0553****	
	(-2.5103)	
LN EURIBOR	-0.7821**	1.0047**
	(-2.3646)	(2.2584)
AGE	-0.0009**	
	(-2.2826)	
NUM FAMILY	0.0014	
	(0.3881)	
OTHER LOANS	0.0673*	
	(1.9096)	
LN INCOME	0.0100***	
	(4.4208)	
PROV OCCUPATION	-0.0038*	0.0156
	(-1.7151)	(1.4511)
MATURITY	-0.0129	0.1936*
	(-1.3642)	(1.6818)
LN_PROP_VALUE	0.1678	-1.5302*
	(1.6359)	(-1.7629)
G HPI L1	-0.5002	4.4715
	(-1.4009)	(1.4331)
COVID	0.1135**	-0.2199***
	(2.3286)	(-4.4147)
PD		1.2411***
		(3.2226)
LGD		11.2073*
		(1.7959)
CONSTANT	2.9264***	18.9989
	(4.7428)	(1.3567)
OBSERVATIONS	24,247	24,247
GEO_FE	Yes	Yes
BORROWER_JOB FE	Yes	
LOAN PURPOSE FE	Yes	

Table 3.15 reports the results of a SEM that includes the log of the mortgage interest rate *(LN_INT_RATE)* and Loan-to-Value *(LTV)*. The SEM is estimated with quasi maximum likelihood (QML) that uses maximum likelihood to fit the model but relaxes the conditional normality assumptions when estimating the standard errors. QML handles nonnormality by adjusting standard errors. The main independent variable of interest is *DT_LN_INT_RATE* which is the interaction between the interest rate applied to the loan transformed into logarithmic form (*LN_INT_RATE)* and the dummy variable identifying loans originated after the introduction of IFRS 9 *(DT)*. Fixed effects are used to control for: the borrower's macro-area of residence *(GEO_FE*), the borrower job *(BORROWER JOB_FE)* and loan purpose *(LOAN_PURPOSE FE)*. Refer to Table 3.A1 for definitions of variables. Robust z-statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

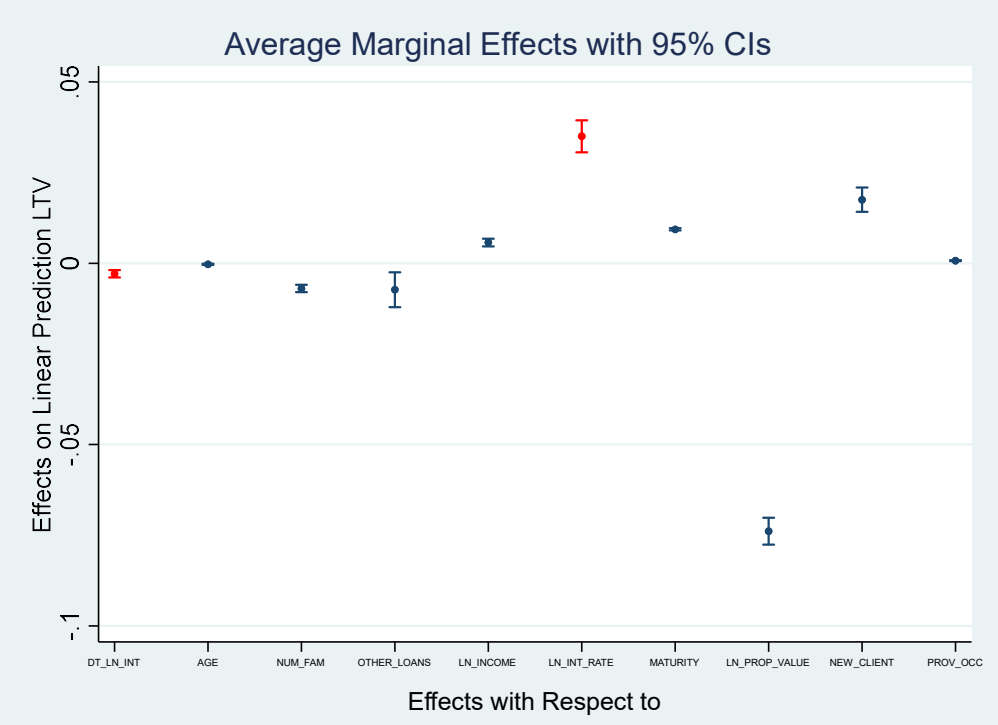

Figure 3.1 Average marginal effects of the determinants on the LTV linear prediction and confidence intervals (estimated from regression 2 Table 3.2). Pre- and post-IFRS 9 period. Marginal effects of *DT_LN_INT_RATE* and *LN_INT_RATE* in red.

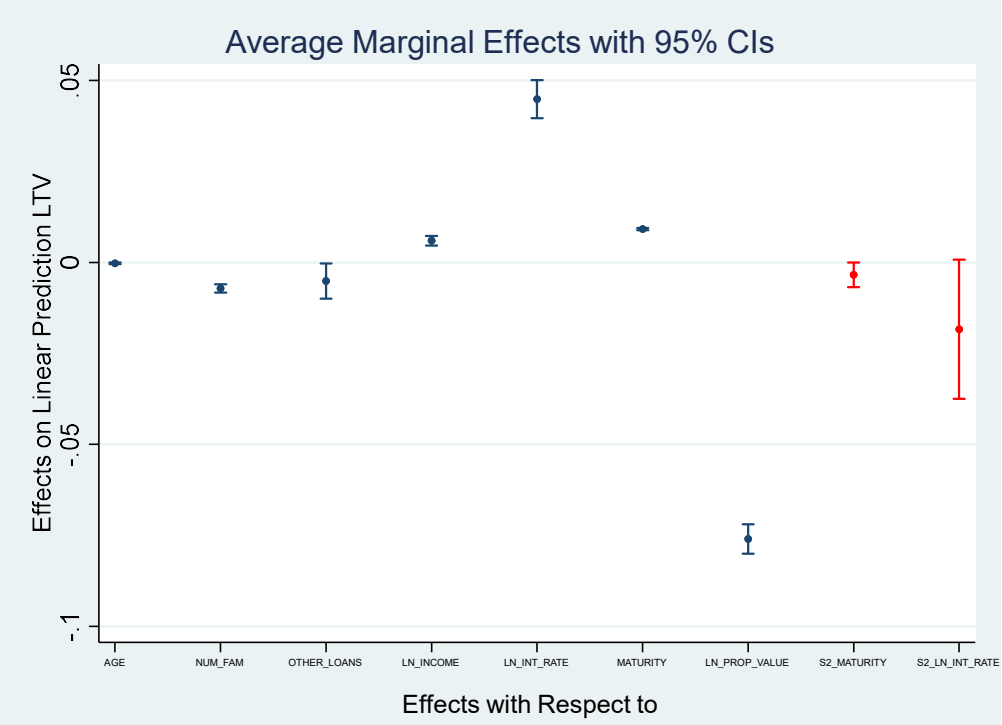

Figure 3.2. Average marginal effects of the determinants on the LTV linear prediction and confidence intervals (estimated from regression 2 Table 3.9). Focus on post-IFRS 9 Period. Marginal effects of *S2_LN_INT_RATE* and *S2_MATURITY* in red.

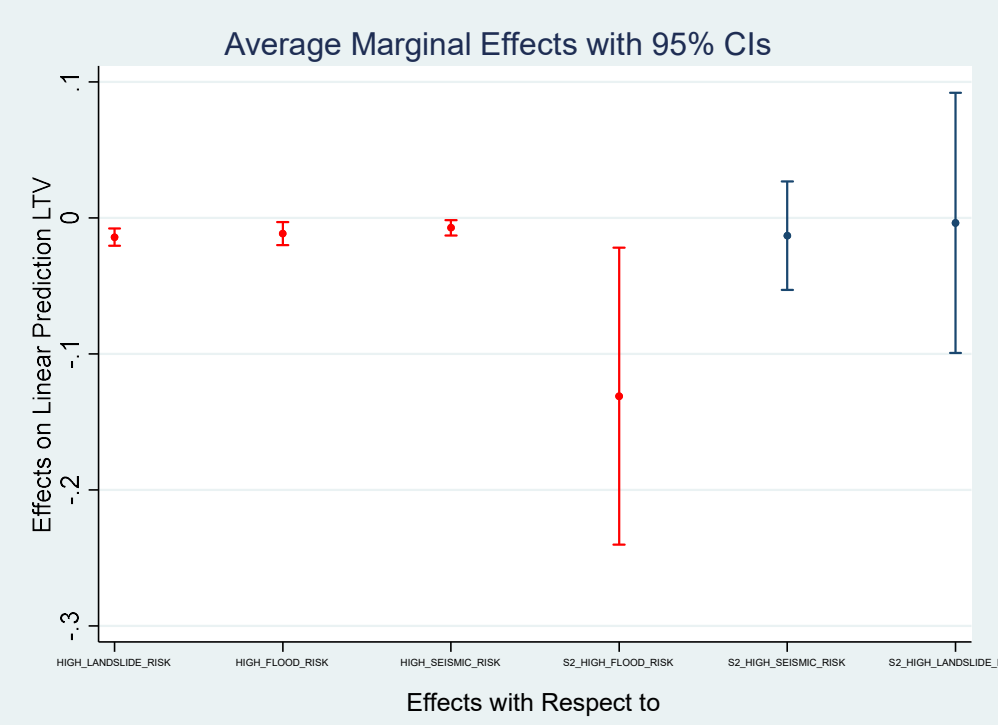

Figure 3.3. Average marginal effects of the determinants on the LTV linear prediction and confidence intervals (estimated from regression 4 Table 3.14). Focus on climate related risks. Marginal effects of *HIGH_LANDSLIDE_RISK, HIGH_SEISMIC_RISK, HIGH_FLOOD_RISK, S2_HIGH_FLOOD_RISK* in red.

Table 3.16. The effects of Interest rates on mortgage LTV, pre- and post-IFRS 9 reform. Heckman selection model.

Dependent variable: *Loan-to-value (LTV)*		
	(1) (HECKMAN)	(2) (2, Tab 2)
DT_LN INT RATE	**-0.0029*** **	**-0.0029*** **
	(-5.5208)	(-5.4718)
LN_INT_RATE	**0.0346*** **	**0.0350*** **
	(16.5427)	(15.5203)
AGE	-0.0003***	-0.0003***
	(-3.4086)	(-3.3942)
NUM FAMILY	-0.0071***	-0.0070***
	(-13.7410)	(-13.6000)
OTHER LOANS	-0.0070***	-0.0073***
	(-3.0460)	(-2.9849)
LN INCOME	0.0060***	0.0058***
	(12.5082)	(10.6957)
MATURITY	0.0094***	0.0094***
	(65.6521)	(58.6109)
LN PROP VALUE	-0.0756***	-0.0739***
	(-47.7592)	(-38.6751)
G HPI L1	0.1978***	0.1990***
	(3.2045)	(3.2917)
NEW CLIENT	0.0176***	0.0175***
	(10.5694)	(10.2834)
PROV OCCUPATION	0.0007***	0.0007***
	(10.2170)	(10.3234)
LN EURIBOR	-0.0372**	-0.0371**
	(-1.9784)	(-1.9965)
CONSTANT	1.4292***	1.3885***
	(70.3454)	(61.6925)
SELECTED OBS	24,247	24,247
NON SELECTED OBS	2,473	0
TOTAL OBS	26,720	24,247
LOAN PURPOSE FE	Yes	Yes
Select model: *dependent variable dummy loan approved*		
OLD (Age above 65)	-2.6816***	
	(-44.85)	
INST ON INCOME ABOVE 50%	-3.4770***	
	(-64.91)	
CONSTANT	2.900***	
	(60.36)	
Mills		
LAMBDA	0.01827***	
	(5.99)	
RHO	0.15536	
SIGMA	0.11760	

Table 3.16 reports in column 1 the results of the Heckman regression. The select model in column (1) estimates the probability of being approved a mortgage as a function of one of the original control variables *OLD* (dummy that takes value 1 if the age of the client is above 65 years) and one additional identifying variable *INST_ON_INCOME* (dummy that takes value 1 if the ratio installment/income is above 50%). In column (2) we report the results of the same model but restricted (see column 2 Table 3.2). Fixed effects are used to control for loan purpose *(LOAN_PURPOSE FE). Z* statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3.17. The effects of Interest rates on mortgage LTV, pre- and post-IFRS 9 reform. Heckman selection model.

Dependent variable: *Loan-to-value (LTV)*		
	(1) (HECKMAN)	(2) (Tab 9, Col. 1)
LN_INT_RATE	**0.0472*** **	**0.0474*** **
	(19.6537)	(17.9585)
MATURITY	**0.0095*** **	**0.0094*** **
	(59.3960)	(55.0810)
S2_MATURITY	**-0.0034** **	**-0.0034** **
	(-2.0974)	(-1.9814)
S2_LN INT RATE	**-0.0186** **	**-0.0188** *
	(-2.0288)	(-1.9163)
AGE	-0.0002***	-0.0002***
	(-2.6165)	(-2.5769)
NUM FAMILY	-0.0078***	-0.0077***
	(-13.7236)	(-13.8379)
OTHER LOANS	-0.0098***	-0.0100***
	(-4.3746)	(-4.1105)
LN INCOME	0.0062***	0.0060***
	(10.6689)	(8.8153)
LN PROP VALUE	-0.0788***	-0.0776***
	(-44.3096)	(-37.8353)
G HPI L1	0.2096***	0.2098***
	(3.3445)	(3.4081)
PROV OCCUPATION	0.0006***	0.0006***
	(7.5056)	(7.7815)
LN EURIBOR	-0.0437**	-0.0434**
	(-2.3260)	(-2.3202)
CONSTANT	1.5466***	1.5034***
	(69.5721)	(63.2327)
SELECTED OBS	19,335	19,335
NON-SELECTED OBS	1,963	0
TOTAL OBS	21,298	19,335
LOAN PURPOSE FE	Yes	Yes
Select model: *dependent variable dummy loan approved*		
OLD (Age above 65)	-.0.7425***	
	-7.66	
INST ON INCOME ABOVE 50%	-7.492***	
	(-58.34)	
CONSTANT	6.7652	
	(53.75)	
Mills		
LAMBDA	0.0144***	
	(3.65)	
RHO	0.1234	
SIGMA	0.1168	

Table 3.17 reports in column 2 the results of the Heckman regression. The select model (HECKMAN) estimates the probability of being approved a mortgage as a function of one of the original control variables *OLD* (dummy that takes value 1 if the age of the client is above 65 years) and one additional identifying variable *INST_ON_INCOME* (dummy that takes value 1 if the ratio installment/income is above 50%). In column (2) we report the results of the same model but restricted (see column 1 Table 3.9). Fixed effects are used to control for loan purpose *(LOAN_PURPOSE FE). Z* statistics are reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

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GLOSSARY OF THE BANK ACCOUNTING AND REGULATORY TERMS

The following glossary reports the most technical terms adopted in this research proposal that are related to the bank accounting and regulatory terms. This glossary aims at supporting the readers less familiar with IFRS 9 and Capital requirements topics.

A

Amortized cost: is the amount at which some financial assets or liabilities are measured and consists of: (1) initial recognition amount, (2) subsequent recognition of interest income/expense using the effective interest method (3) repayments and (4) credit losses.

B

Bad debt: Bad debt is an expense that a business incurs once the repayment of credit previously extended to a client is estimated to be uncollectible. Bad debt is a contingency that must be accounted for by all businesses who extend credit to clients, as there is always a risk that payment will not be received.

C

CET1: Common Equity Tier 1 (CET1) is a component of Tier 1 capital that consists mostly of common stock held by a bank or other financial institution. It is a capital measure that was introduced in 2014 as a precautionary means to protect the economy from a financial crisis. It is expected that all banks should meet the minimum required CET1 ratio of 4.50% by 2019.

Credit scoring: the credit score is the score that summarizes the creditworthiness of the person who requested funding. Banks and financial companies use credit scoring systems to estimate the solvency of a loan and to decide whether or not to grant financing. To define the credit score, the financial institution analyzes all information about the client.

D

Disclosures: IFRS 9 amends some of the requirements of IFRS 7 Financial Instruments: Disclosures including adding disclosures about investments in equity instruments designated as at FVTOCI, disclosures on risk management activities and hedge accounting and disclosures on credit risk management and impairment.

E

ECL: (expected credit losses) losses that result from those default events on the financial instrument that are possible within a prescribed time horizon after the reporting date. In the IFRS 9 framework 12 months for the stage 1 credits and residual lifetime from the stage2 and stage 3 loans

EBA: is the acronym of European Banking Authority, i.e. the EU banking regulator in charge of the European handbook of the banking supervision rules.

EAD: Exposure at default (EAD) is the total value a bank is exposed to when a loan defaults. Using the internal ratings-based (IRB) approach, financial institutions calculate their risk. Banks often use internal risk management default models to estimate respective EAD systems. Outside of the banking industry, EAD is known as credit exposure

F

FASB: in the United States, a non-governmental body SEC has charged with establishing and maintaining generally accepted standards for professional accountants

FVA Fair value accounting uses current market values as the basis for recognizing certain assets and liabilities. Fair value is the estimated price at which an asset can be sold, or a liability settled in an orderly transaction to a third party under current market conditions. This definition includes the following concepts:

H

HTM: Held-to-maturity (HTM) securities are purchased to be owned until maturity, are one of the leading categories that corporations use to classify their investments in debt and equity securities.

Hedge Accounting: Hedge accounting is a method of accounting where entries to adjust the fair value of a security and its opposing hedge are treated as one. Hedge accounting attempts to reduce the volatility created by the repeated adjustment to a financial instrument's value, known as fair value accounting or mark to market.

I

IAS 39: *Financial Instruments Recognition and Measurement* is the accounting principle that outlines the requirements for the recognition and measurement of financial assets, financial liabilities. Financial instruments are initially recognized when an entity becomes a party to the contractual provisions of the instrument and are classified into various categories depending upon the type of instrument, which then determines the subsequent measurement of the instrument (typically amortized cost or fair value). IAS 39 has been replaced by IFRS 9 Financial Instruments

for annual periods beginning on or after 1 January 2018. Under IFRS 9 Loans are classified in two categories: impaired (non-performing) and not impaired (performing).

IASB: The International Accounting Standards Board, typically abbreviated IASB, is the organization that establishes international financial reporting standards or IFRS that are accepted throughout the world. You can think of the IASB as the international FASB that creates accounting principles and standards like GAAP on an international level.

IFRS 9: Financial Instruments issued on 24 July 2014 is the IASB's replacement of IAS 39 *Financial Instruments: Recognition and Measurement.* The Standard includes requirements for recognition and measurement, impairment, derecognition and general hedge accounting. Under IFRS 9 loans are classified in 3 stages according to the credit quality of the transaction, Loan Loss provisions are calculated according to the expected loss models based on the staging classification.

Impairment: a loan is considered to be impaired when it is probable that not all of the related principal and interest payments will be collected.

L

Loan Loss provisions: banks set aside loan-loss provisions (or loan loss allowances, or credit provisions) to take account of the likelihood that some loans may not be repaid in full.

LGD: Loss given default (LGD) is the amount of money a bank or other financial institution loses when a borrower defaults on a loan, depicted as a percentage of total exposure at the time of default.

LTV: is the acronym of loan to value, that is the value of the loan exposure to collateral value

M

Mortgage: a mortgage loan is a debt instrument, secured by the collateral of specified real estate property that the borrower is obliged to pay back with a predetermined set of payment.

N

Non-performing Loans: a nonperforming loan (NPL) is a sum of borrowed money whose scheduled payments have not been made by the debtor for a specified period of time – usually 90 days.

O

Overdrafts: an overdraft is an extension of credit from a lending institution that is granted when an account reaches zero. The overdraft allows the account holder to continue withdrawing money even when the account has no funds in it or has insufficient funds to cover the amount of the withdrawal.

P

PD: probability of default is the likelihood over a specified period, usually one year, that a borrower will not be able to make scheduled repayments. It can be applied to a variety of different risk management or credit analysis scenarios.

Performing Loans: according to the International Monetary Fund, a performing loan is any loan in which: interest and principal payments are less than 90 days overdue; less than 90 days' worth of interest has been refinanced, capitalized, or delayed by agreement; and continued payment is anticipated. All conditions must be present for a loan to be performing. However, the specific definition is dependent upon the loan's particular terms.

Prudential regulation: Prudential regulation is a type of financial regulation that requires financial firms to control risks and hold adequate capital as defined by capital requirements, liquidity requirements, by the imposition of concentration risk (or large exposures) limits, and by related reporting and public disclosure requirements and supervisory controls and processes.

R

Regulatory capital: is the liquid capital that must be held by banks and other depository institutions to cover the risk levels of their assets.

S

Staging criteria: IFRS 9's general approach to recognizing loan loss provisions is based on a three-stage process which is intended to reflect the deterioration in credit quality of loan: **Stage 1** covers loans that have not deteriorated significantly in credit quality since initial recognition or (where the optional low credit risk simplification is applied) that have low credit risk. For this category, the loan loss provisions are calculated as 12 months expected credit losses. **Stage 2** covers loans that have deteriorated significantly in credit quality since initial recognition but that do not have objective evidence of a credit loss event. For this category, the loan loss provisions are calculated as lifetime expected credit losses. **Stage 3** covers loans that have objective evidence of loss at the reporting date. For this category, the loan loss provisions are calculated as lifetime expected credit losses.

SME: small and medium-sized enterprises (SMEs) or small and medium-sized businesses (SMBs) are businesses whose turnover fall below certain limits.

SICR: with the exception of purchased or originated credit-impaired financial assets, the Loan Loss provisions for financial instruments is measured at an amount equal to lifetime expected losses if the credit risk of a financial instrument has significantly increased credit risk (SICR) since initial recognition. Unless the credit risk of the financial instrument is low at the reporting date in which case it can be assumed that credit risk on the financial instrument has not increased significantly since initial recognition. The assessment of whether there has been a significant increase in credit risk is mainly based on an increase in the probability of a default occurring since initial recognition.

SPREAD: Loan Spread is defined as the difference between the nominal interest paid by the client on the loan amount and the reference interest rate observed in the market (Euribor, Ibor etc.)

T

Tier 1 capital: Tier 1 capital is used to describe the capital adequacy of a bank and refers to core capital that includes equity capital and disclosed reserves. Equity capital is inclusive of instruments that cannot be redeemed at the option of the holder.
