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Impact de la réforme Bâle III sur les banques marocaines

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The Impact of the Basel III banking regulation on Moroccan banks[1]

Mohammed Mikou[2]

ABSTRACT

This paper estimates the social costs and benefits of the Basel III banking regulation application to Moroccan banks, which, inter alia, imposed higher capital requirements. The paper quantifies the impact of higher capital requirements on (i) lending rates, (ii) bank refinancing costs, and (iii) banking system resilience. Our findings indicate that the increase in capital requirements for Moroccan banks has a limited impact on lending and refinancing costs. The benefit of greater banking system resilience in terms of systemic risk appears to be more significant in expectations.

Keywords: Capital regulation, Basel III, Moroccan banks

JEL-classification : G21, G28.

RÉSUMÉ

Ce papier estime les coûts et bénéfices sociaux de l'application de la réglementation bancaire Bâle III aux banques marocaines, qui, entre autres, a imposé des exigences plus élevées en matière de capital. Le papier quantifie l'impact de l'augmentation des exigences en capital sur (i) les taux de prêts bancaires, (ii) les coûts de refinancement des banques, et (iii) la résilience du système bancaire. Nos résultats indiquent que l'augmentation des exigences de capital pour les banques marocaines a un impact limité sur les taux de prêts bancaires et sur leur coût de refinancement. Le gain en résilience du système bancaire en termes de risque systémique apparaît plus significatif.

Mots clés : Réglementation des fonds propres, Bâle III, banques marocaines.

Classification-JEL : G21, G28 .

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Introduction

This study aims to quantify the costs and benefits of higher capital requirements resulting from the revised Basel Capital Accord (Basel III). The costs are reflected in the increased lending and funding spreads of Moroccan banks. The benefits arise from the potential reduction in banking crises and the expected GDP losses resulting from such crises. Given the economic importance of the banking sector in Morocco, it is valuable to provide a quantitative assessment of the costs and benefits of the new regulations. Our estimations were intended to be broadly correct, offering orders of magnitude rather than exact point estimates. This approach relies on the first principles of corporate finance and applies standard econometric techniques. It includes estimating the extent to which the risk-return profile of banks and the funding structures change in response to higher capital requirements and calculates the corresponding change in systemic risk.

It is noteworthy that we estimate only the social costs (lending and funding spreads) and benefits (systematic and systemic risk) of higher capital requirements and do not include other aspects of Basel III financial reform. For example, neither the costs and benefits resulting from enhanced liquidity standards, nor the impact of accounting standards are included in our calculations.

Our analysis provides evidence of the beneficial consequences of improved capitalisation on banking resilience and suggests that costs are negligible. Our analysis yields three main results: First, we find that 1 percentage point (pp) increase in the ratio of capital to risk-weighted assets leads to a 7.69 basis points (bp) increase in lending spreads. Since the implementation of Basel III has led to a 2%[3] increase in solvency ratios in Morocco, we estimate the total impact of a 15.4 bp increase in lending spreads, which is lower than that in other countries in comparable literature. Second, our results suggest that an increase in the capital ratio has a negligible effect on bank funding costs, as indicated by the two solvency measures employed. The impact on funding costs is estimated to be approximately 1 bp according to the leverage ratio, whereas it is roughly 2 bp according to the inverse Tier 1 ratio (IT1). According to our estimates, this effect is consistent even if the amount of bank capital doubles. Third, our analysis suggests that an increase in capital can lead to a significant improvement in the average resilience of the Moroccan banking system. However, the extent of this improvement may be moderated during times of financial crises.

This study is organised into four sections. Section 2 provides a review of the existing literature on the impact of Basel III on the banking sector in several countries. Section 3 introduces the methodologies used in our study, and Section 4 presents the empirical findings on the effect of heightened Basel III capital ratios on the lending and funding rates of Moroccan banks as well as their resilience.

[3] In the Moroccan context, the mentioned 2% increase corresponds to the rise in the solvency ratio implemented in 2012, increasing from 10% to 12%, without any changes to the calculation methodology. However, starting from 2014, the calculation method for the solvency ratio became progressively more restrictive due to the implementation of transitional measures regarding the eligibility of different components of capital.

1. Literature Review

The 2008 Global Financial Crisis and the subsequent Great Recession highlighted the importance of the financial system and the need to ensure its stability and efficiency. In response, the G20 leaders tasked the Financial Stability Board (FSB) and the Basel Committee on Banking Supervision (BCBS) to reform global standards for banking regulations and supervision to improve financial stability. Specifically, the BCBS was tasked with raising the quantity and quality of capital requirements, creating new global liquidity standards, fundamentally altering risk-modelling processes, and taking other related actions. Consequently, many complex capital and liquidity rules have been created or expanded. In addition, certain institutions are subject to special oversight and regulation due to their size, complexity, and interdependence. (See Figure 1 for a comprehensive overview of the regulatory reforms that have been implemented or are underway.)

Figure 1: Regulatory reforms (Oliver Wyman 2016)

BASEL III	ONGOING AND RECENTLY COMPLETED WORKSTREAMS
• Quantity and quality of capital (minimum capital requirements and composition thereof)	• Standardized approach for credit risk, and operational risk
• Regulatory buffers (capital conservation buffer and countercyclical buffer)	• Capital floors
• Counterparty credit risk capital requirements (Standardized approach for measuring counterparty credit risk exposures, margin requirements)	• Constraints on use of internal models
• Leverage ratio	• Revised Leverage ratio
• Liquidity reforms (Net Stable Funding Ratio (NSFR) and Liquidity Coverage Ratio (LCR))	• Interest rate risk in the banking book (IRRBB)
• Measuring and controlling large exposures	• Fundamental review of the trading book (FRTB)
	• Securitization
	• Haircut floors for Securities Financing Transactions
	• Total Loss-Absorbing Capacity (FSB regulation)
	• Stress testing (primarily jurisdictional regulation)
	• Step-in risk

Due to the breadth and scope of regulatory reforms, there have been calls for regulators to appraise the cumulative effects of these changes and assess the extent to which their adverse consequences may signal the need for recalibration of regulatory changes. Both market participants and senior officials have raised potential problems with the calibration of the reforms. Both the calibration of reforms considered in isolation (e.g. the overall level of leverage ratio requirements) and the calibration of reforms considered collectively (e.g. the interaction between risk-sensitive and non-risk-sensitive capital ratio requirements) were questioned.

Existing literature presents a wide range of results regarding the optimal calibration of capital reforms, making it difficult to find a conclusive and appropriate answer. Different methodologies and underlying assumptions have resulted in optimal level estimates ranging from 8% to over 20% for risk-weighted assets. As an example of the low end of the calibration, Nguyen (2014) calibrated a model indicating an optimal capital requirement equal to 8% Tier 1 capital to risk-weighted assets, whereas for Begenau (2015), the optimal requirement is 14% Common Equity Tier 1 capital. Using a nearly 200-year dataset across several countries, Miles, Yang, and Marcheggiano (2012) arrive at an optimal bank capital calibration between approximately 16% and 20% Tier 1 capital to risk-weighted assets based on the definitions in effect at the time (which is important as changes in the definition of risk-weighted assets affect the capital ratio). Finally, according to Dagher et al. (2016), capital requirements between 15% and 23% of risk-weighted assets would have been sufficient to absorb losses in most previous banking crises.

The reforms imposed additional costs on banks as lenders in the form of higher funding costs resulting from higher capital and liquidity requirements. These higher costs may then be partially or fully passed on to the broader economy in the form of higher credit costs or lower lending volumes.

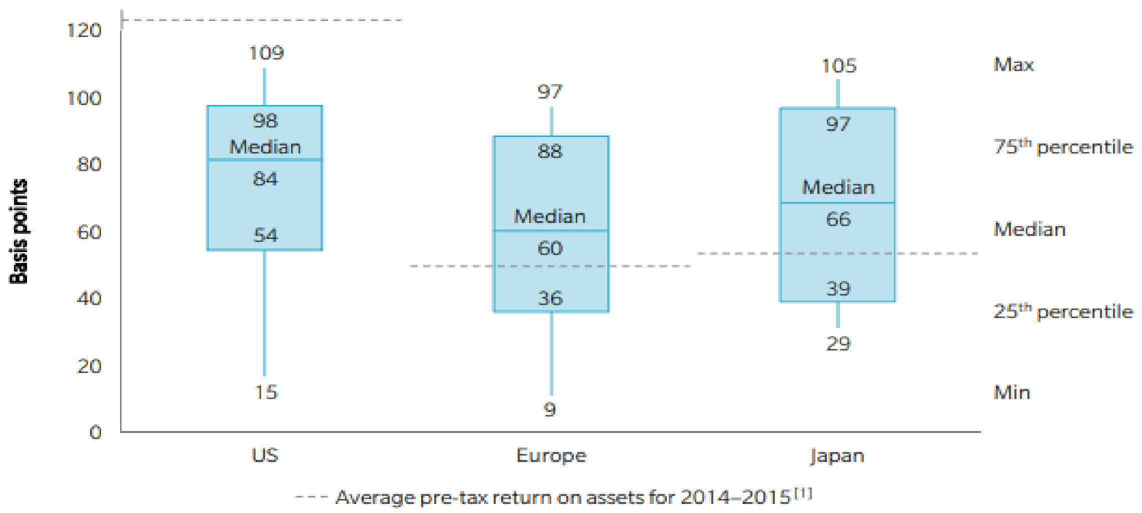
Several studies have been conducted to measure the impact of these reforms on economic financing and growth. Among the first and most substantial are those carried out by the Macroeconomic Assessment Group (MAG) (MAG, BCBS, 'Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements') of the BCBS in 2010 before the introduction of the Basel III reform, which mobilized nearly 97 different models and simulation tools on the effects of the transition. They were complemented by those of the Long-term Economic Impact group (LEI) (LEI, BCBS, 'An assessment of the long-term economic impact of stronger capital and liquidity requirements'), which focused on measuring the long-term effects on economic growth. The MAG concluded, with a wide range of estimates, that the cost of credit would increase by an average of 0.15 pp for each 1% increase in the capital ratio. Until recently, absolute lending costs did not increase on average, as accommodative monetary policies lowered safe interest rates, and thus offset the upward pressure of increased prudential requirements on loan rates. However, as global monetary policy has begun to tighten, this may change. Since 2010, the financial industry, academics, central banks, and other institutions have conducted additional research on the Basel III reforms.

Using a set of assumptions selected to ensure that the studies were reviewed consistently and to reflect the overall impact of the reforms on capital levels, the consulting firm Oliver Wyman published a report that presented the key findings of a 150-page impact study conducted in 2016, based on 400 analyses from academics, official institutions, and the private sector. They estimated the gross impact of the Basel III capital and liquidity requirements on funding costs to vary between 15 and 109 bp in the United States, with a median increase of 84 bp (see Figure 2). In Europe, the impact ranged from 9 to 97 bp, with a median increase of 60 bp. In Japan, the estimated increase in funding costs ranged from 29 to bp, with a median increase of 66 bp. Despite the broader bp effect in the United States, the increase in funding costs is expected to have a relatively larger overall impact in Europe and Japan, where the average pre-tax rates of return on assets are lower than in the United States and where the size of the banking system is much larger than that of their economies.

The magnitude of the impacts is largely the result of differences in the gap between the initial and target capital ratios (higher in the United States and Japan than in Europe) and differences in the density of risk-weighted assets (RWA/total assets), which are higher in the United States than in Europe and Japan. In addition, the impacts analyzed in this study may vary within the jurisdictions described here (for example, within Europe).

Figure 2: Gross impact of regulatory reforms on bank funding costs

GROSS IMPACT OF REGULATORY REFORMS ON BANK FUNDING COSTS



[1] Average of 2014–2015 return as (total net income before taxes)/(total assets); Source: SNL, Oliver Wyman analysis
Source: Oliver Wyman analysis. *Refer to Section 5 and Appendix B for further details and references*

Assessing the impact of financial regulation on bank behaviour is a challenging task for numerous reasons, namely data availability and a potential time lag between the announcement and implementation of measures. To address this issue, the Bank for International Settlements (BIS) developed the Financial Regulation Assessment (FRAME), an interactive and publicly available repository of impact estimates. FRAME currently contains 83 studies and 139 quantitative impact estimates covering 15 countries or regions and facilitates the comparison of regulatory effects across more than 10 variables.

In a study conducted by BIS researchers (Boissay et al., 2019), the authors examined the impact of two regulatory metrics: the capital adequacy ratio and the one-year liquidity metric 'Net Stable Funding Ratio' (NSFR). The authors cautioned that although initial conclusions can be drawn from their analysis, the heterogeneity of the results and the lack of hindsight on certain recent measures need to be considered. The authors found that an increase of 1 pp in the capital adequacy ratio resulted in an average increase of 20 bp or more in banks' weighted average cost of financing. While the impact on credit growth appears to be positive, the authors noted considerable heterogeneity in results across different studies. The authors also found that considering second order (macroeconomic) effects explained some of the dispersion in the results. Without considering these effects, the average impact was 0.29%, but it increased to 2.13% in studies that included them, resulting in an average impact of 0.4%. However, during the transition phase, when banks need to improve their capital ratios, the impact on credit growth was found to be strongly negative at -6.9%.

The authors also compared the impact of regulations on bank behaviour during normal and crisis periods. The one-year liquidity ratio, NSFR, was found to have the clearest countercyclical effects, with banks having more stable funding lending in times of crisis and increasing their credit growth less in normal times. The authors note that a higher NSFR enhances bank resilience and contributes to financial stability. However, further analysis is required, particularly regarding more recent measures, owing to the heterogeneity of the results.

In 2010, Bank Al-Maghrib began the process of transposing the Basel III framework into the Moroccan economic and financial context, with a focus on promoting gradual and prioritised implementation of these international standards. Specifically, Bank al-Maghrib implemented Basel III gradually by prioritising two major reforms related to capital and liquidity. In 2013, the bank issued a circular that transposed the capital standards prescribed by the BCBS in December 2010 with the aim of enhancing the quality and quantity of capital. Concurrently, the bank also issued a new circular on the Liquidity Coverage Ratio (LCR) recommended by the BCBS, aiming to strengthen the liquidity profile of banks and promote their resilience to a liquidity shock.

Under the new regulations, credit institutions are required to maintain a Tier 1 capital of at least 9% and Tier 1 and Tier 2 capital of at least 12%, which are higher than those imposed by the BCBS on its members. Instruments included in the capital must meet the eligibility criteria specific to each category, and the purchase of these instruments should not be directly or indirectly funded by the institution.

The new rules were implemented on 1 January 2014 with a gradual phase in some provisions planned until 2019. Technical notice is being developed to clarify the application of the circular, particularly regarding transitional provisions. Bank al-Maghrib's approach to implementing Basel III appears to prioritise the stability and resilience of the banking system while giving institutions time to adjust to new requirements. Appendix 1 provides additional information on the transposition process.

2. Methodology

This section introduces the methodology used in this study. Several methods and models are used in the literature to analyse the impact of higher capital requirements on banks linked to Basel III, which are utilised by the institutional, academic, and private sectors. Specifically, we can cite the following: (i) capital adequacy modelling, (ii) stress testing, (iii) liquidity modelling, (iv) credit risk modelling, (v) market risk modelling, (vi) dynamic stochastic general equilibrium (DSGE) models, (vii) microsimulation models, (viii) agent-based models, (ix) balance sheet-based methods, and (x) regression methods. A description of these methods and models is provided in Appendix 2. In our analysis, we used the last two methodologies (balance sheet-based methods and regression methods) along with stress testing based on a systemic risk measure, SRISK.

2.1. Impact of capital ratio increase on lending rate

We used an accounting model inspired by Slovik and Cournède (2011). The model features an explicit, simplified representation of the aggregate balance sheet of the banking sector, as shown in Table 1.

Table 1: Aggregate bank balance sheet

Assets	**Liabilities**
Loans	Debt
Other Assets	Common Equity

To measure the impact of a capital ratio increase on the lending rate, we incorporate 1 pp increase in equity relative to risk-weighted assets financed by debt. This increase in bank capital affects bank liabilities and equity structures, as shown in Table 2.

Table 2: Aggregate bank balance sheet

Assets	**Liabilities**
Loans	Debt $-\frac{RWA}{100}$
Other Assets	Common Equity $+\frac{RWA}{100}$

Consequently, the overall bank funding costs increase. By considering the return on both sides of the balance sheet and assuming the banks' cost of equity and debt remain constant, we can deduce the lending spread that banks need to adjust their lending rate and compensate for the change in funding cost:

$$r_t^{AL} \times \mathrm{LA} + r_t^{AO} \times OA = r_t^{D} \times \mathrm{DA} + r_t^{E} \times EA, \tag{1}$$

$$r_t^{*AL} \times LA + r_t^{AO} \times OA = r_t^{D} \times \left(DA - \frac{RWA}{100}\right) + r_t^{E} \times \left(EA + \frac{RWA}{100}\right), \tag{2}$$

$$(r_t^{*LA} - r_t^{LA}) = \frac{(r_t^E - r_t^D)}{LA} \times \frac{RWA}{100}, \quad (3)$$

Where:

LA – Loans to Total Assets (%)	r_t^{AL}–Return on Loans (%)
OA – Other Assets to Total Assets (%)	r_t^{AO} – Return on Other Assets (%)
DA – Liabilities to Total Assets (%)	r_t^{D} – Cost of Borrowing (%)
EA – Common Equity to Total Assets	r_t^{E} – Cost of Equity (%)
RWA – Risk-weighted Assets to Total Assets (%)	

Equation (1) shows that returns on bank assets are equal to bank funding costs, which are determined by the cost of liabilities and the cost of equity. Equation (2) incorporates the 1 pp increase in bank capital relative to risk-weighted assets. Equation (3) is a combination of Equations (1) and (2), which gives the increase in bank lending spreads as a result of 1 pp increase in the ratio of bank capital to risk-weighted assets.

2.2. Impact of capital ratio increase on bank funding

In this study, we present a proposed panel data model guided by Junge and Kugler (2012), Miles et al. (2011), and Toader (2014). The proposed model is based on the theoretical framework of the Modigliani-Miller theorem (MM) and Capital Asset Pricing Model (CAPM).

MM serves as a benchmark for the analysis of changes in capital structures at the microeconomic level. The theorem, under certain initial assumptions, demonstrates that capital structure does not affect the value of a firm and suggests that there is no optimal leverage ratio. However, in practice, it is widely accepted that due to differential tax treatment, equity is often more expensive than debt financing. Therefore, relaxing the MM assumptions allows us to investigate the actual impact of capital requirements on banks' refinancing costs.

An important conclusion of MM is that equity becomes riskier when leverage increases. The theorem states that when more equity capital is utilised, the volatility of the return on equity decreases, while the safety of debt increases, lowering the required rate of return on both forms of funding. This is achieved by maintaining the weighted average cost of capital (WACC) constant (Modigliani and Miller, 1958).

$$R_{asset} = R_{equity}\frac{E}{D+E} + R_{debt}\frac{D}{D+E} = WACC, \quad (4)$$

where R_{asset} is the return on assets, R_{equity} is the return on equity, R_{debt} is the return on debt, E is total equity, and D is total debt.

In accordance with the commonly used CAPM, a firm's equity or systematic risk, denoted by β_{equity}, is determined by the connection between the rate of return on its stock and the general return on the market. This relationship can be expressed as follows:

$$R_{equity} = R_f + \beta_{equity}(R_{market} - R_f). \quad (5)$$

Combining Equations (4) and (5) yields the following expression:

$$\beta_{asset} = \beta_{equity}\frac{E}{D+E} + \beta_{debt}\frac{D}{D+E}, \quad (6)$$

The existence of deposit insurance implies that banks' deposit liabilities are considered to be practically devoid of risk. However, it is not suitable to accept an absence of risk in the case of non-deposit debt. Importantly in the context of the CAPM, the term 'riskless' does not indicate that the default probability of debt is zero. Rather, it refers to the weaker condition that any fluctuation in the value of debt is unrelated to broad market changes. Under this assumption, where the expected return on non-deposit debt approximates the risk-free rate ($R_{debt} \approx R_f$), Equation (6) can be expressed as follows:

$$\beta_{equity} = \beta_{asset}\frac{E+D}{E} = \beta_{asset}\, LVG, \qquad (7)$$

where LVG refers to the leverage ratio. Assuming debt is risk free, we can deduce that equity risk follows a linearly increasing pattern as the leverage ratio increases. This finding suggests that a reduction in the leverage ratio leads to a lower level of systematic risk.

Therefore, we suggest the following panel data model, inspired by Miles et al. (2011), Junge and Kugler (2012), and Toader (2014):

$$Beta_{it} = a + b\, Solvency_{it} + \eta_i + \varepsilon_{it}, \qquad (8)$$

where:

$Beta_{it}$ *: systematic risk,*

$Solvency_{it}$: *Leverage (LVG) or Tier 1 (T1) ratios,*

and η_i: *specific effect i and* ε_{it}: *error term.*

The systematic risk of each bank is calculated according to the CAPM:

$$Beta_i = \frac{covariance(R_i, R_m)}{\sigma_m^2}.$$

After obtaining parameters a and b, it becomes possible to assess the impact of a capital ratio increase on banks' funding costs using Equations (4) and (5).

2.3. Impact of capital increases on bank resilience

In the absence of a commonly accepted academic definition of systemic risk, several international institutions agreed in 2009 to define it as the potential for disruptions in the functioning of financial services caused by the deterioration of some or all of the financial system, which have a widespread negative impact on the actual economy. To provide a simplified overview of the concept of systemic risk, Kaufman and Scott (2003) and Taylor (2000) asserted that it must contain at least three fundamental elements: a trigger, the transmission or contagion of shocks throughout the financial system, and a significant effect on the real economy.

As there are various potential triggers and transmission channels for systemic crises, the literature has developed approximately 30 methods for measuring systemic risk (Bisias et al., 2012). However, this note concentrates on a systemic risk measure that has been widely utilised by central banks in recent years and is extensively reported in the literature: SRISK (systemic risk). This measure is also published daily on certain platforms, such as the V-Lab created by NYU Stern School of Business and managed by a prominent scientific community that includes Robert Engle, the Nobel Prize winner in economics.

SRISK is a measure that estimates the potential loss of capital of a financial institution in the event of a systemic crisis as a way to test its solvency. This is similar to the stress tests that banks are subjected to. If the estimated capital loss is greater than the available capital, the institution is considered to be at systemic risk based on the amount of difference. This implies that a rescue plan up to this amount should be considered to prevent the institution from collapsing during a crisis. Thus, the overall systemic risk in the financial sector is captured by the sum of the systemic risks of all institutions. This aggregate amount reflects the government's potential costs to bail out the financial system, that is, to recapitalise the banks in the event of a systemic crisis.

Quantitatively, SRISK is a measure of the potential loss of capital for an institution under a systemic crisis, determined by the conditional expected capital shortfall given a significant shock to the stock market, resulting in at least a 40% loss in profitability over the next six months. The SRISK measure proposed by Brownlees and Engle (2017) is given by the following equation.

$$SRISK_{it} = E_t(CS_{it+h} | R_{mt+1:t+h} < C),$$

where C is the threshold for the decline in market profitability over six months (-40% by default), and the potential loss CS (capital shortfall) is defined by

$$CS_{it} = kA_{it} - E_{it} = k(D_{it} + E_{it}) - E_{it},$$

where k is the standard solvability ratio[4], E is the capital value of equity, D is total liabilities, and A is quasi-total assets. Appendix 5 provides further information on the mathematical formulations and implementation of SRISK. We refer to Dehmej and Mikou (2020) a more detailed exploration of Srisk in Moroccan context.

To measure the impact of capital ratio increase on SRISK, we incorporate 1 pp increase in equity relative to risk-weighted assets financed by debt. This increase in bank capital will affect SRISK inputs, as showed in Table 3. We make two reasonable assumptions. First, the market price of equity is changing in a proportional manner to common equity. Second, market returns do not react to a single bank's capital increase.

Table 3: Impact of capital increase on SRISK's inputs

SRISK's inputs before capital increase	***SRISK's inputs after capital increase***
Liabilities: D_{it}	$D_{it} - \frac{RWA}{100}$
Common equity: $e_{it,}$	$e_{it,} + \frac{RWA}{100}$
Capital value of equity: E_{it}	$E_{it,} \frac{e_{it,} + \frac{RWA}{100}}{e_{it,}}$
Market return: R_{mt}	R_{market}

It is important to note that the measure employed herein does not directly account for all the factors contributing to systemic risk. Rather, it quantifies systemic risk by evaluating the potential loss ensuing from a triggering event without considering certain significant elements of systemic risk, such as asset correlations between institutions, interbank linkages, or liquidity or confidence crises. These factors are implicitly assumed to trigger systemic risk, but are not explicitly measured in this approach. Furthermore, SRISK computation requires both high-frequency public data (such as daily market prices and daily or weekly market capitalisation) and low-frequency data (e.g. book value of debt). This requirement poses a challenge to data management and analysis. Moreover, SRISK exhibits a rapid escalation in the event of a significant and sustained downturn in the stock market. However, it fails to incorporate such a decline as part of the systemic crisis scenario, with the scenario remaining constant irrespective of the market's performance. Therefore, it is essential to view SRISK as a financial stability indicator rather than as a specific refinancing charge to be utilised in contingency planning.

[4] By default, k is set to be 8% for firms in Africa, Asia, and the Americas, and 5.5% for firms in Europe.

3. Empirical results

This section presents the empirical findings pertaining to the effect of heightened Basel III capital ratios on the lending and funding rates of Moroccan banks as well as their resilience. The results were derived using the methodologies outlined in the preceding section.

To obtain the definitions and statistical descriptions of key variables, refer to Appendices 3 and 4, respectively. We also refer to Appendix 6 for some stylized facts of the Moroccan banking sector in recent years.

3.1. *Impact of capital ratio increase on lending rate*

The estimated sensitivities of bank lending spreads to 1 pp increase in capital requirements are shown in Table 4. The input data are based on the aggregated bank balance between 2014 and 2019. This time range was chosen because the Basel III rules in Morocco, which tightened capital ratio requirements, were implemented in 2014. The implementation of some provisions was planned to be gradually phased until 2019. It is evident that for Moroccan banks, lending assets represent, on average, 66% of total assets, and risk-weighted assets are 70% of total assets. Referring to cost of equity and cost of debt, we use two assumptions due to the lack of data: (i) Return on equity as a proxy of cost of equity which is equivalent to consider that the market valuation of the banking sector is equal to its book value (ii) Cost of debt is assumed to be equal on average to 2%[5] where debt is compounded from approximately 50% of overnight non-remunerated deposits.
As shown in Table 4, 1 pp increase in the ratio of capital to risk-weighted assets will increase bank lending spreads by 7.69 bp in Morocco. The potential impact of Basel III on bank lending spreads can be computed by combining the estimated bank lending spread sensitivities with the bank capital increase required. Following the Basel reform, solvency ratios increased in Morocco by 2% of risk-weighted assets. We deduce that the potential impact on lending spread in Morocco is 15.72 bp, which is comparatively lower than other countries. Slovik and Cournède (2011) suggest that to meet the Basel III requirements effectively as of 2019, banks would on average increase their lending spreads by approximately 50 bp across three main OECD economies (United States, Japan, and Europe).
Boissay et al. (2019) concluded, based on BIS's platform FRAME, including 83 studies and 139 quantitative impact estimates, that 1 pp increase in the ratio of capital to risk-weighted assets will increase bank lending spreads on average by 10 bp for 15 countries or regions, while our estimate for Morocco is 7.86 bp.

Table 4: Impact of capital increase on lending rate

Years	$r^E - r^L$ (%)	AL (%)	RWA (%)	$r^{AL}_{t+1} - r^{AL}_t$ (BP)
2014	8,2	69	73	8,67
2015	7,1	66	69	7,38
2016	6,6	67	70	6,92
2017	7,5	65	70	8,09
2018	7,5	63	68	8,07
2019	7,4	63	69	8,01
Average	7,38	66	70	7,86

$r^E - r^L$ is the spread between cost of equity and cost of debt, AL is loan to total assets, RWA is risk weighted asset to total loans, and $r^{AL}_{t+1} - r^{AL}_t$ is lending spread.

[5] The assumption is based on an average estimate of pondered returns of different components of aggregated banking sector debt namely overnight and term deposits, which represents 75% of debt.

3.2. Impact of capital ratio increase on bank funding

This section investigates the potential impact of changes to the funding structure of banks, as mandated by Basel III standards, on their systematic risk (equity beta), return on equity, and average cost of capital. The first stage of the analysis focuses on exploring the relationship between beta and capital structure, specifically through the examination of the leverage and IT1. Tier 1 capital is a critical variable that reflects a bank's funding structure. In the second stage, we quantify the effects of an increase in the capital ratio on the cost of equity as estimated by the WACC.

Initially, we calculate the systematic risk of Moroccan banks by computing their equity betas using returns from the MASI index and the daily stock market returns of Attijari Wafa Bank, Bank of Africa, Banque Populaire, Crédit du Maroc, CIH Bank, and BMCI from 2004 to 2022. Figure 3 displays the average equity betas of these banks for the 2004-2022 period.

To investigate the relationship between the equity beta and bank capital structure, using Equation 8 we regress the individual banks' semi-annual equity betas on their leverage ratio and IT1. The leverage ratio (LVG) is defined as the total assets of a bank divided by its Tier 1 capital, while IT1 is the risk-weighted assets of a bank divided by its Tier 1 capital. We provide three model estimates: a pooled OLS estimate, fixed effects (FE) estimate, and random effects (RE) estimate to account for bank-specific effects.

Table 5 presents the regression results with standard errors adjusted for clustering on banks. Both the FE and RE estimates show similar results, with a coefficient around 0.03 for IT1 and approximately 0.027 for the leverage ratio. In the pooled OLS estimate, the impact of changes in leverage on equity beta is somewhat higher, with a coefficient of approximately 0.031 for the leverage ratio and a slightly lower impact of around 0.028 for IT1.

Therefore, our results are robust to two alternative models: fixed and random effects. The risk-weighted IT1 is a better explanatory variable for equity beta than the leverage ratio.

While the amount of pure capital increases relative to the amount of debt (i.e. the inverse capital ratio or leverage decreases), the equity beta decreases. This explanation relies on the fact that banks' balance sheets are steadier and beta systematic risk is lower, as the bank is less vulnerable to market fluctuations. This intermediate result supports regulators' proposals for bank recapitalisation.

Figure 3. Average beta across major Moroccan banks 2004-2022

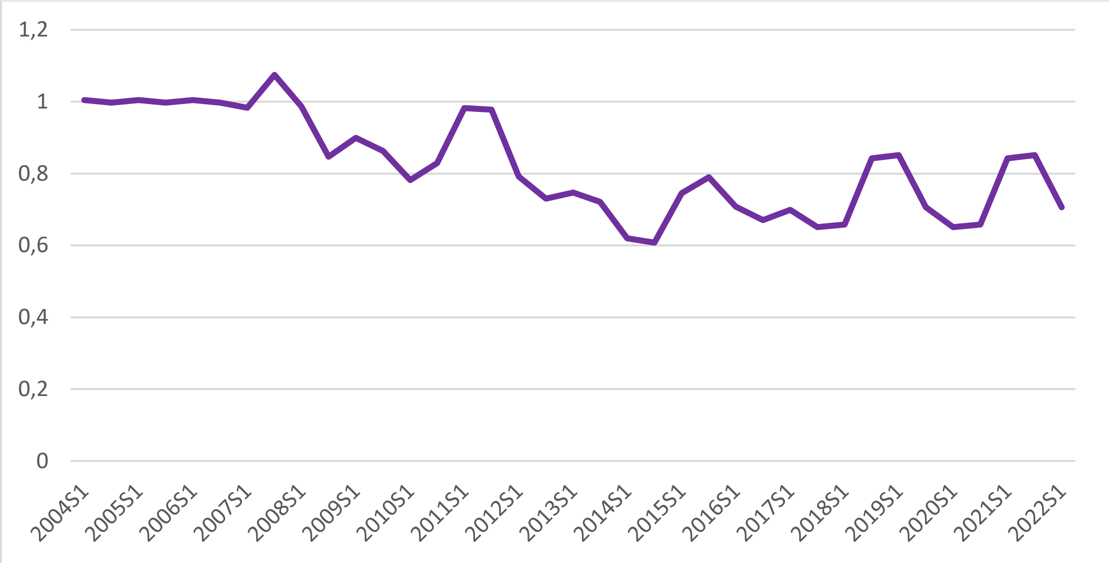


Table 5: Bank equity beta and leverage: Pooled OLS, Fixed and Random Effect

Variables	(1) Beta OLS	(2) Beta FE	(3) Beta RE	(4) Beta OLS	(5) Beta FE	(6) Beta RE
		LVG			IT1	
Solvency	0.031***	0.027***	0.027***	0.028***	0.03***	0.03***
Constant	0.397***	0.453***	0.452***	0.554***	0.539***	0.539***
Observations	222	222	222	222	222	222
R^2	0.121	0.503	0.118	0.041	0.479	0.073
R^2 adj	0.117	0.489	0.114	0.037	0.464	0.068

*Significance levels : *** p < 0.001; ** p < 0.01; * p < 0.05.*
LVG is the leverage ratio, and IT1 is the inverse Tier 1 ratio.

Using the coefficients from the fixed effects regression between equity betas and solvency ratio (leverage or Tier 1 ratio), we obtain from Equation (5):

$$R_{equity} = R_f + \beta_{equity}(R_{market} - R_f) = R_f + (\hat{a} + \hat{b}\ Solvency_{it})(R_{market} - R_f), \quad (7)$$

where $\hat{a}$ is a constant, and $\hat{b}$ is the coefficient of the solvency ratio from the beta regressions. Since $\hat{b}$ for both leverage and IT1 is estimated to be positive from Table 5, (7) implies that the higher the leverage or IT1 of a bank, the greater the required return on its equity.

We use the estimated relationship between bank leverage and the equity beta to assess how changing leverage affects the weighted average cost of funds. We express banks' average cost of funding (typically referred to in corporate finance theory as the WACC) as the weighted sum of the cost of its equity and the cost of its debt.

Using aggregated data in 2019 for the six Moroccan banks quoted on the exchange market, we measure the impact of an increase in capital ratio, metalising by 1% RWA increase in Tier 1 capital, on bank funding costs, as summarised in Tables 6 and 7. Banks' funding costs seem to have a negligible impact on the two solvency measures. Following the leverage ratio, the potential impact is approximately 1 bp, which is approximately 2 bp according to IT1. Even if the amount of bank capital doubles, our estimates suggest that the average cost of bank funding increases by less than 10 bp. We conclude that even proportionally large increases in bank capital are likely to have a small impact on borrowing costs faced by bank customers. One explanation could be that higher capital levels reduce the riskiness of a bank and, therefore, lower the expected returns required by equity and debt holders which corresponds to the MM theorem.

Table 6: Impact on funding cost using LVG estimation ($\widehat{a}$=0.45 and $\widehat{b}$=0.027)

Tier 1 Capital	LVG	R_{equity}	WACC
Tier 1	11,7	5,58%	2,70%
Tier 1 + $\frac{RWA}{100}$	10,74	5,47%	2,71%
Impact in bp	-96	-11	+1

Table 7: Impact on funding cost using IT1 estimation ($\widehat{a}$=0.539 and $\widehat{b}$=0.03)

Tier 1 Capital	IT1	R_{equity}	WACC
Tier 1	8,95	5,75%	2,71%
Tier 1 + $\frac{RWA}{100}$	8,22	5,66%	2,73%
Impact in bp	-73	-9	+2

3.3. Impact of capital increases on bank resilience

In the previous section, we provide evidence of a positive relationship between capital structure and the systematic risk of banks on one side and their funding costs on the other side. Banks with stronger capitalisation are less dependent on public funds and therefore present less systematic risk.

This section assesses another aspect of enhancing the banking system's resilience through an increase in the capital buffer with respect to systemic risk. To this end, we compute the cumulative systemic risk of six publicly traded banks on the Casablanca Stock Exchange (Attijari Wafa Bank, Bank of Africa, Banque Populaire, Crédit du Maroc, CIH Bank, and BMCI) using the SRISK measure during the Covid-19 crisis (2020-2021).

Note that systematic and systemic risks are related but distinct concepts in finance. Systematic risk, also known as market risk, refers to the overall risk inherent in a particular market or asset class, which cannot be eliminated through portfolio diversification. This risk arises from factors such as changes in interest rates, economic conditions, or political events that affect the entire market. By contrast, systemic risk is the risk of disruption to the financial system caused by the failure of an individual institution or a group of interconnected institutions. This risk can arise from various sources, such as financial market shocks, operational failures, or catastrophic events, and can lead to the breakdown of the financial system and even a wider economic crisis.

Our findings show that the average systemic risk decreased by 25% in 2020 and 31% in 2021 after 1% increase in solvency ratio, as summarised in Table 8. Therefore, the average SRISK decreased from 11.85 billion MAD to 8.93 billion MAD in 2020 and from 5.41 billion MAD to 3.79 billion MAD in 2021. Furthermore, the maximum SRISK decreased from 73.87 billion MAD to 71.66 billion MAD in 2020 and from 11.06 billion MAD to 7.56 billion MAD in 2021. Consequently, the maximum systemic risk decreased by 3% in 2020 and 32% in 2021.

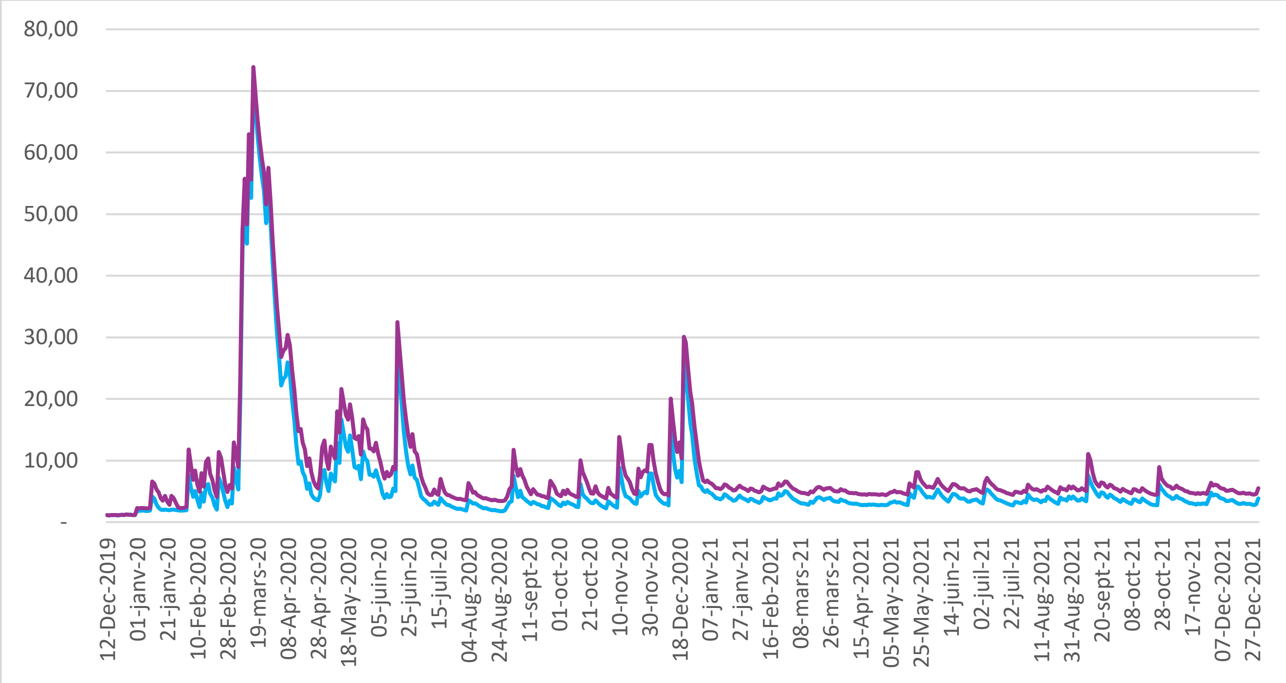
From Figure 4, which shows the dynamics of the SRISK measure from 2020 to 2021, a peak is clearly evident in March 2020, coinciding with the height of the COVID-19 crisis in Morocco. This indicates that SRISK is a relevant systemic risk in our case, and the positive impact of improving resilience is time dependent. In normal times, the improvement is important, whereas during times of crisis, the improvement is moderated.

Our analysis suggests that an increase in capital can lead to an important improvement in the average resilience of the Moroccan banking system. However, the extent of this improvement may be moderated during times of financial crises.

Table 8: SRISK of Moroccan major banks during COVID-19 crisis before (in blue) and after (in red) 1% of RWA increase of capital

SRISK (in billions of MAD)	2020	Impact	2021	Impact
Average SRISK (with E and D inputs)	11.85	-	5.41	-
Average SRISK (with E+RWA/100 and D-RWA/100 inputs)	8.,93	-25%	3.72	-31%
Max SRISK (with E and D inputs)	73.87	-	11.06	-
Max SRISK (with E+RWA/100 and D-RWA/100 inputs)	71.66	-3%	7.56	-32%

Figure 4: SRISK of Moroccan major banks during COVID-19 crisis before (in blue) and after (in red) 1% of RWA increase of capital



Conclusion

This paper investigates the impact of Basel III capital ratios on Moroccan banks' lending and funding rates as well as their resilience. The empirical results suggest that 1 pp increase in capital to risk-weighted assets ratio will weakly increase bank lending spreads by 7.69 bp in Morocco. Therefore, given the extra capital requirements of 2 pp, the total potential impact of Basel III on bank lending spreads in Morocco is estimated at approximately 15.4 bp, which is lower than that of other countries. Furthermore, this study shows that bank funding costs are lowly impacted by an increase in capital ratios. Even if the amount of bank capital doubles, the average cost of bank funding increases by less than 10 bp. Finally, the study quantifies the improvement in the banking system's resilience after an increase in the capital buffer, showing that the average systemic risk decreased by 25% in 2020 and 31% in 2021. Overall, these findings provide useful insights for policymakers and banking stakeholders in Morocco.

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Appendices

A1: Basel III transposition process in Morocco (BSR 2017 Bank Al-Maghrib)

As early as 2010, Bank Al-Maghrib worked to transpose the Basel III framework, while considering the specificities of the national economic and financial context and promoting a gradual and prioritised implementation of international standards.

Capital regime[6]: the transposition of the capital regime concerned the following:

• Implementing the eligibility criteria for capital instruments;

• Setting capital requirements higher than those recommended by the Basel Committee (8%, 9%, and 12% for core equity, Tier 1, and solvency ratios, respectively);

• Introducing, for macro-prudential purposes, the counter-cyclical capital buffer which authorities can set to between 0 and 2.5% of risk-weighted assets.

Treatment of systemically important banks «SIB»: The 2014 Banking Law introduced the principle of applying more binding prudential rules for systemically important banks «SIB». In this respect, the methodology for determining these institutions was defined, and their list was agreed upon and approved by the Coordinating Systemic Risk Monitoring Committee. Work is in progress to calibrate the capital surcharge to be applied as well as the implementation schedule.

Short-term liquidity metric 'Liquidity Coverage Ratio' (LCR): the circular on the short-term liquidity ratio 'LCR' was published in 2013. This ratio entered into force in July 2015, after a period of observation of 18 months, after which adjustments were made. On this date, the minimum ratio to be respected by the banks was set at 60 pp and then gradually raised by 10 pp per year to reach 100 pp on 1 July 2019.

Net stable funding ratio (NFSR): This liquidity ratio is determined in the long term. It restricts banks' long-term financing to the long-term liabilities they have. A review of this reform is evolving.

Leverage ratio: Reflections on the adoption of this standard at the national level led to the conduct of an impact study, whose findings showed that Moroccan banks used this technique moderately. The Bank included this reform in its regulatory programme for 2019.

Revised requirements for credit, market, and operational risks: Bank Al-Maghrib planned to review the transferability of the new revisions made by the Basel Committee in December 2017 and to define, on this basis, a regulatory roadmap.

[6] Starting from 2014, the calculation method for the solvency ratio became progressively more restrictive due to the implementation of transitional measures regarding the eligibility of different components of capital. This step is important in Basel III transposition process in Morocco.

A2: A table summarising the major methods and models used for analysing and assessing the impact of higher capital requirements on banks linked to Basel III:

Method/Model	Reference	Description
Capital adequacy modelling	Hawaldar, Meher, Kumari and Kumar 2022	Simulates the impact of changes in risk weights, capital buffers, and other regulatory requirements on banks' capital adequacy ratios.
Stress testing	Acharya, Berner, Engle, Jung, Stroebel, Zeng and Zhao, 2023	Involves subjecting banks to hypothetical scenarios of economic and financial stress and assessing the resilience of their balance sheets.
Liquidity modelling	Olivier Jeanne and Damiano Sandri 2023	Simulates the impact of changes in liquidity requirements, such as the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR), on banks' ability to meet short-term and long-term funding needs.
Credit risk modelling	Basle Committee on Banking Supervision, April 1999	Simulates the impact of changes in credit risk weights, collateral requirements, and other regulatory requirements on banks' credit risk exposure.
Market risk modelling	T. Clifton Green Emory and Stephen Figlewski 2000	Simulates the impact of changes in market risk weights, stress scenarios, and other regulatory requirements on banks' exposure to market risk.
Dynamic stochastic general equilibrium (DSGE) models	Chari and Kehoe, 2006	Simulates the interactions between households, firms, and the government, and can help evaluate how changes in bank capital requirements affect the broader economy.
Microsimulation models	Birkin, Mark; Wu, Belinda, 2012	Simulates the impact of changes in capital requirements on individual banks' balance sheets, profitability, and risk-taking behaviour.
Agent-based models	Shattock, Andrew, Le Rutte, Epke, 2021	Simulates the behaviour of individual agents (such as banks) and how they interact with each other.
Balance sheet-based methods	Chen and Qu, 2020; Barattieri and Thaler, 2021	Evaluates whether banks have enough capital to meet regulatory requirements and absorb potential losses and assesses the impact of higher capital requirements on banks' profitability and lending conditions.
Regression methods	David A. Freedman, 2009	Identifies the factors that affect banks' capital ratios and the impact of higher capital requirements on banks' financial performance, financing costs, and risk-taking behaviour.

A3: Description of variables

Variable	Definition
Tier 1	Tier 1 capital is a bank's core capital, consisting of equity capital and disclosed reserves. It is used to measure a bank's financial strength and is the highest quality of capital available to a bank.
RWA	Risk-weighted assets (RWA) are a bank's assets weighted by a risk factor to reflect the likelihood of default. The higher the risk, the higher the weight, and therefore the higher the capital requirements.
Total assets	Total assets refer to the sum of all assets held by a company or financial institution, including cash, investments, property, and equipment.
Tier 1 ratio/ Inverse Tier 1 (IT1)	Tier 1 capital ratio is the ratio of a bank's Tier 1 capital to its total risk-weighted assets. It is a measure of a bank's financial strength and its ability to absorb losses. IT1 is the RWA over Tier 1 capital.
Leverage ratio (LVG)	The leverage ratio is the ratio of a bank's Tier 1 capital to its total assets. It is a measure of a bank's ability to withstand losses and is used to assess its financial stability.
Cost of equity (r_t^E)	The cost of equity is the return a company requires to compensate its equity investors for the risk they take on by investing in the company. It is calculated using the capital asset pricing model (CAPM), which considers the risk-free rate, the market risk premium, and the company's beta.
Cost of debt (r_t^D)	The cost of debt is the return a company must pay on its debt to compensate its lenders for the risk they take on by lending money to the company. It is calculated based on the interest rate paid on the debt.
Systematic risk (β_{equity})	Systematic risk is the risk that affects the entire market or a specific sector of the market. It is also known as market risk and cannot be eliminated through diversification. Examples of systematic risk include economic recessions, political instability, and natural disasters.

A4: Descriptive statistics of main variables

Variable	Obs.	Mean	Std. Dev.
Beta	222	0.82	0.37
TIER 1	222	10 042	8 506
RWA	222	94 666	78 944
Total asset	222	132 766	107 873
LVG	222	13.85	4.07
IT1	222	9.71	2.65

A5: Srisk calculation method

In the calculation of SRISK, two other measures of systemic risk are considered: MES and LRMES. These were introduced by Acharya, Engle, and Richardson, who measured the potential loss in terms of the financial performance of an institution under financial stress. MES represents the loss in performance in one day, conditioned on a significant loss in the market, which is the conditional expectation given by

$$MES_{i,t} = \mathbb{E}_t\left(-R_{i,t+1} \middle| R_{m,t+1} < C\right),$$

where R_i and R_m represent the returns of the institution's stock and the market return (considered the return of the MASI index for Morocco), and C is a constant (assumed to be equal to 2%). Several methods are available for calculating MES. We have implemented a nested Monte Carlo method, which will be the subject of an upcoming academic publication, and have also adapted a dynamic conditional correlation algorithm with a GJR GARCH estimation (developed by Benoit and Hurlin).

The latter involves modelling returns as follows:

$$r_{m,t} = \sigma_{m,t}\varepsilon_{m,t},$$

$$r_{i,t} = \sigma_{i,t}\varepsilon_{i,t} = \sigma_{i,t}\rho_{i,t}\varepsilon_{m,t} + \sigma_{i,t}\sqrt{1-\rho_{i,t}^2}\xi_{i,t},$$

where σ_(m,t) and σ_(I,t) represent the volatilities of market and financial institution i at time t, ρ_(i,t) is the correlation between r _(m,t) and r_(i,t), and ε_(m,t) and ξ_(i,t) are independent and identically distributed normal random variables with zero mean and unit variance. Thus, the MES can be written as follows:

$$MES_{i,t-1} = \sigma_{i,t}\rho_{i,t}E_{t-1}\left(\varepsilon_{i,t}\middle|\varepsilon_{m,t} < \frac{C}{\sigma_{m,t}}\right) + \sigma_{i,t}\sqrt{1-\rho_{i,t}^2}E_{t-1}\left(\xi_{i,t}\middle|\varepsilon_{m,t} < \frac{C}{\sigma_{m,t}}\right).$$

The conditional volatilities used in the calculation of the conditional expectation in the previous equation are modelled using an asymmetric GJR-GARCH model, specified as follows:

$$\sigma_{m,t}^2 = \omega_m + \alpha_m r_{m,t-1}^2 + \gamma_m r_{m,t-1}^2 I_{r_{m,t}<0} + \beta_m \sigma_{m,t-1}^2,$$
$$\sigma_{i,t}^2 = \omega_i + \alpha_i r_{i,t-1}^2 + \gamma_i r_{i,t-1}^2 I_{r_{i,t}<0} + \beta_i \sigma_{i,t-1}^2,$$

où σ_(m,t)^2 and σ_(i,t)^2 represent the conditional volatilities of the market and financial institution i, respectively. The indicator variables I_(r_(m,t)<0) and I_(r_(i,t)<0) allow the model to capture the asymmetric effects of volatility leverage because it has been empirically shown that negative shocks have a greater impact on volatility than positive shocks.

For LRMES, which estimates the value of cumulative loss over six months, the following approximation proposed by Acharya, Engle, and Richardson was used:

$$LRMES_{i,t,T} \approx 1 - \exp\left(-18 \times MES_{i,t}\right).$$

SRISK is expressed as a function of LRMES, the values of debt (liabilities) L, and equity (equities) E of the institution, as follows:

$$SRISK_{i,t} = k.L_{i,t} - (1-k).E_{i,t}.\left(1 - LRMES_{i,t}\right),$$

where k is the prudential capital ratio of the equity. It should be noted that the total SRISK of the financial system is calculated as the sum of the positive parts of the SRISK of all financial institutions that make it up.

$$SRISK_t = \sum_{i=1}^{N}(SRISK_{i,t})_+.$$

A6: Stylized facts of the Moroccan banking sector in recent years

Figure 1 illustrates the downward trend of lending rates over the past decade. However, it is observed that these rates are not very sensitive to the implementation of the Basel reform, thanks in particular to its gradual introduction aimed at minimizing the impact on Moroccan banks. Our research work estimates that the increase in bank capital had a weak positive impact on lending rates, which seemingly did not alter their downward trend. This trend can be explained by the fact that lending rates are primarily influenced by the policy rate and the more accommodative monetary policy between 2010 and 2021, as demonstrated in Figure 2.

Figure 1: Evolution of lending rates in Morocco

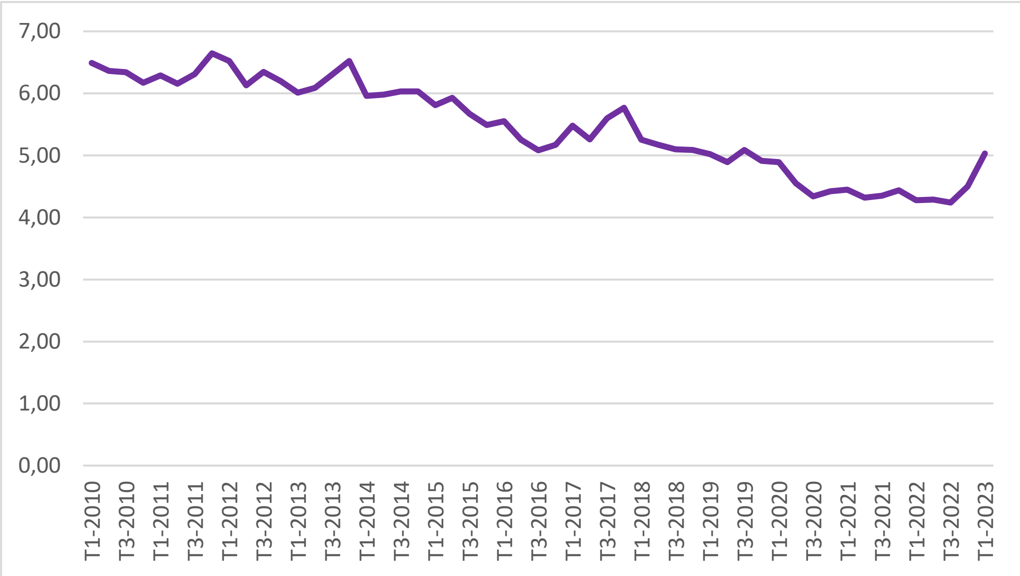

Figure 2: Policy interest rate

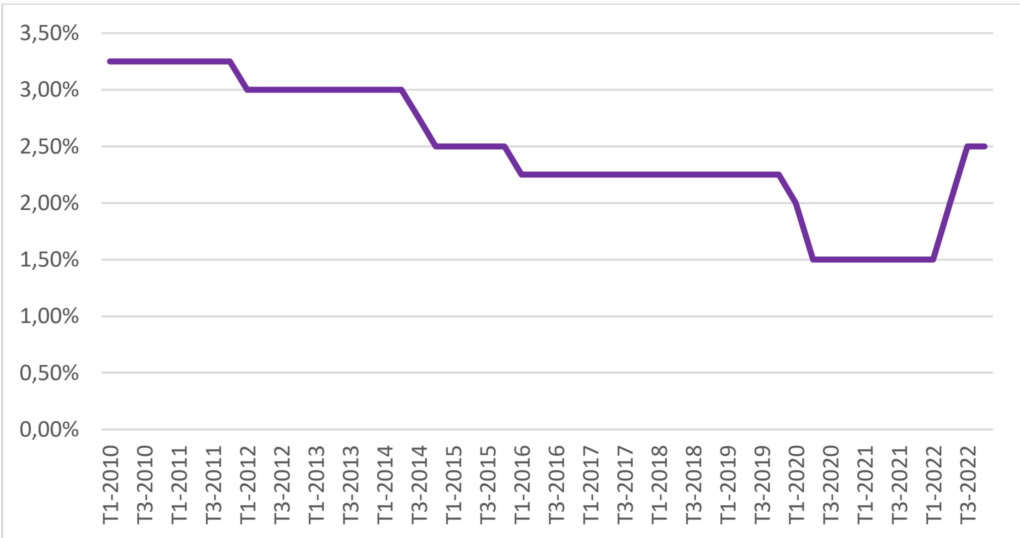

Figure 3 presents the main component of financing for Moroccan banks, which is deposits, accounting for two-thirds of their total debt (with a significant portion being non-interest-bearing demand deposits). This graph highlights a downward trend in the cost of debt related to deposits between 2010 and 2022. This observation can be explained by the decrease in the policy interest rate during this period.

Figure 3: Remuneration of Deposits by Moroccan Banks - Aggregated Data

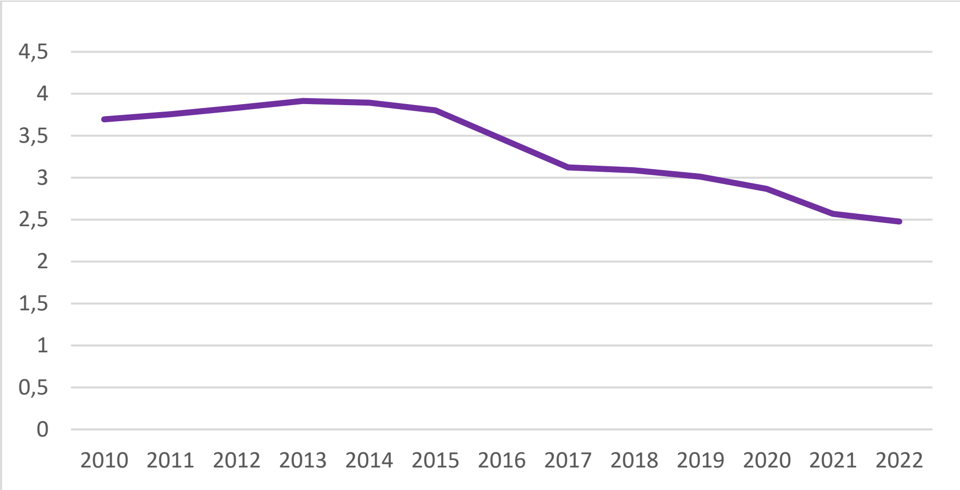

Figure 4 highlights a downward trend in bank profitability, measured by ROE, between 2010 and 2022.

Figure 4: Bank Sector Profitability (ROE)