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Expected Credit Losses and Regulatory Capital: Effects of IFRS 9 in European Banks

Manuela Rodrigues Boscia[1], José Alves Dantas[2,*], Vitor Leone[3], Herbert Kimura[4]

[1]Accounting Department, Central Bank of Brazil, Brasília, Brazil
[2]Accounting Department, University of Brasilia, Brasília, Brazil
[3]Leicester Castle Business School, De Montfort University, United Kingdom
[4]Department of Management, University of Brasilia, Brasília, Brazil
*Corresponding author: josealvesdantas@unb.br

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Abstract The purpose of this study was to determine the effects of adopting the ECL model on the regulatory capital of European banks, especially whether the post-IFRS 9 capital behaviour pattern suggests evidence of underestimated or excessive regulatory capital requirements in the pre-IFRS 9 period. The results of the empirical tests carried out using five different metrics, confirmed that, besides a significant capital buffers' reduction when the IFRS 9 was first adopted, there was, mostly likely, a regulatory capital underestimation in the period prior to the adoption of the ECL model, since there is evidence that efforts of capital recompositing were taken by the European banks after the implementation of the new accounting standard.

Keywords: *expected credit losses, IFRS 9, regulatory capital, banks, loan loss provision, ECL*

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1. Introduction

Following the 2008 financial crisis a debate began about the role of accounting in ensuring financial stability [1]. It was found that provisions based on incurred losses often prove to be insufficient to bear losses associated with credit risk, as well as being inadequate regarding the moment of recognition [2]. Studies from the Financial Stability Board (FSB), conducted in 2009, showed that the increases of loan loss provisions (LLP) when the losses materialized, led to a pro-cyclical effect, contributing to aggravate the crisis [3].

The G20 raised concerns about accounting methods employed by banks to assess credit losses, arguing that the incurred loss model delays the recognition of losses and, hence, prevents any corrective measures from being taken by financial institutions. A lack of proper risk assessment and the pro-cyclical nature of the impairment recognition, end up resulting in underestimated and delayed provisions (too little, too late), leading to severe criticism from various interest groups, such as regulators and auditors towards accounting polices [4,5].

Following this context, several studies have explored how provisioning practices based on the incurred credit loss (ICL) model (backward-looking) can contribute to pro-cyclicity in bank loans and business, while provisions based on the expected credit loss (ECL) model (forward-looking) can cooperate to reduce that effect in the banking industry [6,7,8,9].

Furthermore, the recognition of losses during the financial crisis was considered inappropriate, since a significant volume of credit losses was recognized during the crisis, leading to the depletion of regulatory capital [10], highlighting the close relationship between banking accounting and prudential regulation. Equity, as determined by accounting standards, is the starting point for calculating banks' regulatory capital. Thus, the LLP influence greatly both the earnings and equity of banks, affecting the regulatory capital. As shown by previous research, this interaction can create incentives for bank capital management through LLP [8,11,12,13,14,15].

The crisis also led to the questioning of the LLP based on the ICL model, which had a decisive influence on the edition of the International Financial Reporting Standard (IFRS) 9, that came into force from 2018 onwards, prescribing the ECL model. The new rules were expected to change the behaviour of banks during credit crises, by potentially reducing pro-cyclicality [16], also affecting the bank's regulatory capital and capital management policies. That would be expected to happen because of the LLP – considered to be the main accruals of banks [17] – significant influence on the regulatory capital [2].

In that sense, the negative impact on regulatory capital arising from an increase in LLP, as a result of a change in accounting practices, necessarily implies a reduction in regulatory capital rates, all else being equal. Since the Basel regulatory requirements have remained unchanged, it would be necessary to restore the capital consumed by the increasing of the loan loss allowance (LLA), if the bank wishes to maintain its solvency at the same level it

was before IFRS 9. Hence, considering the interaction between the Basel III framework and IFRS 9, the understanding that regulatory capital was possibly underestimated before the application of IFRS 9 is reasonable, and if the capital depleted by IFRS 9 implementation is rebuild afterwards, that underestimation would be, therefore, amended. In contrast, if the regulatory solvency indicators do not return to pre-IFRS 9 levels, remaining in that new, shortened level, it could be argued that there was an overestimation of capital needs before the ECL model was adopted, since, in that scenario, the banks would not be taking any measures to restore the regulatory capital to the previous level.

In this sense, the objective of this study was to determine the effects caused by the adoption of ECL model in the regulatory capital of European banks, especially whether the post-IFRS 9 pattern suggest evidence of underestimated or excessive regulatory capital requirements in the pre-IFRS 9 period.

To carry out the empirical tests, data from 99 banks, supervised by the European Central Bank (ECB), were considered, representing 18 European Union countries, during 2015-2019. The results, using five different metrics, confirmed the premise of capital underestimation in the period prior to the adoption of the ECL model – since the results shown regulatory capital movements indicating that European banks are making efforts to restore their capital buffers consumed by IFRS 9 first time adoption.

Discussions about the impacts of the LLP standard on the soundness of the financial system raised questions such as those addressed in this study: can the adoption of the ECL model compromise capital buffer levels? Before IFRS 9 came into force, did banks rely on accounting provisions to face part of the unexpected losses? Would reserves for unexpected losses, i.e. bank capital, be underestimated before the adoption of the ECL provision model? Or, in fact, is it just a classification matter, and would the adoption of IFRS 9 allow reserves for ECL, which in that case had been misallocated as a part of the capital, to be classified properly from then on?

The empirical results shed some light upon these issues, providing probable answers to these questions in the context of ECL model adoption in the European banking system. The tests support the believe that the European banking system would be undercapitalized in the pre-IFRS 9 period, and the ECL model contributed to the identification and mitigation of this problem, as the banks made efforts to rebuild their capital base consumed by the LLP increase.

The analysis of capital behaviour to a great extent may enhance the understanding of factors related to banking soundness, capital costs and credit supply expansion policies practiced by banks. The adoption of IFRS 9 within the domain of the European markets offered an opportunity to expand knowledge of the influence of the ECL model on capital, and potentially can provide some guidance of what may happen in other key markets regarding the effects of the change in LLP, considering banking capital and financial soundness. The consequences of adopting one or other accounting models for LLP, could have a significant impact on how banks assess credit and on regulatory capital management, which is inherently sensitive to credit risk. Lessons from the empirical finding can also help legislators and prudential regulation setters on other markets to understand the practical implications on the regulatory capital of raising provisions levels.

The paper is structured as follows. The next section presents a discussion of the literature and the arguments that support the study hypothesis. Then, the data and the method are described, and the econometric model is specified. Finally, the results of the empirical investigation are analysed. The conclusion section indicates limitations of the study and highlights the research contributions.

2. Background and Hypothesis

2.1. The Effect of ECL on Regulatory Capital

One of the roles of capital in banking is to provide a reserve for protection against peak losses that exceed expected levels. Peak losses do not often occur, but when they do materialize, can be quite large [18]. Losses above expected levels are usually called unexpected losses – those that banks know are probably going to occur, but whose exact timing and degree of severity are unknown. To some extent, interest rates, including risk premia, calculated on risk-weighted credit exposures, may absorb some components of unexpected losses, but never their entirety. That's why capital is needed, to cover the risks of such peak losses. The expected losses are predicted in terms of credit losses average level that the bank reasonably expects to experience. Financial institutions regard expected losses as a cost component of business and manage them in a variety of ways, including through pricing and provisioning.

Regulatory capital must be high enough to face large, unexpected losses, that is: high losses, although low in frequency. Additionally, provisions should absorb expected losses – those that occur more frequently, but in less significant amounts [19]. The effectiveness of regulatory capital as a cushion to absorb unexpected shocks is based upon the existence of a first level of protection, provided by expected loss provisions, as highlighted in Figure 1.

In this context, the Basel III framework [20] highlights two types of provision: the specific provisions, which are attributed particularly to a specific operation or set of operations; and the general provisions. The latter are constituted to face future losses when they materialize and are eligible for being counted as regulatory capital, at the additional tier 2, respecting pre-established prudential limits. The possibility of general provisions to be qualify as part of regulatory capital shows that there is a close relation between non-specific provisioning and capital. A migration to the ECL model, under IFRS 9, significantly reduces the conceptual differences between accounting and prudential losses.

The Figure 2 illustrates, through a loss distribution function, the volume of provisions recognized according to the ICL model at point A, and the respective increase under the ECL model at point A'. The regulatory capital required remains unchanged.

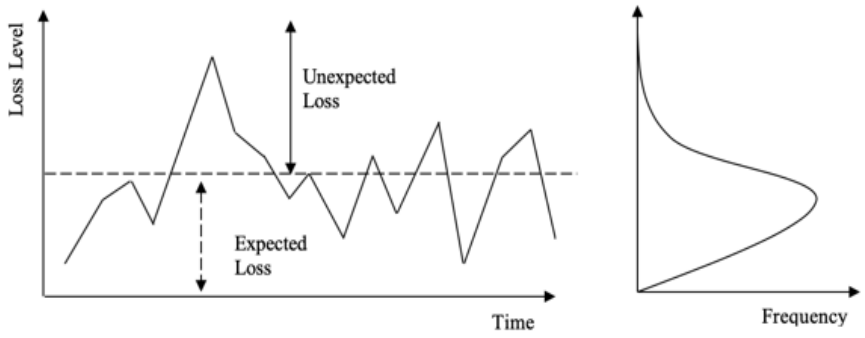

Figure 1. Perspectives of expected loss and unexpected loss, including levels of loss and frequency. Adapted from BCBS [18]

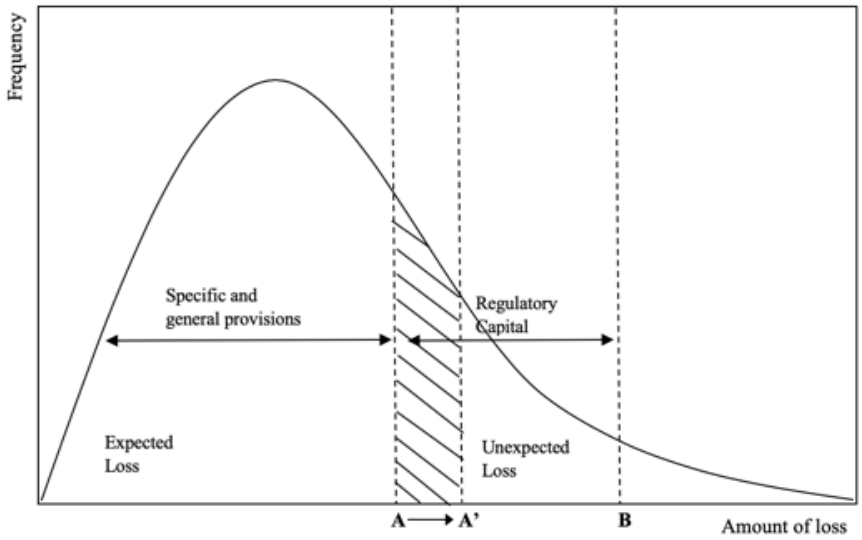

Figure 2. Potential IFRS 9 effects on regulatory capital

To better explore the Figure 2, the following demonstration (Table 1) aims to evidence the mathematical relationship between provisions and regulatory capital resulting from the adoption of the ECL model, all else being equal.

Table 1. Relationship between provisions and regulatory capital caused by the ECL model

$\Delta RC = (B–A')–(B–A)$	(2.1)	$\Delta LLA = A'–A$	(2.7)
$\Delta RC = B–A'–B+A$	(2.2)	$A' = \Delta LLA+A$	(2.8)
$\Delta RC = –A'+A$	(2.3)		
$\Delta RC–A = –A'$	(2.4)	**A' = A'**	(2.8)=(2.6)
$A' = –(\Delta RC–A)$	(2.5)	$\Delta LLA+A = –\Delta RC+A$	(2.9)
$A' = –\Delta RC+A$	(2.6)	$\Delta LLA = –\Delta RC$	(2.10)

Which: ΔRC is the regulatory capital variation, caused by the adoption of the ECL model; **A** is the amount of loan loss allowance when applying the ICL model; **A'** is the amount of loan loss allowance when applying the ECL model; **B** is the amount of provisions and regulatory capital (expected and unexpected losses); ΔLLA is the loan loss allowance variation, caused by the adoption of the ECL model.

The LLA increase, due to the implementation of IFRS 9, caused a reduction of capital, which necessarily entail a reduction in capital rates. Meanwhile, following Basel III, the capital regulatory requirements for banks suffered no modification at the time IFRS 9 was first adopted. Thus, if the bank wants to maintain the same solvency ratios observed at prior to the IFRS 9 implementation, it will be necessary to reconstitute the capital consumed by an LLP increase. In this sense, the way the regulatory capital and the ECL model interact leads to the hypothesis that the regulatory capital could be undersized before the adoption of the new model, being the recompositing of capital rates responsible for the correction of that situation.

Although the capital ratio considers the exposure to credit, market and operational risks, the credit risk accounts for the bulk of most banks' risk-taking activities and regulatory capital requirements [21]. Hence, this study focuses on the impact of the adoption of IFRS 9 considering exclusively the banks' credit risk.

2.2. Hypothesis

LLP and banking capital are cushions designed to preserve banks solvency, protecting them against both expected and unexpected losses. Considering their different purposes, LLP and capital must be establish upon different premises. The optimal amount of regulatory capital is determined mainly taking in regard strategic and long-term arguments, reflecting, among other aspects, the trade-off between risk and assets returns, and the regulatory requirements, without considering specific macroeconomic conditions [22]. LLP are more directly linked to the quality of the loan portfolio and, thus, are more susceptible to short-term fluctuations resulting from the macroeconomic environment and to changes in counterparties solvency [8].

The prospect view of credit quality, introduced by IFRS 9, requires banks to recognize the LLP before a loss event occurs and even when the likelihood of loss is low. As a result, the LLP have a greater impact on retained earnings, an essential regulatory capital component. In general, the ECL model is expected to significantly increase the provisions [2,3,22,23]. In this context, it is reasonable to understand that the adoption of the ECL model led to a regulatory capital reduction when the IFRS 9 was first implemented, with a consequent shortfall in regulatory capital ratios, at different levels, all else being equal.

After the IFRS 9 was initially adopted, and once the reduction in regulatory capital has been confirmed, it may be expected that banks take actions to rebuild their capital resources consumed by the increase in provisions or, otherwise, they can choose to keep their capital at the new level. There are two possibilities of understanding regarding the situation prior to the adoption of the IFRS 9, which are either regulatory capital underestimation or overestimation, depending on how banks reacted after the regulatory capital reduction, and whether they took measures to restore it to a pre-IFRS 9 level.

Considering the premise that if banks promote the restoration of regulatory capital, seeking to re-establish capital ratios to a similar level pre-IFRS 9, it is assumed that this would be the amount considered by the banks as necessary to bear unexpected losses. In other words, after regulatory capital dilapidation, banks saw as necessary to rebuild that core capital to face unexpected losses. For this reason, it would be evidences of a regulatory capital underestimation before the IFRS 9 implementation, because the capital could be considered inflated by the failure to recognize ECL. Thus, to the extent that a proportion of the resources necessary to support unexpected losses was consumed by the provisions set aside for ECL, it would be necessary to restore the full amount.

Alternatively, if it is confirmed that banks do not seek to restore capital buffers, which would then remain at the new reduced level, after the first time IFRS 9 was adopted, it could be assumed that the capital management for banks indicates that this new capital level is sufficient to bear unexpected losses, suggesting that capital in the pre-IFRS 9 period would be overestimated. In that case, some capital is now reallocated to the new ECL, which no need for a new capital recompositing.

Considering this, and with the support of the arguments put forward by BCBS [2], ESRB [3], and Sanchidrián and García [24] about the movements that may be caused by ECL model adoption, the following hypothesis is formulated:

H_1: Since IFRS 9 came into force, European banks have been taking measures to rebuild capital buffers, being configured a regulatory capital underestimation in the period prior ECL model adoption.

3. Method

3.1. Regulatory Capital Metrics

In the light of the severe consequences of the global financial crisis, the Basel III reforms [20] introduced higher minimum levels of Common Equity Tier 1 (CET1), Tier 1 capital and total capital ratios. CET1 became the predominant form of regulatory capital, made up of common shares and retained earnings. Under a macro-prudential perspective three additional capital buffer requirements were introduced: the conservation buffer, the countercyclical buffer, and the systemic risk buffer. A phased implementation was scheduled for the conservation buffer, while the activation of the countercyclical buffer depends on supervisory determinations, after assessing market credit growth conditions that may pose risks to the financial system. The systemic risk buffer is applicable to global systemically important banks (G-SIBs) depending on the systemic importance attributed to the institution by the supervisors. All additional capital buffers must be met with CET1.

The Basel framework also recommends the application of Pillar 2 (P2R) requirements, which are determined at the discretion of the Supervisory Review and Evaluation Process (SREP), an annual procedure which selected European banks overseen by the ECB must be subject to. Depending on SREP results, supervisors may ask banks to hold additional capital reserves, which must be met with CET1.

The combination of Pillar 1, Pillar 2 and additional buffers, results in the total capital requirement for a specific institution (overall capital requirement (OCR)), which is, therefore, different for each bank and may also change over time. It is worth examining each aspect of the prudential requirements, as well as the OCR of each institution, individually. By observing those specifics aspects, the measurement of the effects of the ECL model will be more accurate and more granular. As a result, regulatory capital behaviour after IFRS 9 implementation can be understood from a more general level up to a highly personalized level. To achieve this goal, we intend to measure different types of capital buffers, as shown in Equation (3.1), following Carvalho and Dantas [25].

$$BCap_{i,t} = Cap_{i,t} - CapR_{i,t} \quad (3.1)$$

which: $\boldsymbol{BCap_{i,t}}$ is the Capital Buffer, represented by the surplus of Capital ($\boldsymbol{Cap_{i,t}}$) in relation to minimum capital requirements ($\boldsymbol{CapR_{i,t}}$), for a bank *i*, in period *t*.

The ***BCap*** measure is calculated, alternately, in five different ways, seeking to identify the: (i) capital surplus linked to Pillar 1 requirements (***BPilar1***); (ii) the capital surplus linked to total SREP requirements (***BSREP***); (iii) capital surplus linked to total capital requirements applicable to the bank (***BOCR***); (iv) capital surplus linked to the specific Pillar 1 regulatory requirement to be met with Common Equity Tier 1 (***BCET1***); and (v) capital surplus linked to the total regulatory requirements that must be met entirely by Common Equity Tier 1 (***BrCET1***). The use of different measures of capital buffers allows a type of sensitivity analysis, increasing the robustness of the findings.

3.2. Impacts at the Time when IFRS 9 was First Adopted

Preliminary to the test of research hypothesis **H_1**, we evaluated the impact of the first-time adoption of IFRS 9, performing a statistical comparison of the regulatory

capital buffers of banks, on 31/12/2017, with this same capital measure, immediately after deducting the variation in LLA, brought about by adopting IFRS 9. Only the new provisions will be considered, that is, the increase in the LLA due to the change of the accounting model. It is expected that the capital buffer held on 12/31/2017 (pre-IFRS 9) will be higher than that verified on 01/01/2018 (post-IFRS 9), measured according to Equation (3.2).

$$BCap_{i,18} = BCap_{i,17} - \Delta LLA_{i,18} \quad (3.2)$$

which: $\boldsymbol{BCap_{i,18}}$ is capital buffer, represented by the excess of capital in relation to regulatory requirement, of bank *i*, on 01/01/2018, after the effects of the ECL model; $\boldsymbol{BCap_{i,17}}$ is capital buffer, represented by the excess of capital in relation to regulatory requirements, of bank *i*, on 31/12/2017 (Eq. 3.1); and $\Delta\boldsymbol{LLA_{i,18}}$ is LLA variation, caused by the adoption of the ECL model by bank *i*, on 01/01/2018.

In carrying out the tests, the **BCap** variable will assume the alternating capital buffer measures – **BPillar1**, **BSREP**, **BOCR**, **BCET1** and **BrCET1**.

According to Equation (3.2), regulatory capital on 01/01/2018 is different from that reported by the bank on 31/12/2017 solely because of the impact of LLP recognized through IFRS 9, whether this effect is positive or negative. The possible mitigation of the effects on the capital, caused by the provisions increase, because of the application of prudential transition arrangements (phase-in) allowed by BCBS and in line with the EBA guidelines, is disregarded. The aim is to assess only the impact of changes in provisions on capital for all institutions.

3.3. Evolutionary Pattern of Capital Buffers

The model (3.3) was implemented to carry out the empirical analysis to test hypothesis $\mathbf{H_1}$. It examines the relationship between the capital buffer calculated for the current and previous time, aiming to provide evidence of buffer restoration to the pre-IFRS 9 levels or the maintenance of its level at the new point reached after the ECL model has come into force.

$$BCap_{i,t} = \beta_0 + \beta_i + \beta_1 BCap_{i,t-1} + \beta_2 SIZE_{i,t} + \beta_3 ROE_{i,t} + \beta_4 RISKcred_{i,t} + \beta_5 RISKasset_{i,t} + \varepsilon_{i,t} \quad (3.3)$$

Based on hypotheses $\mathbf{H_1}$ the model includes the independent variable of interest, represented by the coefficient β_1, tested separately for each capital buffer examined – ***BPillar1***, ***BSREP***, ***BOCR***, ***BCET1*** and ***BrCET1***. Control variables ***SIZE***, ***ROE***, ***RISKcred*** e ***RISKasset*** were also incorporated to ensure the tests were robust and to assess the effects of other characteristics on the behaviour of the capital buffers.

The variables were measured as shown in Table 2.

The trend and behaviour of the variables in the period prior to the adoption of the ECL model were assessed and, following this, the changes that had occurred after its implementation were also evaluated. For that purpose, the model (3.3) was estimated in two different periods – pre and post IFRS 9.

Table 2. Measurement of variables and data source

Variable	Measurement
$\boldsymbol{BCap_{i,t}}$	Capital Buffer, represented by the surplus of Capital in relation to minimum capital requirements, for a bank i, in period t.
$\boldsymbol{BPilar1_{i,t}}$	Pillar 1 buffer, represented by the surplus of total capital in relations to Pillar 1 requirements, for a bank i, in period t.
$\boldsymbol{BSREP_{i,t}}$	SREP buffer, represented by the surplus of total capital in relations to SREP requirements, for a bank i, in period t.
$\boldsymbol{BOCR_{i,t}}$	Overall capital requirement buffer, represented by the surplus of total capital in relations to overall capital requirements, for a bank i, in period t.
$\boldsymbol{BCET1_{i,t}}$	CET1 buffer, represented by the surplus of CET1 in relations to minimum CET1 requirements, for a bank i, in period t.
$\boldsymbol{BrCET1_{i,t}}$	CET1 Restricted buffer, represented by the surplus of CET1 in relations to all capital requirements to be met entirely by CET1, for a bank i, in period t.
$\boldsymbol{SIZE_{i,t}}$	Size of bank i, in period t, defined as the natural logarithm of total assets
$\boldsymbol{ROE_{i,t}}$	Profitability level of bank i, in period t, as measured by the return on equity
$\boldsymbol{RISKcred_{i,t}}$	Risk of the credit portfolio of bank i, in period t, defined as the ratio between loan losses allowance (LLA) and the loan portfolio
$\boldsymbol{RISKasset_{i,t}}$	Risk of the bank's assets, of bank i, in period t, defined as the ratio between risk-weighted assets (RWA) to total assets

Source of the data: semi-annual informations from banks' financial reports available on the banks' own website, in the period between 2015 and 2019.

The expected results of each independent variable of the model (3.3) regarding the behaviour of the dependent variable are summarized below.

a) Coefficient β_1: capital buffer from the previous period – $\boldsymbol{BCap_{i,t-1}}$

This variable test whether the capital buffer for the current period is influenced by the surplus capital observed in the immediately preceding period. It is the classic characterization of a dynamic model, in which the value of the dependent variable is initially explained by its lagged behaviour.

The underlying premise is that banks encourage their regulatory capital management to maintain some stability, causing investors, depositors, and regulators to attribute a lower risk to the entity. Thus, it is expected that in the pre-IFRS 9 period, the tests will not reveal very significant coefficients – given the premise that the capital buffer has some level of stability – and a positive relationship with the dependent variable, in line with the findings of Barth, Gomez-Biscarri, Kasznik, and López-Espinosa [26] and Stolz and Wedow [27].

By assessing this variable behaviour in the post-IFRS 9 period, it will be possible to find evidence of capital buffer restoration to pre-IFRS 9 levels, or of the buffers being maintained at the new level reached after implementing the ECL model.

In the post-IFRS 9 period, positive values for β_1, combined with the outcome of $\beta_{1,postIFRS9} > \beta_{1,preIFRS9}$, corroborate hypothesis $\mathbf{H_1}$, which predicts the regulatory capital underestimation at the pre-IFRS 9 period. This outcome is based on the premise that the detection of growth trends in capital buffers after IFRS 9, with greater intensity than that observed in the pre-IFRS 9 period, provides evidence that there is an effort made by banks to rebuild the capital buffer at the time when the IFRS 9 was adopted.

b) Coefficient β_2: bank size – $\boldsymbol{SIZE_{i,t}}$

The size of banks can influence the capital buffer in the following ways: (i) the too-big-to-fail hypothesis assumes that large banks receive support from the regulator in insolvency situations, and hence, could afford to have smaller buffers [28]; (ii) the experience, greater expertise and asset diversification capacity of larger banks would be responsible for reducing the risk awareness, which makes it possible to maintain smaller capital buffers [29]. Then, a negative relationship between the ***SIZE*** and ***BCap*** variables is expected.

c) Coefficient β_3: profitability level – $\boldsymbol{ROE_{i,t}}$

More profitable banks might be able to increase their capital base more easily, using retained earnings, while less profitable banks are likely to have more difficulty in strengthening their capital base [25,30]. Therefore, is expected a positive relationship between the ***ROE*** and ***BCap*** variables.

d) Coefficient β_4: credit portfolio risk – $\boldsymbol{RISKcred_{i,t}}$

According to Ayuso, Pérez, and Saurina [31], Flannery and Rangan [32], and Nier and Baumann [30] ex-ante risk measures tend to be associated with larger capital buffers. Thus, the ***RISKcred*** variable, which represents the credit portfolio risk, seeks to assess the ex-ante effect. The better the quality of the loans, the lower the provisions and losses and, hence, the greater the capital, with a positive relationship between ***RISKcred*** and ***BCap*** being expected.

e) Coefficient β_5: asset risk – $\boldsymbol{RISKasset_{i,t}}$

Still following Ayuso, Pérez, and Saurina [31], Flannery and Rangan [32], and Nier and Baumann [30], it is possible to assume that ex-post risk metrics arise from lower regulatory capital. The ***RISKasset*** variable is an indicator of the risk level to which banks are exposed, representing the bank's total risk and the ex-post effect. Thus, the higher this proportion, the smaller would be the regulatory capital, since the assumption of greater risks would most likely generate greater capital expenditure, so that a negative relationship between ***RISKasset*** and ***BCap*** is expected.

3.4. Sample and Data

Empirical tests were carried out using data from the main European banks supervised by ECB, owing to their economic and financial importance within the European Union, according to Regulation (EU) No. 1024, of 2013. Additionally, this choice was motivated by the way IFRS 9 was implemented in the EU, being adopted at the very same moment for all banks supervised by the ECB. Also, these banks are subject to a uniform prudential framework. Thus, it is possible to compare the effects of the adoption of the ECL model between banks, even between different jurisdictions.

In 2020, there were 117 significant entities, from 18 countries in the European Union, supervised by ECB, that were initially considered for inclusion in the study sample (see Table 3). Semi-annual information was used, available on the banks' own website, in the period between 2015 and 2019. All the data were collected from the banks' financial reports. However, the information needed to carry out the tests, was not always available, the main reasons being as follows: (i) the bank did not disclose the information; or (ii) the information disclosed was not sufficiently clear. Thus, the final sample consists of 99 banks (Table 3).

Table 3. Number of significant banks directly supervised by the ECB in January 2020

Countries	Banks supervised by the ECB	Final sample
Germany	21	13
Spain	12	12
Italy	12	11
France	11	10
Malta	9	8
Belgium	7	7
Austria	6	5
Ireland	6	5
Luxemburg	5	3
Greece	4	4
Cyprus	3	3
Estonia	3	3
Finland	3	3
Latvia	3	3
Portugal	3	3
Slovenia	3	3
Slovakia	3	2
Lithuania	3	1
Sum	117	99

4. Results and Analysis

4.1. Impact on Capital Buffers at the First Time IFRS 9 was Adopted

The empirical tests begin with calculation of the European bank's capital buffers ***BCET1***, ***BrCET1***, ***BPillar1***, ***BOCR***, and ***BSREP*** for 31/12/2017 (pre-IFRS 9) and for 01/01/2018 (post-IFRS 9). These moments are separated by the event of interest under study –IFRS 9 first time adoption – which leads to an expectation of the presence of a significant impact on the sample mean between those two moments. The capital buffers measured at both dates were compared, applying the t-test of comparison between means for paired samples (Table 4).

Table 4. Comparison of the capital buffers through mean difference tests, on 31/12/2017 and 01/01/2018

	BCET1	*BrCET1*	*BPillar1*	*BOCR*	*BSERP*
31/12/2017 Mean	0.14	0.11	0.13	0.10	0.12
01/01/2018 Mean	0.13	0.10	0.13	0.10	0.11
Nominal Diff	-0.01	-0.01	-0.01	-0.01	-0.01
% Difference	-5.5%	-7.1%	-5.1%	-6.5%	-5.7%
T-Statistic	2.99	2.99	3.54	3.54	3.54
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Significance	***	***	***	***	***

Which: *BCET1* is the common equity tier 1 capital buffer; *BrCET1* is the restricted common equity tier 1 capital buffer; *BPillar1* is the capital buffer of Pillar 1, which considers the capital surplus in relation to the Pillar 1 requirements; *BOCR* is the overall capital requirement buffer; *BSREP* is the capital buffer for the supervisor review (Supervisory Review and Evaluation Process).
Statistical significance level: *** (1%), ** (5%) and * (10%)

After the comparison tests between means had been conducted, it was found that the means for the pre and post IFRS 9 moments, for the five proposed buffer metrics, are statistically different. Hence, the results obtained provide evidence that at the time when IFRS 9 was first adopted, there was a reduction in the capital buffers of European banks. The findings corroborate the various theoretical predictions [2,3,24] based on the premise that the increase in provisions to bear credit losses, inherent in the ECL model, would cause a capital reduction in banks.

The statistical significance proof of the ***BOCR*** and ***BrCET1*** variables is especially interesting, as these buffers capture information regarding capital margins at a very individualized level, since they included specific requirements defined by the supervisory entity based on the institutions' idiosyncrasies. Thus, the results provide evidence that prospective provisioning represents a paradigm shift capable of impacting the capital structure and, hence, the institutions' solvency. The reduction in capital margins caused by the IFRS 9 also suggests restrictions in the ability of banks to grant credit, owing to the capital margins reduction, making desirable for capital planning to consider the accounting provisioning model assumptions.

The variables were winsorized at 5% to assess whether the presence of outliers in the sample could modify the results. The results were consistent with those found in the original database – without the treatment of outliers {1}.

4.2. The Evolution of Capital Buffers in the Post-IFRS 9 Period – Hypotheses H_1

The descriptive statistics of the base model (3.3) variables are consolidated in Table 5, including the half-yearly information from European banks for the entire sample period, from 2015 to 2019.

Table 5. Descriptive statistics for the continuous variables of the base model (3.3)

Variable	Mean	Median	Max.	Min.	St. Dev.
BCET1	0.13	0.10	1.08	-0.03	0.10
BrCET1	0.09	0.07	1.02	-0.08	0.10
BPillar1	0.12	0.09	1.05	-0.05	0.11
BOCR	0.09	0.06	0.98	-0.10	0.11
BSREP	0.11	0.08	1.00	-0.08	-0.11
SIZE	11.35	11.22	14.68	6.30	1.62
ROE	0.02	0.03	0.34	-1.06	0.09
RISKcred	0.04	0.02	0.30	0.00	0.05
RISKasset	0.43	0.40	0.98	0.04	0.18

Which: *BCET1* is the common equity tier 1 capital buffer; *BrCET1* is the restricted common equity tier 1 capital buffer; *BPillar1* is the capital buffer of Pillar 1, which considers the capital surplus in relation to the Pillar 1 requirements; *BOCR* is the overall capital requirement buffer; *BSREP* is the capital buffer for the supervisor review (Supervisory Review and Evaluation Process); *SIZE* indicates the size of bank; *ROE* indicates the profitability level of institution; *RISKcred* indicates the risk of the credit portfolio of institution; *RISKasset* indicates the risk of the bank's assets.

Regarding ***BCET1***, ***BrCET1***, ***BPillar1***, ***BOCR*** and ***BSREP*** capital buffers, the central tendency measures (mean and median) show that European banks had a capitalization level above what is required, but with characteristics of dispersion. It is noteworthy that there is evidence of negative values for all the buffers, represented by events which the impact of LLA at the time of IFRS 9 adoption was significant, consuming capital ratios, e.g. Bank of Cyprus.

To ensure the empirical robustness{1}, a series of robustness tests was carried out: (i) the stationary tests Im, Pesaran and Shin (IPS), ADF-Fisher, and PP-Fisher were conducted on non-dichotomous variables to verify possible unit roots in the series; (ii) the variance inflation test (VIF) to test the risk of multicollinearity; (iii) the Hausman test to analyse the endogeneity risk; and (iv) the Durbin-Watson (DW) and the Breusch-Godfrey tests to detect the possible presence of autocorrelation and heteroscedasticity between the regression residuals. The results showed the non-presence of unit roots, multicollinearity, endogeneity, autocorrelation, and heteroscedasticity risks.

The Chow Test was conducted to assess whether the presence of individual bank effects justifies the use of panel data. The results revealed that the fixed effects model is more appropriate than the pooled model. Once the convenience of using the panel data was verified, it was defined the fixed effects model as the most appropriate for the estimations given that the banks in the sample are all those that were classified by the ECB as a significant entity, due to their economic and financial importance within the European Union. Greene [33] highlights that when a model is likely to include the full set cross-sections then the fixed effect model may be the appropriate one.

Finally, the model (3.3) was estimated to find evidence of capital buffer restoration to the pre-IFRS 9 levels or evidence that the capital level was kept near at the new lower point, reached after the ECL model came into force. According to the results shown in Table 6, the coefficients associated with the capital buffer variable from the previous period, showed statistically significant positive signs, in the periods before (Panel A) and after (Panel B) IFRS 9, for all the buffers tested {1}.

The analysis of the lagged capital buffer variable coefficients shows values for β_1 post-IFRS 9 that are positive and higher than the values of β_1 pre-IFRS 9, also for all the metrics assessed (***BCET1***, ***BrCET1***, ***BPillar1***, ***BOCR*** and ***BSREP***). The capital buffer coefficients in the post-IFRS 9 period are always above 1.0 – indicating constant growth – while in the pre-IFRS 9 period the coefficients are around 0.8 – suggesting, in general, reductions in relation to the immediately previous semester. Thus, it was found that $\beta_{1,postIFRS9} > \beta_{1,preIFRS9}$, providing evidence that leads to the confirmation of hypothesis $\mathbf{H_1}$, by configuring the underestimation of the capital requirements premise in the period prior to the adoption of the ECL model. The identification of capital buffer growth movements in the period after IFRS 9, with greater intensity than that observed before IFRS 9, provides evidence that European banks are actively implementing measures to restore the capital buffers that were consumed when IFRS 9 was adopted.

Table 6. Model (3.3) estimates results, for the periods before and after IFRS 9

$BCap_{i,t} = \beta_0 + \beta_i + \beta_1 BCap_{i,t-1} + \beta_2 SIZE_{i,t} + \beta_3 ROE_{i,t} + \beta_4 RISKcred_{i,t} + \beta_5 RISKasset_{i,t} + \varepsilon_{i,t}$

Variable	BCET1	BrCET1	BPillar1	BOCR	BSREP
Panel A: pre-IFRS 9 period					
C	0.03***	0.04***	0.04***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bcap(-1)	0.84***	0.74***	0.85***	0.79***	0.81***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SIZE	-0.00	-0.00**	-0.00	-0.00*	-0.00*
	(0.16)	(0.02)	(0.19)	(0.07)	(0.09)
ROE	0.05***	0.05***	0.05***	0.05***	0.05***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RISKcred	0.06***	0.07***	0.05**	0.05**	0.04*
	(0.00)	(0.00)	(0.01)	(0.03)	(0.06)
RISKasset	-0.02**	-0.02***	-0.03***	-0.03***	-0.03***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Obs. (n)	312	312	314	314	314
R^2	0.81	0.69	0.83	0.74	0.75
F-stat	140.77	77.19	168.66	97.54	104.83
Prob(F-stat)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Panel B: post-IFRS 9 period					
C	0.01	0.00	0.01	0.01	0.01
	(0.61)	(0.77)	(0.63)	(0.73)	(0.69)
BCap(-1)	1.05***	1.03***	1.04***	1.02***	1.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SIZE	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.58)	(0.69)	(0.53)	(0.63)	(0.70)
ROE	-0.00	-0.00	-0.00	0.00	0.00
	(0.73)	(0.93)	(0.87)	(0.93)	(0.94)
RISKcred	0.05**	0.04**	0.06**	0.05**	0.05**
	(0.01)	(0.03)	(0.01)	(0.03)	(0.03)
RISKasset	-0.01**	-0.01**	-0.01	-0.01	-0.01
	(0.02)	(0.03)	(0.16)	(0.13)	(0.16)
Obs. (n)	348	348	348	348	348
R^2	0.93	0.92	0.94	0.93	0.94
F-stat	515.49	458.93	588.97	527.81	550.42
Prob(F-stat)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Which: BCET1 is the common equity tier 1 capital buffer; BrCET1 is the restricted common equity tier 1 capital buffer; BPillar1 is the capital buffer of Pillar 1, which considers the capital surplus in relation to the Pillar 1 requirements; BOCR is the overall capital requirement buffer; BSREP is the capital buffer for the supervisor review (Supervisory Review and Evaluation Process); SIZE indicates the size of bank; ROE indicates the profitability level of institution; RISKcred indicates the risk of the credit portfolio of institution; RISKasset indicates the risk of the bank's assets.
P-value in parentheses. Statistical significance level: *** (1%), ** (5%) and * (10%)

The complementary interpretation of those outcomes and the results obtained in Table 3, which suggested a significant reduction in the capital buffer levels of European banks when IFRS 9 was first adopted, strengthens, and confirms hypothesis $\mathbf{H_1}$. After an immediate reduction in capital buffers on 01/01/2018, the buffer growth trend was more prominent than the tendency seen in the period prior to IFRS 9.

The underestimation of regulatory capital was observed before IFRS 9 came into effect, since this capital had, very likely, been inflated by the failure to properly recognize ECL, leading to a significant reduction in capital buffers and, subsequently, to the perception that the remaining buffers would not be sufficient to cover unexpected losses. Therefore, it was necessary to rebuild banks' capital in the post IFRS 9 period.

For the period prior to IFRS 9, positive coefficients were expected for the capital buffers, ***BCap(-1)***, although below 1.0, according to the premise regarding the stability capital buffers' levels, in line with the findings of Barth, Gomez-Biscarri, Kasznik and López-Espinosa [26] and Stolz and Wedow [27]. Regardless the coefficients being around 0.8 for all tested metrics, the results suggest a tendency towards a reduction in the buffer, even if slight, in the period prior ECL model. This kind of behaviour can be justified by the gradual implementation of Basel III, which imposed a systematic increase in capital requirements between 2013 and 2019. Thus, there was an

annually reduction of capital buffers, which were affected by the increase in capital requirements at the beginning of each year. During this period, after the initial impact of the increase on the prudential requirement, it is likely that banks have made capitalization efforts, generating a cycle of raising and lowering the capital buffer as the Basel III schedule was moving forward, up to 2019.

Regarding the control variables, estimations related to pre IFRS 9 period found that, in general, the capital buffers of European banks are: negatively related to banks size (***SIZE***) and assets risk (***RISKasset***); and positively associated with profitability levels (***ROE***) and credit risk (***RISKcred***) – which corroborates the predictions made about their association with the dependent variable, based on Afzal [29], Ayuso, Pérez, and Saurina [31], Carvalho and Dantas [25], Flannery and Rangan [32], Fonseca and González [28], and Nier and Baumann [30].

After IFRS 9 implementation, no statistically relevant relationships were found for the dependent variable, in any of the analysed buffers, for the variables ***SIZE*** and ***ROE***. The poor ability of these control variables to explain the capital buffer behaviour in the post-IFRS 9 period can, perhaps, be attributed to the fact that movements in capitalization levels in this period may be more influenced by the prospect of rebuilding capital levels than by other factors. In the case of the variables representing credit risk (***RISKcred***) and assets (***RISKasset***), positive and negative associations were found, respectively, with capital buffers, in line with expectations, with the caveat that in the case of this second variable, statistical significance can only be verified for estimates with ***BCET1*** and ***BrCET1***. The relevance of credit risk to the capital buffer behaviour is consistent with the premise that this risk is fundamental in determining the LLP.

4.3. Analysis

Maintaining adequate solvency levels to support unexpected losses is essential for the continuity of the bank's activities and for systemic risk mitigation. Therefore, capital must be properly dimensioned. In contrast, the recognition of ECL arising from credit risk reduces profitability and directly consumes banking capital. Properly balancing capital requirements and credit risk is a constant challenge for banks.

By following the evolutionary patterns of the European banks' capital between 2015 and 2019, it was possible to identify a modification in regulatory capital composition. Mainly, an increase in the representativeness of core capital over the analysed period is noticed. Therefore, the analysis of the results provides indications that Basel III reforms were able to strengthen capital, increasing its quantity and quality. Even so, the adoption of ECL model, suggests change in banks' capital.

Certainly, IFRS 9 brings more challenges to credit risk management and for capital measurement. The significant increment in the LLP at IFRS 9 first time adoption, as evidenced, indicates that the objectives regarding the size of provisions were very likely achieved. However, the aims related to the improvement in the timing of the LLP, should still be established over the next few years, and under different, or even stressful, circumstances.

As of 01/01/2018, banks must continuously assess the nature, probability of loss and risks involved in loans, as well as those related to credit granting decisions, adjusting their policies to IFRS 9 demands. At the same time, bank capital must be prepared to immediately absorb negative impacts of new loan loss recognitions. The efforts made to rebuild the capital in the post-IFRS 9 period suggests that banks are aware of this necessity. The perception of the bank's risk by external users of accounting information can be directly affected if the bank is not alert to unexpected fluctuations in LLP and capital.

The reduction on banks' capital margins, because of IFRS 9, also compromises their capacity of granting credit, making it desirable for capital planning to consider the ECL model assumptions. Having sufficient capital to expand their activities and take advantage of market opportunities, without compromising solvency levels, is a matter of the utmost importance for banks. The trend of capital growth at a higher pace than the one observed in the pre-IFRS 9 period, which suggests banks efforts to rebuild capital, point to an active capital management. Future analyses, also considering dividend distribution policies, can better explore this aspect.

Another challenge, also related to the increased in discretion, is comparability between banks in different jurisdictions, since similar circumstances can give rise to different amounts of provisioning depending on choices made by the banks. The role of Pillar 2 supervisory processes, such as SREP, may go through changes of scope to meet new supervisory needs. Observing the behaviour of Pillar 2 requirements and systemic risk over the next few years, can bring relevant information in this context.

As credit risk will materialize more quickly, which could make earnings and capital more volatile, it will be relevant to assess the possible impacts on banks' cost of capital and funding.

Considering aspects related to systemic risk, a prospective credit risk assessment and its impact on capital should contribute to mitigate bank loan procyclicality, as was expected by the standard-setters and supervisory bodies when the IFRS 9 was designed [8]. Once again, the results obtained seem to point to the maintenance of higher levels of LLP and capital, which should be, possibly, more adequate than those verified before IFRS 9. With more accurate accounting information, which provisions made in accordance with ECL model are expected to provide, the users will probably be able to make better decisions, better allocating their resources and contributing to the strengthening of the banking system. This can be particularly relevant since during the global financial crisis, the big accountancy companies failed in spotting the quality of banks assets and liabilities.

5. Conclusion

The purpose of this work was to determine whether the post-IFRS 9 pattern generates evidence of underestimated or excessive regulatory capital requirement in the pre-IFRS 9 period. The tests results indicate that, since the banks took measures to rebuild their capital base after the

IFRS 9 implementation, it is likely that regulatory capital was underestimated in the period pre-IFRS 9.

The limitations of the research are related to the fact that following the IFRS 9 publication in 2016, with effects only starting from January 2018, it is possible that some banks have been preparing to receive the standard, by adopting capital management actions in the pre-IFRS 9, which are not captured by the method used in the empirical tests. In any case, the tests were able to detect an impact of the ECL model on capital buffers. Nevertheless, the regression model seems to be adequately specified, incorporating the relevant control variables established from the literature review.

The paper brings contributions to the ongoing and relevant debate about financial system regulation. The assessment of capital buffers behaviour in the pre and post IFRS 9 periods made it possible to better understand how the ECL model and bank capital interacted, while shedding light on factors related to the maintenance of reserves to support expected and unexpected losses. One of the main problems brought to light by the 2008 crisis was the insufficiency of reserves to support losses that – at the very least – should have been expected, culminating in the excessive expenditure of resources that were destined to support unexpected losses.

The process of responding to the implementation of IFRS 9 is still ongoing. Little time has passed since the adoption of the new model, the phase-in scheduled for transitioning effects will be completed by 2022, and future financial crises are yet to test the resilience of the ECL model, and the adequacy of the capital buffer levels. The findings of this study, while clarifying key factors, encourage new research questions, which may explore, for example, the impact of adopting IFRS 9 in banking niches or specific countries, identify other variables that may influence capital buffers behaviour from 2018 onwards, or verify the behaviour trends found in this study.

Finally, examining the impact and implications of adopting IFRS 9 in the European banking system provides evidence of what may happen in other key markets, regarding the effects of changing the provisioning model in capital banking and bank soundness. Contributions also extend to regulatory bodies and standard setters, which can use these research results to carry out impact studies, or to assess the conditions for applying the ECL model and its possible consequences for bank solvency.

Note

{1}Non-tabulated tests are available on request, including: comparison of capital buffers at the first time IFRS 9 was adopted, with winsorized at 5%; the stationary tests Im, Pesaran and Shin (IPS), ADF-Fisher and PP-Fisher; the variance inflation test (VIF) to test the risk of multicollinearity; the endogeneity test; the Durbin-Watson (DW) and the Breusch-Godfrey tests to detect autocorrelation and heteroscedasticity between the regression residues; and the model (3.3) estimations for the periods before and after IFRS, with winsorized data at 5%.

Statement of Competing Interests

The authors have no competing interests.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon request.

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