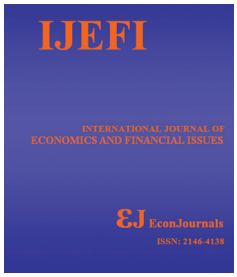

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Interaction between Policy Rates and Inflation: A Panel Analysis of the Effects of Monetary Duality on Bank Profitability in Morocco

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ABSTRACT

This article explores the concept of monetary duality to analyze how the interaction between the policy rate and inflation affects the profitability of commercial banks in Morocco. To accomplish this, we utilized econometric panel data modeling, focusing on a sample of six banks from 2010 to 2023. The results indicate that neither the policy rate nor inflation, when considered individually, significantly impacts bank profitability. However, their interaction becomes significant after correcting the model, suggesting a potential moderating effect of inflation and implying that the effectiveness of interest rates depends on the inflationary context. Additionally, the analysis highlights the varying influence of certain structural variables. Consequently, the study offers targeted recommendations for Bank Al-Maghrib and banking institutions, and it opens avenues for future research into non-linear effects and banking dynamics.

Keywords: Policy Rate, Inflation, Moderating Effect, Monetary Duality, Bank Profitability, Panel Data.
JEL Classifications: E43, E31, G21, C33.

1. INTRODUCTION

Global financial balances have been significantly affected by several major macroeconomic disturbances over the past decade. Central banks have been forced to adapt their monetary policy instruments rapidly in response to events such as the COVID-19 epidemic, the war in Ukraine and persistent inflationary pressures. These factors have resulted in exceptional volatility in financial markets, skyrocketing energy and commodity prices, and an overall increase in inflation worldwide. In this context, adjusting the key interest rate (traditionally a standard tool for macroeconomic stabilization) has become increasingly complex. The effectiveness of this tool in influencing financing conditions and bank profitability now seems to depend on the current inflationary environment, raising questions about the true effectiveness of monetary policy during times of external shocks.

Faced with rising import prices, especially for energy and alimentation, Morocco saw Bank Al-Maghrib begin a gradual tightening of its monetary policy in 2022, marking a departure from a prolonged period of accommodation. In March 2025, amid ongoing external uncertainties and a fragile economic recovery, BAM adjusted its stance by lowering its key rate by 25 basis points to 2.25%. This decision aims to balance support for the economy with the need to control inflation (Bank Al-Maghrib, 2025). Macroeconomic forecasts project moderate inflation of around 2% for 2025 and 2026, alongside gradual economic growth ranging between 3.2% and 4.2% for the period from 2024 to 2026 (Bank Al-Maghrib, 2025). These forecasts reflect a stabilization approach and emphasize the critical importance of thoroughly assessing the actual impact of fluctuating interest rates on the profitability of Moroccan commercial banks, particularly in an uncertain and unstable inflationary environment. Recent

research indicates that the effects of interest rate variations on bank profitability are neither uniform nor systematic; rather, they depend on macroeconomic conditions such as inflation and market stability. This variability suggests that banks cannot always predict the evolution of these parameters. For instance, Bikker and Vervliet (2018) demonstrated that when interest rates remain sustainably low, interest margins decline, negatively affecting long-term profitability, especially in times of high inflation. Additionally, a study by Altavilla et al. (2018) in the eurozone revealed that the impact of monetary policy is asymmetrical depending on the level of inflation: during periods of high inflation, banks tend to pass on rate increases to loans more quickly than to deposits, affecting their net profitability. On another note, research by Tan and Floros (2012) focusing on emerging economies confirmed that the inflationary environment influences banks' ability to respond to monetary signals, particularly regarding the pricing of credit products.

This research highlights the emergence of what we term the "monetary duality effect," which refers to the structural interaction between the central bank's key interest rate and the level of inflation in relation to banking performance. Specifically, changes in the key interest rate do not uniformly affect bank performance; their impact varies with inflation dynamics. Thus, the central question of this study is: to what extent does the level of inflation modulate the effect of Bank Al-Maghrib's policy rate on the profitability of Moroccan commercial banks? To address this question, the research is organized around three main hypotheses. First, we posit that the policy rate significantly impacts bank profitability in Morocco. Second, we assert that inflation acts as a moderator, either reinforcing or attenuating the impact of the policy rate. This interaction is not uniform across banks; it varies based on structural characteristics such as the size or market share of each institution.

The objective of this study is to investigate this duality within the specific context of the Moroccan banking sector, with a focus on the interplay between monetary policy and the macroeconomic environment. This study aims to contribute to the academic literature by offering a new perspective on the monetary transmission channel in a developing country. A notable feature of this research is the introduction of an interaction variable between the key interest rate and inflation, an aspect that is rarely explored in studies regarding Morocco. Additionally, this research seeks to provide a deeper understanding of the role of the inflationary environment in the implementation of monetary policy, ultimately offering an innovative viewpoint on the subject. Beyond its theoretical significance, this research holds substantial practical importance. It delivers valuable insights to monetary authorities regarding the effectiveness of their interest rate decisions and provides strategic guidance to financial institutions in adapting their margin, risk, and capital management strategies to the macroeconomic environment. Consequently, this study contributes to the stabilization and resilience of the national financial system.

This study is organized as follows: It begins with a review of the literature on several key topics, including monetary policy, bank profitability, monetary transmission in an inflationary context, and the moderating effect of inflation. Following this, a section outlines the methodology, which details the econometric model, the data utilized, and the selection of variables. The empirical results are then presented and discussed in relation to the Moroccan economy. Finally, the study concludes with practical recommendations and suggestions for future research.

2. LITERATURE REVIEW

2.1. Monetary Policy and Bank Profitability

Bank profitability is significantly influenced by monetary policy decisions, particularly through interest rates, which are the central banks' main tool for affecting the financial system. The theory of bank intermediation, as formulated by Ho and Saunders (1981), suggests that interest margins are directly impacted by changes in key interest rates, as these rates affect the difference between lending rates and deposit rates. During periods of monetary tightening, banks can increase their net margins when lending rates adjust more swiftly than deposit rates. However, when interest rates are excessively low or high, this dynamic may reverse, resulting in squeezed margins or increased default risk.

From another perspective, the credit channel theory (Bernanke and Gertler, 1995) emphasizes the role of monetary policy in modulating the supply of credit through financing costs and the structure of banks' balance sheets. This channel is especially relevant in emerging economies where bank financing is predominant. Several recent empirical studies support these theories while highlighting the importance of structural specifics. For instance, Claessens et al. (2018) demonstrate that persistently low interest rates in advanced economies significantly reduce bank profitability due to prolonged margin compression. Borio and Gambacorta (2021) point out a non-linear effect: as interest rates approach zero, bank margins become increasingly sensitive to their fluctuations.

These findings also apply to emerging markets. Dzeha et al. (2023) note that the transmission of key rates to profitability is especially pronounced in poorly capitalized banks, indicating a heightened vulnerability to monetary changes. Although Morocco has received relatively little attention in recent literature, it shares several structural characteristics: high banking concentration, a central role in intermediation for financing the economy, and a strong sensitivity to decisions made by Bank Al-Maghrib.

Furthermore, some studies examine the impact of an inflationary environment on banks' ability to adjust profitability in response to rate fluctuations. Perry (1992) suggests that moderate inflation can increase nominal incomes, thereby reinforcing the effects of key rates. Conversely, high inflation tends to obscure monetary signals, rendering policies less clear and undermining the stability of bank revenues (Francis, 2021). Recent analyses by the IMF (Bergant et al., 2025) confirm this post-pandemic tension: to control inflation, central banks have raised rates, which has negatively affected bank margins, exposing institutions to new liquidity risks. English et al. (2024) call for a reassessment of transmission mechanisms in the context of persistent inflationary pressures.

Lastly, Lane (2024), the chief economist at the European Central Bank, emphasizes the increasing interconnection between financial stability and monetary policy, with banks serving as both transmission channels and direct targets for central bank actions. This underscores the importance of an integrated approach that simultaneously considers interest rates, inflation, and the structural specifics of national banking systems.

2.2. Inflation and Money Transmission

Inflation plays a crucial role in how effectively monetary policy is transmitted through the banking system, affecting the speed, intensity, and symmetry of banks' responses to interest rate decisions. In an inflationary environment, traditional transmission mechanisms become more uncertain, as price changes influence expectations, borrowing behavior, and the structure of bank balance sheets.

Mishkin (2007) notes that inflation can distort the interest rate channel by disrupting relative prices, making central bank signals less clear. When inflation is perceived as unstable or poorly managed, economic agents tend to react more to their expectations than to nominal interest rates, which reduces the effectiveness of monetary adjustments. Consequently, the expectations channel becomes just as important as the direct interest rate channel.

Borio and Hofmann (2017) provide significant empirical evidence that, in high-inflation contexts, increases in interest rates affect lending rates more quickly and intensely than deposit rates, thus altering the dynamics of bank margins and lending incentives. This asymmetry is particularly evident in emerging economies, where the inflexibility of deposits and specific structural characteristics of the banking market amplify second-round effects.

Altavilla et al. (2018) conducted an in-depth study of the eurozone and found that bank profitability is highly influenced by the real interest rate environment. During periods of low or unstable inflation, the effectiveness of monetary transmission diminishes, as banks struggle to adjust their margins amid intense competition for deposits. In their comparative study, Samarina and Apokoritis (2020) analyze the evolution of monetary policy frameworks in advanced economies after the global financial crisis. They argue that persistent inflation has prompted central banks to reassess their targeting strategies and expand their range of intervention tools, highlighting a growing tension between maintaining price stability and achieving operational efficiency.

Coibion and Gorodnichenko (2021) take a behavioral approach, revealing that households' and firms' perceptions of inflation significantly influence their consumption and investment decisions, regardless of official announcements, complicating the monetary transmission process. Hofmann et al. (2024) introduce an important distinction in how monetary responses handle inflationary shocks: when inflation is driven by demand, central banks tend to respond more vigorously with rate hikes; conversely, in the case of a supply shock, adjustments are more cautious to avoid excessively slowing down economic activity. This differentiated targeting alters transmission channels and their effects on bank profitability.

Falck et al. (2021) further this discussion by showing that disagreement among agents regarding inflation expectations undermines the effectiveness of monetary transmission. The greater the divergence in expectations, the more varied the responses to interest rates, diminishing the overall impact. This perspective builds on Roberts (1998), who emphasized the critical role of expectations in the effectiveness of monetary policy. Katusiime (2018) highlights how inflation volatility can lead to credit contraction in developing countries, demonstrating that price instability increases banks' risk aversion, which hampers financing for the real economy. Similarly, Sanyal (1996) argues that unanticipated inflation can disrupt credit circuits and diminish the overall efficiency of monetary mechanisms. Lastly, Borio et al. (2022) stress the necessity of aligning monetary policy with macroprudential frameworks and financial regulations, especially during prolonged periods of inflation, when transmission channels become fragmented and asymmetric across different banking segments.

These findings converge on a central theme: inflation should no longer be viewed merely as a cyclical variable, but rather as a structural factor that modulates monetary efficiency. It influences not only the magnitude of banks' responses to interest rate changes but also the clarity, timing, and fairness of their transmission in an environment marked by persistent macroeconomic uncertainties.

2.3. Moderating Effect of Inflation

While the direct effects of monetary policy on bank profitability are well documented, recent literature highlights a more complex dynamic: inflation serves not only as an explanatory variable but also as a moderating factor in monetary transmission mechanisms. This means that the impact of the policy rate on bank profitability is neither constant nor linear, but rather conditioned by the prevailing level of inflation.

The moderating role of inflation has been particularly explored by Borio and Gambacorta (2017), who examined how the effectiveness of monetary policy, through the bank credit channel, tends to diminish in an environment of persistently low rates. Their study indicates that when nominal rates are low, banks become more selective in granting credit, especially in the presence of inflationary pressures or uncertain real returns. This behavior restricts the monetary transmission to financing conditions and, ultimately, affects bank profitability. This phenomenon underscores the non-linear relationship between policy rates, inflation, and bank performance, which is now well-established in the literature. It justifies the introduction of an interaction term between interest rates and inflation in empirical modeling (Dell'Ariccia et al., 2018) to better capture the differentiated effects across different price regimes.

Several research studies on monetary pass-through and the inflationary environment, including those by López-Villavicencio and Mignon (2017), show that the inflation regime and monetary policy strategy play crucial roles in transmitting macroeconomic signals to prices and credit behavior, particularly in emerging countries. Ha et al. (2020) confirm that the degree of pass-through, whether concerning interest rates or exchange rates, largely

depends on inflation stability. When inflation is poorly anchored, adjustments become more uncertain, impacting both banking decisions and the effectiveness of monetary policies.

Additionally, the degree of inflation anticipation appears to play a significant role. When inflation is well anticipated, banks can proactively adjust their pricing, thereby cushioning the impact of monetary shocks. Conversely, unexpected or poorly controlled inflation disrupts the intermediation function and makes rate adjustments riskier (Gambacorta and Shin, 2018). Therefore, inflation's moderating effect is both economic and behavioral.

From a structural perspective, Caselli and Roitman (2016) investigate non-linearities in the monetary transmission mechanism in emerging countries, focusing on exchange rate pass-through in various inflationary contexts. Their analysis reveals that the effects of monetary shocks, particularly via relative prices, are amplified in high-inflation or poorly anchored economies, while they may be attenuated in more stable institutional settings. This finding emphasizes the need to consider structural specifics, such as the monetary regime or the level of banking competition, in analyzing transmission channels.

Thus, inflation functions as a contextual filter: it amplifies or attenuates the effects of the policy rate, depending on its characteristics, predictability, and its interaction with the banking system's structure. For this reason, including a moderating effect in econometric models is not only methodologically justified but essential for accurately reflecting the complexity of real dynamics, especially in emerging economies such as Morocco.

3. METHODOLOGY AND DATA

3.1 Approach and Sample

This study adopts an explanatory approach based on panel data modeling to analyze the combined impact of the policy rate and inflation on bank profitability in Morocco. Special attention is given to their interaction, which is considered a moderating effect.

The sample consists of a balanced panel of six Moroccan commercial banks over the period from 2010 to 2023, totaling 84 observations. This selection is based on the complete availability of data and the representativeness of the chosen banks, which dominate the market in terms of deposits, loans, and profitability.

The period covered includes a variety of economic contexts, such as the post-crisis period, the COVID-19 pandemic, recovery phases, and monetary tightening. This diversity reinforces the relevance of the analysis. Utilizing a panel approach allows for capturing both temporal effects and the specific characteristics of each bank.

3.2. Variables and Data Sources

The selection of variables is informed by the findings in the literature. Bank profitability is assessed using return on assets (ROA), which is defined as the ratio of net income to total assets. This benchmark is widely utilized in empirical research. The primary explanatory variables include Bank Al-Maghrib's policy rate (expressed as an annual percentage), the annual inflation rate (measured by the yearly change in the consumer price index), and their interaction term, which aims to capture the moderating effect of inflation on the transmission of monetary policy.

To ensure the reliability of the estimates, several control variables are incorporated. Bank size is measured by the logarithm of total assets. Portfolio quality is represented by the ratio of non-performing loans (NPL) to total loans. The capital ratio (Tier 1) corresponds to the ratio of core capital to risk-weighted assets. Leverage is calculated as the ratio of total assets to shareholders' equity. The liquidity ratio is measured by the ratio of liquid assets to short-term deposits. Finally, real GDP (in logarithm) is included to reflect national macroeconomic conditions.

Data are sourced from official publications, including the annual reports of Moroccan banks, reports from Bank Al-Maghrib, and statistics from the Haut-Commissariat au Plan (HCP). Econometric analysis was conducted using Stata 15 software.

3.3. Model Specification

The estimated model is a linear panel data model tested for fixed and random effects, utilizing the Hausman test to select the most appropriate specification. The estimated relationship is expressed as follows:

$$ROA_{it} = \alpha + \beta_1 PR_t + \beta_2 INF_t + \beta_3 (PRxINF)_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where:

- ROA_{it} is the profitability of bank i in year t,
- PR_t policy rate,
- INF_t inflation,
- $PRxINF_t$ their interaction,
- X_{it} the vector of control variables,
- μ_i specific unobserved effects,
- ε_{it} the term error.

4. MODELING RESULTS

4.1. Multicollinearity Test

One of the crucial preliminary steps in building the econometric model was to assess the presence of multicollinearity among the explanatory variables. As noted by Gujarati and Porter (2009), multicollinearity can distort regression results by increasing the variance of the estimated coefficients, which in turn reduces their statistical reliability, even if they appear to be significant. To diagnose this issue, the Variance Inflation Factor (VIF) was employed (Tables 1 and 2).

The initial results indicated extremely high VIF values for both the inflation rate (VIF = 95.49) and the interaction term (VIF = 103.85). These values far exceed the critical threshold of 10 suggested by Belsley et al. (2005), reflecting a substantial overlap of information between the variables involved in the interaction. This raises concerns about the stability of the estimates.

To address this issue, the policy rate and inflation rate variables were centered around their arithmetic mean before creating the interaction term. This method, recommended by Aiken and

Table 1: VIF Analysis, before centering

Variable	VIF	1/VIF
Interaction	103.85	0.009629
Inflation rate	95.49	0.010472
Policy rate	3.59	0.278612
Leverage ratio	2.47	0.405016
Bank size	2.33	0.429144
NPL ratio	2.12	0.469546
Liquidity ratio	1.90	0.527061
Tier 1 ratio	1.02	0.984791
Real GDP	1.21	0.829590
Mean VIF	23.87	

Source: Author's calculation, Stata 15

Table 2: VIF Analysis, after centering

Variable	VIF	1/VIF
Leverage ratio	2.47	0.405016
Bank size	2.33	0.429334
NPL ratio	2.22	0.449456
Liquidity ratio	1.90	0.527063
Tier 1 ratio	1.82	0.549391
Interaction	1.81	0.553862
Policy rate	1.63	0.613860
Inflation rate	1.58	0.633020
Real GDP	1.21	0.829750
Mean VIF	1.88	

Source: Author's calculation, Stata 15

West (1991), significantly reduces the collinearity caused by the cross terms while maintaining the model's capacity to capture a moderating effect. After the transformation, all variance inflation factors (VIFs) fell below the 2.5 threshold, with an average of 1.88. This indicates a negligible level of collinearity, ensuring the stability of estimates in subsequent regressions.

4.2. Stationarity Test

Before estimating the model using panel data, it was crucial to check the stationarity of the time series. This step is necessary to ensure the validity of econometric inferences and to avoid spurious regressions. As noted by Baltagi (2008) and Gujarati and Porter (2009), including non-stationary variables can distort results, particularly due to unaddressed common stochastic trends.

For this reason, the Harris-Tzavalis unit root test was applied to the main variables of the model: the dependent variable (Return on Assets, ROA) and the central explanatory variables (the policy rate and the inflation rate). These variables were centered around their mean to minimize collinearity issues. The results are presented in the tables below (Tables 3 and 4):

The null hypothesis regarding the presence of a unit root is rejected for the Return on Assets (ROA), indicating that it can be considered stationary at level. In contrast, the centered inflation variable exhibits clear non-stationarity ($P > 0.25$), warranting its transformation into a first difference.

Although the p-value (0.0649) suggests a tendency towards non-stationarity, we have opted to maintain the key interest rate at its current level for several reasons. First, it serves as a monetary policy instrument, and its absolute value has direct economic significance, particularly in relation to lending rates

Table 3: Harris-Tzavalis unit root test

Variable	z-statistic	P-value	Stationarity decision
ROA	−3.5992	0.0002	Stationary
Policy rate (centered)	−1.5147	0.0649	Weak evidence of non-stationarity
Inflation rate (centered)	−0.6564	0.2558	Non-stationary

Source: Author's calculation, Stata 15

Table 4: Harris-Tzavalis unit root test (first difference)

Variable	z-statistic	P-value	Stationarity decision
Δ Inflation	−11.0032	0.0000	Stationary

Source: Authors' calculations, Stata 15

and intermediation margins. Second, the empirical stability of the policy rate observed in Morocco from 2010 to 2023, characterized by extended periods of inertia, reduces the risk of bias associated with non-stationary dynamics.

Finally, transforming the variable into a difference would have compromised the clarity of the interaction effect with inflation, which is a central focus of the analysis. Once transformed, the inflation variable in first difference satisfies the stationarity criterion:

4.3. Panel Model Estimation

4.3.1. Fixed-effects estimation (FE)

The results from the fixed-effects model (Table 5) indicate that the policy rate variable has a positive coefficient of 0.0339; however, it is not statistically significant ($P = 0.56$), which aligns with theoretical expectations. The differentiated inflation variable is also not significant ($P = 0.491$) and has an expected negative coefficient of −0.0104. The interaction term shows a relatively high positive coefficient of 10.4535, but it remains insignificant ($P = 0.312$), consistent with expectations.

Regarding the control variables, the bank size shows a slightly negative coefficient of −0.0039, which is not significant ($P = 0.875$) and presents an unexpected sign. The NPL ratio is weakly significant ($P = 0.065$) with a negative coefficient of −0.0955, as expected. The Tier 1 ratio is also insignificant ($P = 0.414$) with an expected sign and a coefficient of -0.0276.

The leverage ratio variable is highly significant ($P = 0.001$) with a positive coefficient of 0.0986, which aligns with expectations. Conversely, the liquidity ratio is insignificant ($P = 0.774$) and exhibits a moderate negative effect of −0.0030, which is consistent with intuition. Finally, real GDP is significant ($P = 0.015$) with a positive coefficient of 0.0187 in line with expectations.

4.3.2. Random-effects estimation (RE)

The random-effects model displays similar trends (Table 6). The policy rate variable remains insignificant ($P = 0.406$) with a positive coefficient of 0.0543, as expected. The differentiated inflation variable shows a negative sign (−0.0078) but remains insignificant ($P = 0.642$). The interaction term is also insignificant ($P = 0.401$), although a positive sign was anticipated.

In contrast, the bank size variable is highly significant this time ($P = 0.000$), with a positive coefficient of 0.0249, consistent with

Table 5: Fixed-effects (within) regression

Variable	Coefficient	Std. Error	t	P-value	95% Confidence interval
Policy rate	0.0339	0.0578	0.59	0.560	−0.0817, 0.1494
Δ Inflation rate	−0.0104	0.0151	−0.69	0.491	−0.0406, 0.0197
Interaction	10.4535	10.2598	1.02	0.312	−10.0554, 30.9624
Bank size	−0.0039	0,0244	−0.16	0.875	−0.0450, 0.0527
NPL ratio	−0.0955	0.0508	−1.88	0.065	−0.1970, 0.0061
Tier 1 ratio	−0.0276	0.0336	−0.82	0.414	−0.0947, 0.0395
Leverage ratio	0.0986	0.0282	3.49	0.001	0.0421, 0.1550
Liquidity ratio	−0.003	0.0105	−0.29	0.774	−0.0241, 0.0180
Real GDP	0.0187	0.0075	2.51	0.015	0.0038, 0.0336
Constant (_cons)	0.005	0.0096	0.52	0.602	−0.0142, 0.0243

R^2 (within): 0.4786 R^2 (between): 0.6028 R^2 (overall): 0.5511. F (9, 62)=6.32 Prob>F = 0.0000
(F-test)=F (5, 62)=5.16 Prob>F = 0.0005
Source: Author's calculation, Stata 15

Table 6: Random-effects GLS regression

Variable	Coefficient	Std. Error	z	P-value	95% Confidence interval
Policy rate	0.054258	0.065271	0.83	0.406	−0.0737, 0.1822
Δ Inflation rate	−0.00782	0.016835	−0.46	0.642	−0.0408, 0.0252
Interaction	9.565038	11.37892	0.84	0.401	−12.7372, 31.8673
Bank size	0.024937	0.004499	5.54	0	0.0161, 0.0338
NPL ratio	−0.02896	0.044162	−0.66	0.512	−0.1155, 0.0576
Tier 1 ratio	−0.00506	0.031717	−0.16	0.873	−0.0673, 0.0571
Leverage ratio	0.058726	0.019288	3.04	0.002	0.0209, 0.0965
Liquidity ratio	−0.02807	0.006399	−4,39	0	−0.0406, −0.0155
Real GDP	0.019126	0.008276	2.31	0.021	0.0029, 0.0353
Constant (_cons)	0.02095	0.005345	3.92	0	0.0105, 0.0314

R^2 (overall): 0.6782
Wald $\chi^2(9)$: 141.21 Prob > χ^2: 0.0000
Source: Author's calculation, Stata 15

expectations. The NPL ratio is not significant (P = 0.512), but it has the expected negative sign (−0.0290). The Tier 1 ratio variable remains insignificant (P = 0.873), showing a consistent negative sign (−0.0051).

The leverage ratio is significant (P = 0.002) with a positive effect of 0.0587, which aligns with expectations. The liquidity ratio is highly significant (P = 0.000) and exhibits a negative sign (−0.0281), as anticipated. Real GDP is also significant (P = 0.021), with a positive sign of 0.0191, in line with expectations.

4.4. Hausman test

To determine the most appropriate econometric specification between the fixed-effects (FE) model and the random-effects (RE) model, a Hausman test was conducted (Table 7). This test evaluates the null hypothesis that unobserved individual differences (specifically, bank-specific effects) are uncorrelated with the explanatory variables. If this hypothesis is not rejected, the RE model is considered more efficient and unbiased, making it the preferred choice. Conversely, if the null hypothesis is rejected, the FE model is favored to prevent biased estimates.

In this study, the Hausman test gives a $\chi^2(9)$ statistic of 8.88 with a P-value of 0.4486, which does not allow us to reject the null hypothesis. Consequently, the differences between the FE and RE estimators are not systematic, and entity-specific effects can reasonably be considered exogenous. This result justifies the adoption of the random-effects model as the main econometric framework for interpretation, since it provides greater statistical efficiency while maintaining the validity of the coefficients.

Table 7: Hausman test

Variable	Coef. (FE)	Coef. (RE)	Diff (b-B)	S.E.
Policy rate	0.0338924	0.0542575	−0.0203651	.
Δ Inflation rate	−0.010444	−0.0078197	−0.0026243	.
Interaction	10.45349	9.565038	0.8884551	.
Bank size	0.0038641	0.0249373	−0.0210732	0.0240248
NPL ratio	−0.0954963	−0.0289609	−0.0665354	0.0251089
Tier 1 ratio	−0.027625	−0.0050586	−0.0225664	0.0108693
Lifting ratio	0.0985761	0.058726	0.0398501	0.0206213
Liquidity ratio	−0.0030316	−0.0280698	0.0250382	0.0083447
Real GDP	0.0187172	0.0191257	−0.0004085	.

$Chi^2(9)$=8.88, P=0.4486. Source: Author's calculation, Stata 15

This choice is all the more pertinent as the RE model offers a higher overall R^2 (0.6782 vs. 0.5511 in FE), overall significance confirmed by the Wald test (P < 0.001), as well as robust effects on several key variables such as bank size, leverage ratio and GDP growth. The Hausman test thus provides a rigorous methodological anchor to support the consistency of the model selected, in line with panel econometrics standards.

4.5. Final Estimate with Correction

After validating the specification using the Hausman test, the random-effects model was re-estimated with adjusted standard errors to account for any heteroscedasticity within the groups (clustered by bank) (Table 8). This robust estimation enhances the reliability of the statistical inferences while maintaining the hierarchical structure of the panel.

The final estimate is based on the random−effects model, selected following the Hausman test (P > 0.44), to which several methodological corrections have been incorporated: refocusing of the policy rate and inflation rate variables to reduce multicollinearity, differentiation of inflation to ensure stationarity, and adjustment of standard errors to correct for potential heteroscedasticity (clustered by panel id). These adjustments guarantee greater statistical reliability and economic validity of the estimates.

The corrected results confirm some major structural effects. The policy rate variable shows a negative coefficient (−0.0543), insignificant (P = 0.143), suggesting partial monetary transmission. The differentiated inflation rate effect is also negative (−0.0079) and insignificant (P = 0.412), while the interaction between the two remains positive (9.56), but without statistical significance (P = 0.271). Although not statistically robust, these results point to the hypothesis of a moderating effect of inflation on bank profitability.

With regard to banking variables, bank size shows a negative and highly significant effect (− 0.0244; P = 0.000), suggesting an inverse relationship between size and profitability. Conversely, the NPL ratio showed a negative effect (−0.0678; P = 0.013), in line with expectations: a deterioration in the loan portfolio reduces performance. The Tier 1 ratio is insignificant (P = 0.557), while the leverage ratio emerges as significant (0.0579; P = 0.040), with a moderate positive effect, suggesting that controlled use of leverage can boost profitability. The liquidity ratio is negative (−0.0281) and significant (P = 0.000), reflecting a penalty on profitability in the event of excessive liquidity.

Finally, real GDP retains a positive (0.0191) and significant (P = 0.027) effect, confirming the pro-cyclical sensitivity of bank profitability to economic conditions. This result supports the idea that growth favors credit demand and margin improvement.

4.6. Validation of correction choice

This estimate includes a first-order autoregressive error structure (AR(1)), which enables us to test for the presence of serial autocorrelation in the errors of the panel data. This specification acknowledges that residuals from the same bank may be correlated over time, potentially violating the assumption of independent errors (Table 9).

The rho_ar parameter, estimated at 0.393, indicates a moderate level of error autocorrelation, which confirms the necessity for robust econometric methods. Additionally, the value of rho_fov, which is 0.878, suggests that a significant proportion of the total variance can be attributed to bank-specific effects. This finding is consistent with the structural heterogeneity of the Moroccan banking sector.

The estimated coefficients from the analysis are largely consistent with those obtained from the robust random effects model. The policy rate variable shows an insignificant effect (P = 0.831), indicating that there is no direct impact from the policy rate when accounting for serial dependence. Similarly, inflation remains insignificant (P = 0.972), as does the interaction term; while its coefficient is relatively high at 5.59, it lacks statistical significance

Table 8: Random-effects model (with robust standard errors)

Variable	Coef.	Std. Err.	z	P>|z|	95% Confidence interval
Policy rate	0.054258	0.037029	1.47	0.143	−0.0183181, 0.1268332
Δ Inflation rate	−0.00782	0.011421	−0.68	0.494	−0.0302051, 0.0145658
Interaction	9.565038	4.700479	2.03	0.042	0.3522683, 18.77781
Bank size	0.024937	0.003526	7.07	0	0.0180272, 0.0318474
NPL ratio	−0.02896	0.037712	−0.77	0.443	−0.1028746, 0.0449528
Tier 1 ratio	−0.00506	0.04145	−0.12	0.903	−0.0862988, 0.0761815
Lifting ratio	0.058726	0.024785	2,37	0.018	0.0101474, 0.1073046
Liquidity ratio	−0.02807	0.009475	−2.96	0.003	−0.0466401, −0.0094995
Real GDP	0.019126	0.004268	4.48	0	0.0107607, 0.0274907
_cons	0.02095	0.00829	2.53	0.011	0.004702, 0.0371977

R^2: Within: 0.4264; Between: 0.8752; Overall: 0.6782 corr (u_i, X)=0; rho=0
Source: Author's calculation, Stata 15

Table 9: Panel regression results, FE with AR (1) correction

Variable	Coefficient	Std. Err.	t	P>|t|	95% Confidence interval
Policy rate	−0.01696	0.07923	−0.21	0.831	−0.17569, 0.14176
Δ Inflation rate	−0.00045	0.01302	−0.03	0.972	−0.02654, 0.02564
Interaction	5.59263	9.47737	0.59	0.557	−13.39282, 24.57807
Bank size	−0.0317	0.03622	−0.88	0.385	−0.10426, 0.04086
NPL ratio	−0.04859	0.06177	−0.79	0.435	−0.17224, 0.07514
Tier 1 ratio	0.02159	0.03865	0.56	0.579	−0.05584, 0.09902
Lifting ratio	0.07082	0.03459	2.05	0.045	0.00153, 0.14011
Liquidity ratio	−0.01294	0.01142	−1.13	0.262	−0.03582, 0.00994
Real GDP	0.01282	0.00628	2.04	0.046	0.00025, 0.02539
_cons	0.01407	0.00628	2.24	0.029	0.00149, 0.02664

R^2 (within)=0.3581, R^2 (between)=0.0827, R^2 (overall)=0.0000, corr (u_i, Xb)=−0.7243. F (9, 56)=3.47, Prob>F = 0.0018. rho_ar=0.3932, sigma_u=0.0052, sigma_e=0.0019, rho_fov=0.8789, F (u_i=0)=2.31, Prob>F = 0.0558. Source: Author's calculation, Stata 15

(P = 0.557). This may be due to the fact that the fixed-effects autoregressive (FE-AR(1)) estimate is based on a smaller sample size (71 observations compared to 77), which diminishes statistical power.

On the other hand, two variables are significant at the 5% level: the leverage ratio (coefficient = 0.0708; P = 0.045) and real GDP (coefficient = 0.0128; P = 0.046). These findings reinforce the importance of structural and macroeconomic determinants in bank profitability. The leverage ratio, which indicates optimized leverage, is positively associated with profitability, while the positive effect of real GDP suggests that banks are benefiting from a dynamic economic environment.

Overall, the analysis confirms that moderate error autocorrelation is present, yet the key results remain robust. Therefore, using a final estimate with clustered robust errors is empirically justified and enhances the reliability of the conclusions drawn from the main model.

4.7. Discussion of the Results

The empirical results obtained from the fixed-effects model with AR(1) correction indicate a complex relationship between monetary policy, inflation, and bank profitability in Morocco. Contrary to expectations based on financial intermediation theory (Ho and Saunders, 1981), the policy rate does not appear to have a significant direct effect on profitability, as measured by Return on Assets (ROA). This finding contradicts Hypothesis 1 and can be attributed to the structural characteristics of the Moroccan banking system, which is marked by high concentration, low deposit flexibility, and limited sensitivity of interest rates to monetary adjustments.

Moreover, monetary policy adjustments from 2010 to 2023 were often cautious and delayed, particularly in response to successive external shocks (such as the pandemic, geopolitical tensions, and soaring international prices). This observation aligns with the findings of Claessens et al. (2018), Borio and Gambacorta (2017), and Lane (2024), who emphasize the ineffectiveness of the rate channel in environments with low competition and high structural inertia.

Recent analyses (Ha et al., 2020; Hofmann et al., 2024) support the idea that the impact of monetary policy depends strongly on the anticipation of economic agents, its source (endogenous or imported), and the reactions of monetary authorities. However, the positive coefficient of the interaction variable between the policy rate and inflation suggests a potential moderating effect: when inflation is well anticipated, banks can adjust their margins more effectively in response to changes in the policy rate. This interpretation is supported by the work of Altavilla et al. (2018), who show that monetary transmission is enhanced in a predictable inflationary environment, and by Coibion and Gorodnichenko (2020), who underscore the importance of expectations in the effectiveness of monetary policy. Thus, although Hypothesis 2 is not statistically confirmed, it has credible economic and theoretical support.

The results also indicate that certain structural factors play a more direct role. The leverage ratio emerges as significant with a positive effect on profitability, reflecting the effective optimization of banks' own resources. This relationship is consistent with the findings of Tan and Floros (2012), who highlight the importance of leverage as a performance tool in emerging banking systems. Additionally, real GDP is positively related to ROA, confirming the procyclical nature of bank profitability: an improving economic climate enhances credit demand, reduces default risks, and fosters a generally positive dynamic for margins, as shown by Francis (2021) and Sanyal (1996). These insights provide partial support for Hypothesis 3, emphasizing that the combined effects of monetary variables are influenced by banks' structural characteristics and the business cycle.

On the other hand, more traditional variables such as bank size, credit portfolio quality, or capitalization do not appear to be significant. This may be attributed to the relative homogeneity of the sample or the low variability of these indicators over the period analyzed. However, the lack of statistical significance does not imply the absence of an economic effect, especially for variables like the bad debt ratio, whose impact is well documented in the literature (Dzeha et al., 2023; English et al., 2024) but can be mitigated through provisioning or credit restructuring mechanisms.

Overall, these findings suggest that the transmission of monetary policy to bank profitability is neither automatic nor uniform; it is highly contingent upon the inflationary context, the macroeconomic environment, and the internal characteristics of banks. The inclusion of an interaction variable proves relevant in capturing this complexity, although the moderating effect is not statistically significant in this initial estimate. These results invite further exploration through more advanced modeling, incorporating thresholds or non-linear effects, to identify the circumstances under which monetary policy proves effective or ineffective. They also raise questions about the need for central banks to adopt more context-sensitive policies, tailored to the nature of inflation and the structural characteristics of the national banking system.

5. CONCLUSION

This study explored the relationship between monetary policy and bank profitability in an inflationary context, specifically focusing on how inflation moderates the effect of Bank Al-Maghrib's key interest rate in Morocco. Using a balanced panel of six commercial banks from 2010 to 2023, the researchers employed econometric panel data modeling, incorporating rigorous corrections for issues like stationarity, multicollinearity, and heteroscedasticity.

The findings indicate that neither the policy rate nor inflation, when considered individually, has a significant impact on profitability as measured by Return on Assets (ROA). However, when examining their interaction, a significant relationship emerges in the corrected model, which provides partial support for the hypothesis of a

monetary duality effect. Specifically, the results allow for the rejection of the first hypothesis, which posited that the policy rate would have a significant direct effect on bank profitability. The second hypothesis, suggesting that inflation plays a moderating role, is partially validated; while the interaction is not significant in all models, it shows robustness in the corrected version. Finally, the third hypothesis, which states that this relationship varies between banks due to structural factors, is also partially confirmed, with significant variables including leverage and GDP.

From a strategic perspective, these results advocate for a more contextual approach to monetary policy that differentiates adjustment mechanisms based on the nature of inflation—whether it is imported, structural, or anticipated—and considers the sensitivity of banking institutions to changes in interest rates. There is a call for enhanced coordination between monetary policy and prudential supervision, particularly to ensure that the most vulnerable banks—those at risk in terms of leverage, liquidity, or capitalization—can effectively absorb the effects of external monetary shocks. For banking authorities, this means supplementing traditional monetary policy instruments with targeted tools aimed at fostering financial resilience. Commercial banks should also focus on actively incorporating the inflationary environment into their pricing strategies, risk management, and asset allocation models.

Despite its methodological rigor, this research has certain limitations, including a small sample size, annual data frequency, and the absence of behavioral variables (such as expectations and market sentiment) or a non-linear approach. These limitations present promising avenues for future research, particularly through the integration of threshold models or dynamic specifications tailored to different banking profiles. Ultimately, this study adds to the discussion on effective monetary policy in emerging economies by illustrating that the impact of interest rates cannot be fully understood without considering the inflationary context, the banking structure, and the strategic decisions made by financial system participants.

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