

Exploring the Impact of the Negative Interest Rate Policy on Bank Profitability in Japan

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Executive Summary

This study examines Japan's introduction of a Negative Interest Rate Policy (NIRP) in 2016 and assesses its effect on bank profitability. Using panel data for 168 Japanese banks from 2010 to 2024, the analysis compares the pre- and post-NIRP periods and examines whether lower policy rates reduced profitability through the compression of Net Interest Margins (NIM). The study also assesses whether the impact differed across bank types, particularly between regional banks and megabanks, given differences in diversification, balance sheet structure and income sources. The policy was intended to stimulate lending and economic activity after decades of low growth and deflation, but raised concerns for Japan's bank-focused financial system. The results show that lower interest rates are associated with weaker bank profitability, with the effect operating primarily through NIM. However, the impact is not uniform across institutions. Megabanks show a stronger overall profitability response to interest rate changes than regional banks, although this difference is not observed when NIM is used as the dependent variable. This suggests that while margin pressure is broadly similar, banks differ in how it translates into overall profitability. The relationship between interest rates and profitability also weakens after NIRP, suggesting a gradual change in monetary transmission once rates enter negative territory. Overall, the findings indicate that negative interest rates reduced bank profitability through margin compression. It also highlighted important differences across institutions and the policy trade-off between monetary accommodation and banking sector resilience.

AI Statement

I acknowledge the use of generative AI in drafting and literature search in this paper. However, the work reported remains my own.

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1. Introduction & Rationale

1.1 Policy Background

Japan experienced a prolonged period of low inflation and subdued economic growth following the bursting of the Japanese asset price bubble in the early 1990s (Mayer & Schnabl, 2022). Over this period, the Bank of Japan (BOJ) used conventional monetary policy tools, including sustained reductions in policy rates, the introduction of the Zero Interest Rate Policy (ZIRP) in 1999, and early forms of forward guidance. These measures proved insufficient to generate sustained inflation, raising broader concerns about how effective conventional monetary policy is in a persistently low rate environment.

The BOJ therefore looked to unconventional monetary policy, starting with Quantitative and Qualitative Easing (QQE) in April 2013. The BOJ committed to large scale purchases of Japanese Government Bonds to substantially expand the monetary base under QQE. Despite the scale of these purchases, inflation remained below target, and the effectiveness of quantity-based easing appeared to weaken. In response, the BOJ introduced the NIRP in January 2016, applying a -0.1% rate to a portion of excess reserves held by banks or other financial institutions. The aim was to reinforce existing monetary easing measures by encouraging banks to reduce reserve holding and increase lending in the economy (BOJ, 2016).

Although negative interest rates were intended to stimulate the economy, concerns were raised about inadvertent consequences for the banking sector. Because Japan's financial system is heavily bank-centred, disruptions to banks' balance sheets can have broad macroeconomic and financial stability consequences; the health of the banking sector is critical for credit provision and economic performance (Hoshi & Kashyap, 1999).

Understanding how negative interest rates affect bank profitability is central to evaluating the effectiveness and potential trade-offs of unconventional monetary policy.

1.2 Research Question

This dissertation examines how the BOJ's NIRP affected bank profitability in Japan, specifically analysing the differences between megabanks¹ and regional banks. The existing literature largely focuses on aggregate banking outcomes, while this study emphasises the potential for heterogeneous effects across institutions with different business models, funding structures and degrees of income diversification.

This distinction is important because there is significant variation in their exposure to low interest rates. The structural differences imply that NIRP may have uneven effects across institutions, with important implications for regional economic activity and financial stability.

1.3 Economic Mechanisms

Several mechanisms link negative interest rates to bank profitability, the most direct being the Interest Margin Channel. NIM reflect the profitability of banks' core intermediation activities and are sensitive to changes in the interest rate environment. In a negative rate environment, it becomes challenging for banks to cut deposit rates because they are constrained by a zero lower bound, whilst lending rates continue to adjust downwards. This asymmetry reduces the interest income banks earn on their assets relative to their funding costs (Heider et al, 2017).

Beyond this direct effect, negative interest rates also create a trade-off between lending volumes and profitability. While lower interest rates reduce profitability per unit, they may stimulate credit demand and increased lending volumes. The overall effect on profitability therefore depends on whether higher lending activity compensates for lower margins (Altavilla et al, 2018). At the same time, compressed margins can encourage banks to rebalance their portfolios toward riskier assets, hence increasing risk exposure (Borio & Zhu, 2012). While such behaviour may support short-term profitability, it raises concerns for long-term financial stability.

These mechanisms may operate differently across bank types. Japanese megabanks tend to be large, diversified and internationally active, with a significant share of income coming from

¹ Megabanks refer to Japan's largest, systemically important banking groups, primarily Mitsubishi UFJ Financial Group, Sumitomo Mitsui Financial Group, and Mizuho Financial Group, characterised by their large asset size, diversified income sources, and significant international operations.

non-interest sources. By contrast, regional banks depend more heavily on domestic lending and interest income, potentially making them more exposed to prolonged margin compression (Wu, 2024). Examining this difference is central to understanding how NIRP affects not only aggregate profitability, but also its distribution across the banking system.

1.4 Contribution

This dissertation makes three main contributions. First, it examines the effects of NIRP over an extended time horizon, allowing for an assessment of medium-term profitability outcomes rather than focusing solely on short-run responses to policy implementation. Second, it employs bank-level panel data, enabling the analysis to control for unobserved heterogeneity across institutions and to exploit variation over time. Third, and most importantly, it explicitly examines differences between megabanks and regional banks, addressing a gap in the literature which has largely focused on aggregate banking outcomes without addressing heterogeneity within countries.

By focusing on a structurally segmented banking system, this study gives to a more nuanced understanding of how unconventional monetary policy has varied impact on different types of bank, and whether such policies may generate uneven distributional effects across the banking sector.

1.5 Structure of the Dissertation

The dissertation is organised in six chapters. Chapter 2 reviews the existing theoretical and empirical work on negative interest rates and bank profitability. Chapter 3 describes the data, and Chapter 4 explains the methodological approach. Chapter 5 presents the results alongside a series of robustness checks, and Chapter 6 concludes with the main policy implications.

2. Literature review

2.1 Introduction

This literature review assesses the relationship between the NIRP and bank profitability, focusing specifically focus on heterogeneity across Japanese banks. While conventional monetary theory suggests that lower interest rates stimulate lending and economic activity, a

growing body of research highlights that this relationship may weaken or reverse when rates approach, or fall below, zero. In such environments, bank profitability becomes a central channel through which monetary policy operates.

2.2 Theoretical Perspectives on Bank Profitability and Monetary Policy

The relationship between monetary policy and bank behaviour is central to macro-financial literature, as changes in interest rates affect both banks' earning capacity and their willingness to supply credit. Banks generate profits through maturity transformation, earning a spread between lending returns and funding costs (Windsor et al., 2023). Foundational studies on the bank lending channel highlights how monetary policy influences credit supply through balance sheet conditions, funding constraints and informational frictions (Mishkin, 1996; Bernanke & Gertler, 1995), implying that profitability and lending are jointly shaped by the monetary environment.

This relationship becomes more complex as interest rates approach the zero lower bound. Lending rates typically fall with monetary easing, while deposit rates are less flexible due to the availability of cash and depositor behaviour. This creates deposit rate rigidity and compresses NIM, as asset yields adjust more rapidly than funding costs (Boucinha & Burlon, 2020; Demiralp et al., 2019). NIRP should therefore be viewed as a policy that alters the structure of bank intermediation by placing sustained pressure on the interest margin that underpins profitability.

This mechanism is formalised by the "reversal rate" hypothesis (Brunnermeier & Koby, 2018), which introduces a non-linear relationship between monetary policy and bank behaviour. Monetary easing becomes counterproductive below a certain threshold, because weaker bank profitability reduces banks' capacity or willingness to lend. This challenges the assumption that lower rates are always expansionary. Instead, once margins are sufficiently compressed, the banking sector may become less responsive to monetary easing. This insight is particularly relevant in Japan, where banks had already operated in a prolonged low rate environment prior to the introduction of NIRP in 2016, potentially bringing some institutions closer to the reversal rate threshold.

Related theoretical foundations are provided by the liquidity trap literature. Krugman et al. (1998) and Eggertsson et al. (2001) highlight the limits of conventional monetary policy when interest rates approach zero, while Buiter (2009) challenges the idea that zero is a hard limit, suggesting that negative rates are feasible if central banks make certain institutional

changes. While this literature explains why NIRP can be implemented, it provides limited insight into how bank profitability evolves once such policies are in place.

To understand how negative interest rates affect bank profitability more directly, it is necessary to consider formal models of bank behaviour. In Ho and Saunders' (1981) framework, banks behave like risk-averse dealers, choosing loan–deposit spreads that offset interest rate uncertainty and reflect their market power. The Monti-Klein framework (Klein 1971, Monti, 1972) similarly models banks as intermediaries with market power in loan and deposit markets, implying that margins depend on pricing behaviour and the elasticity of loan and deposit demand. Both approaches imply that sustained monetary easing places downward pressure on spreads, particularly where deposit pricing is constrained. However, these models assume a degree of pricing flexibility that may not exist when retail deposit rates are effectively bounded at zero. They explain why margins fall, but are less effective in explaining how banks adjust when the traditional model of profitability comes under pressure.

Other perspectives suggest that the effects of NIRP are not unambiguously negative. A portfolio rebalancing, or “search for yield” (Mimmel et al., 2018), mechanism implies that banks facing lower returns on reserves may shift towards higher-yield lending or riskier assets in an attempt to stabilise earnings. This view is consistent with Abel (1983), and Borio & Zhu (2012) who show that uncertainty or lower expected returns can encourage investment. However, the irreversibility literature points in the opposite direction. Bernanke (1983) and Dixit & Pindyck (1994) argue that very low or negative interest rates may increase the option value of holding liquid assets when future rates are uncertain. This implies that banks may become more cautious rather than more expansionary, which is relevant for Japan where prolonged low rates and weak growth may increase uncertainty, leading to caution and failing to stimulate credit supply.

The theoretical literature provides mixed views. NIRP is expected to compress margins, but its overall effect on profitability depends on banks' behavioural responses and institutional context. Theoretical analysis suggests that NIRP may redistribute profitability across banks rather than affect all institutions uniformly.

2.3 Empirical evidence on NIRP and Bank Profitability

The empirical literature broadly supports the prediction that NIRP compresses NIM, but provides more mixed evidence on its impact on overall profitability. Evidence from European

banking systems consistently shows that negative rates reduce interest income because lending yields fall while deposit costs remain constrained near zero (Demiralp et al., 2019). However, while margin compression is a robust finding, its effect on profitability is more nuanced. Studies of Euro area and Swiss banks show that although margins declined when negative rates were introduced, the overall impact on profitability was partially offset by increased lending activity, non-interest income and cost efficiency improvements (Altavilla et al., 2018; Basten & Mariathan, 2018). This suggests that profitability outcomes depend not only on the mechanical effect of lower rates, but also on banks' ability to adjust their business models.

A second strand of the literature focuses on behavioural responses, particularly lending and portfolio reallocation. Evidence indicates that banks facing negative rates may increase lending as a substitute for low-yield reserves, consistent with a portfolio rebalancing mechanism (Heider et al., 2017). However, this result varies across institutions. Regional banks which tend to be more reliant on deposit funding appear more exposed to margin compression under negative rates, as constraints on deposit pricing limit their ability to pass through policy rate changes. This results in larger declines in NIM and creates stronger incentives to adjust behaviour through lending, cost efficiency or income diversification (Freriks & Kakes, 2024). This highlights that NIRP produces heterogeneous outcomes across banks.

Cross-country evidence reinforces the importance of institutional context. The impact of negative rates varies across countries depending on financial structure and policy design (Jobst & Lin, 2016; Bech & Malkhozov, 2016). Structural features such as reliance on deposit versus wholesale funding also shape how effectively banks can absorb these pressures. Large cross-country panel studies show that banks with more diversified income streams are better able to offset losses from reduced interest income, while more deposit-dependent institutions face more persistent profitability pressures (Lopez, Rose & Spiegel, 2020). More recent comparative evidence confirms this pattern across both European and Japanese banks, showing that while negative rates reduce NIM, their impact on overall profitability is often mitigated through income diversification (Jayed & Mohammed, 2026). These findings suggest that NIRP cannot be evaluated in isolation from institutional arrangements.

Unlike many European economies, Japan introduced NIRP after an extended period of very low interest rates and weak economic growth, with very low rates in place since the late

1990s (Haba et al., 2025). As a result, the policy did not represent a clear structural break, but rather an extension of an already highly accommodative monetary regime. As Demiralp et al. (2019) note, this complicates identification because profitability outcomes may reflect the cumulative effects of prolonged monetary easing rather than NIRP alone. While this limits causal interpretation, it does not eliminate the value of analysing how profitability evolved once policy rates became negative.

Empirical evidence for Japan shows meaningful effects. Financial market responses suggest that NIRP had an immediate negative impact on expected bank profitability, with equity prices of financial institutions declining following the policy announcement (Hong & Kandrak, 2022). Micro-level evidence suggests that NIRP also influenced lending composition, with more affected banks reallocating credit towards riskier borrowers (Nakashima & Takahashi, 2021). However, these adjustments did not necessarily translate into sustained improvements in profitability, indicating a disconnect between short-run balance sheet responses and longer-term earnings outcomes. Over longer horizons, sustained exposure to low or negative rates has been associated with weaker profitability and a gradual reduction in loan supply, consistent with the reversal rate hypothesis (Brunnermeier & Koby, 2018).

The literature supports several key conclusions. NIRP consistently compresses NIM, particularly in the short run and banks respond through behavioural adjustments, such as increased lending, portfolio reallocation and income diversification, to partially offset these effects. Also, long term consequences are more uncertain, with evidence suggesting that sustained margin compression may weaken intermediation capacity and alter credit allocation. Crucially, differences in funding structures and institutional context play a central role in shaping outcomes.

2.4 Methodological Approaches in the Literature

The methodological literature consistently points to bank-level panel data as an appropriate framework for examining how NIRP affects profitability. Panel methods allow researchers to examine how the same banks respond over time to changes in the interest rates, instead of relying solely on cross-sectional comparisons. Studies such as Altavilla et al. (2018) and Heider et al. (2017) employ fixed-effects panel models to control for unobserved heterogeneity across banks.

Alternative approaches exist but are less applicable to this research question. Event studies are effective in capturing short-term market reactions but do not reflect realised profitability outcomes. Cross-country panel analyses offer broader comparisons but may obscure institutional features specific to the Japanese context. Difference-in-differences approaches are difficult to implement, as NIRP was applied uniformly across Japanese banks, leaving no credible domestic control group.

Given these limitations, a fixed-effects panel framework provides the most appropriate empirical strategy. This approach identifies the effect using changes within each bank over time, while holding constant any characteristics that do not vary across banks. The use of both ROAA and NIM measures further strengthens the analysis by linking empirical results directly to the theoretical mechanisms identified in the literature.

2.5 Hypotheses

The literature reviewed above establishes that NIRP places downward pressure on bank profitability primarily through margin compression, but that the overall effect depends on banks' ability to adjust. Both theoretical and empirical evidence emphasise the importance of heterogeneity, yet this angle remains underexplored within individual banking systems.

In Japan, this gap is particularly significant. The banking system is characterised by a structural divide between megabanks and regional banks. While existing studies document the aggregate effects of NIRP, they do not systematically compare these groups over time. As a result, it remains unclear whether regional banks experienced greater profitability pressure, whether megabanks were better able to offset these effects, and how NIRP influenced the distribution of profitability across the banking system.

This dissertation addresses this gap by examining how NIRP affected profitability across different bank types in Japan and whether NIM compression was the primary transmission channel. The analysis is guided by the following hypotheses:

H1: Lower policy interest rates are linked to lower bank profitability.

H2: Lower policy interest rates are linked to lower NIM.

H3: The negative impact of lower rates on profitability is stronger for regional banks than megabanks.

H4: The relationship between interest rates and bank profitability differs between the pre- and post-NIRP periods.

3. Data

3.1 Data Sources

To analyse the impact of Japan's NIRP on bank profitability, this study constructs a panel dataset of Japanese banks covering the period 2010 to 2024. The sample consists of 168 banks operating within Japan, including both megabanks and regional banks. Banks are included based on the availability of financial statement data, resulting in an unbalanced panel where observations vary across banks and time.

Focusing on a single-country sample means the analysis can isolate the effects of monetary policy within a common macroeconomic and regulatory environment. This is particularly important in the context of NIRP, as cross-country studies may be distorted by difference in financial structure and policy design. By examining variation within Japan, the analysis recognises differences across banks while keeping institutional conditions constant.

The sample period captures both the pre- and post-NIRP environments surrounding the policy's introduction in January 2016. This provides a sufficient pre-policy window to establish baseline trends in profitability, while also allowing for the analysis of medium-term adjustments following the transition into negative interest rate territory. As NIRP was introduced after an extended period of near-zero rates, the use of a relatively long time horizon is important for distinguishing persistent effects from short-term fluctuations.

Financial data at bank level are taken from the Orbis BankFocus database, which reports standardised statements for banks worldwide. Variables extracted include ROAA, NIM, total assets, shareholder funds, and profit. The use of standardised data improves comparability across institutions and reduces measurement inconsistencies.

Total assets are transformed using the natural logarithm to capture scale effects and reduce skewness. A capital ratio is constructed as shareholder funds divided by total assets, capturing differences in financial resilience across banks. Observations with missing values were retained as blank entries and excluded automatically during regression analysis. While this approach preserves the available data, it introduces an unbalanced panel structure, which is accounted for in the econometric framework.

Monetary policy data were incorporated to capture changes in the interest rate environment. Annual policy interest rates were obtained from BOJ statistics and merged with the dataset by year. This analysis incorporates both a continuous policy rate and a post-NIRP dummy. This

dual specification allows the model to capture both marginal changes in the interest rate environment and structural shifts linked to the introduction of negative rates.

The final dataset contains approximately 2,000–2,500 bank-year observations, depending on data availability. Summary statistics and data preparation were conducted in Microsoft Excel while econometric analysis was performed using Gretl.

3.2 Variable Definitions

The key variables used in the empirical analysis are defined in Table 1.

Table 1: Variable Definitions

VARIABLE	DEFINITION	SOURCE
ROAA_CLEAN	Return on average assets, adjusted for extreme outliers	BankFocus
NIM	Net interest margin (interest income minus interest expense relative to assets)	BankFocus
LOG_ASSETS	Natural logarithm of total assets	BankFocus
CAPITAL_RATIO	Shareholder funds divided by total assets	BankFocus
POLICY_RATE	BOJ policy interest rate (annual average)	BOJ
POST_NIRP	Dummy variable equal to 1 from 2016 onwards	Author
MEGA_DUMMY	Dummy variable equal to 1 for megabanks	Author

ROAA is used as the primary measure of profitability, as it captures the efficiency with which banks generate earnings from their asset base, and is less sensitive to differences in leverage than return on equity. To reduce the influence of extreme observations and improve the robustness of the results, ROAA is adjusted for outliers.

NIM is used as a secondary dependent variable to demonstrate the transmission mechanism of monetary policy. As NIRP is expected to affect profitability primarily through margin compression, using both ROAA and NIM allows the analysis to distinguish between overall profitability effects and the specific interest margin channel. Bank size, measured as the logarithm of total assets, controls for economies of scale, diversification and differences in business models. The capital ratio captures variation in financial resilience, which may influence how banks react to changes in the interest rate environment.

The megabank dummy identifies the three megabanks which is central to testing for heterogeneous effects of NIRP across bank types.

3.3 Summary Statistics

Summary statistics for the main variables are presented in Table 2.

Table 2: Summary Statistics

VARIABLE	MEAN	STD. DEV.	MIN	MAX	OBSERVATIONS
ROAA_CLEAN	0.165	0.233	-2.463	2.820	2132
NIM	1.315	0.468	-1.061	4.407	1995
LOG_ASSETS	14.38	1.594	6.229	19.619	2132
CAPITAL_RATIO	0.059	0.041	0.013	0.485	2132
POLICY_RATE	0.019	0.063	-0.06	0.121	2132

The summary statistics highlight several important features of the data. Average profitability is relatively low which is consistent with the prolonged low interest rate environment in Japan. NIM exhibit limited variation, reflecting compressed spreads across the banking sector. Also, the distribution of bank size is highly dispersed, indicating substantial heterogeneity between megabanks and regional banks. This provides further justification for the use of interaction terms and fixed effects in the empirical analysis.

Importantly, the policy rate varies only over time rather than across banks. As a result, identification relies on how common changes in the interest rate environment interact with differences across banks and within-bank variation in profitability over time. This reinforces the importance of modelling heterogeneity in the empirical framework.

3.4 Visual Trends

Figure 1: Net Interest Margin: Megabanks vs Regional Banks (2010-2024)

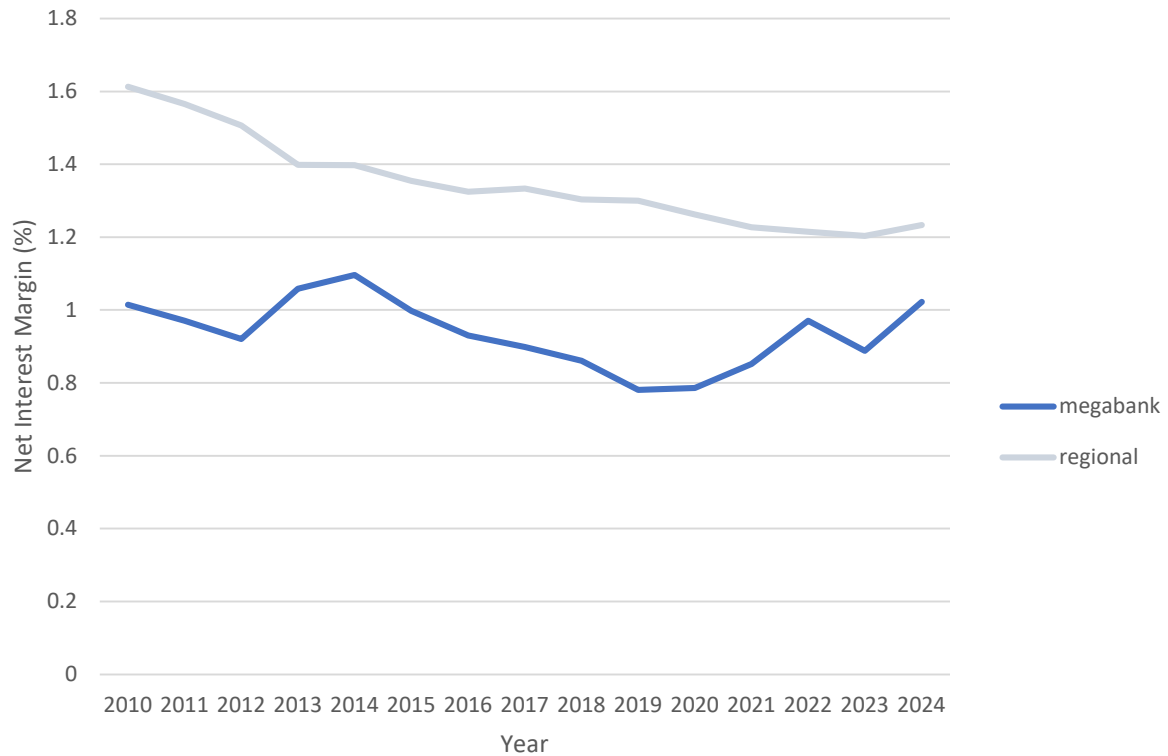


Figure 1 presents the evolution of NIM for megabanks and regional banks over the sample period. Regional banks consistently exhibit higher NIM than megabanks, reflecting their greater reliance on traditional deposit lending activities. However, both groups display a clear downward trend in margins over time, indicating a gradual compression of spreads across the banking sector. Importantly, margins continue to decline following the introduction of the NIRP in 2016, but gradually rather than as a sharp structural break. This suggests that the effects of NIRP operate through persistent margin compression, rather than an immediate discrete shift. This pattern supports the use of a continuous policy rate measure alongside a post-NIRP indicator in the empirical specification.

A modest increase in margins is observed for megabanks towards the end of the sample period, particularly in 2024, which may reflect the end of the NIRP. However, given its timing and limited observations, this should be interpreted with caution. Overall, the figure provides preliminary evidence consistent with the hypothesised transmission mechanism and reinforces the importance of modelling heterogeneity across bank types.

4. Methodology

4.1 Econometric Framework

To assess how Japan's NIRP has influenced bank profitability, the analysis relies on a panel data framework that incorporates both cross-sectional differences and time-series dynamics in bank-level observations. This structure allows the behaviour of the same banks to be tracked as monetary conditions evolve, while controlling for fixed institutional characteristics. Panel data methods are standard in empirical banking research because they provide more credible identification than approaches based only on cross-sectional or time-series variation. The baseline econometric specification is:

$$ROAA_{it} = \alpha + \beta PolicyRate_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

where $ROAA_{it}$ measures the profitability of bank i in year t , $PolicyRate_t$ represents the BOJ's policy interest rate, and X_{it} is a vector of bank specific control variables. The term μ_i captures unobserved, time-invariant heterogeneity, while ε_{it} is the idiosyncratic error term.

As the policy rate varies only over time, identification relies on how common changes in the interest rate environment interact with within-bank variation in profitability and differences across banks, rather than purely cross-sectional variation. The coefficient β captures the relationship between the interest rate environment and bank profitability, rather than a purely cross-sectional effect.

To examine the transmission mechanism, the model is also estimated using NIM:

$$NIM_{it} = \alpha + \beta PolicyRate_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

This allows the analysis to test whether monetary policy primarily affects profitability through margin compression.

To explore heterogeneity across bank types, an interaction term is introduced:

$$ROAA_{it} = \alpha + \beta_1 PolicyRate_t + \beta_2 (PolicyRate_t \times Mega_i) + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

where $Mega_i$ is a dummy variable equal to one for megabanks and zero for regional banks. The coefficient β_2 captures differences in sensitivity to interest rates across bank types.

4.2 Baseline Model Specification

The baseline specification includes control variables that are common in banking literature to isolate the impact of monetary policy. Bank size, logarithm of total assets, captures economies of scale and diversification, while the capital ratio reflects financial resilience and risk-bearing capacity which may influence how banks respond to changes in interest rates.

A central feature of the empirical strategy is the use of bank fixed effects. Japanese banks differ in ways that are difficult to observe, such as management quality, risk appetite and business structure, which are likely correlated with profitability. The fixed effects estimator removes these factors, ensuring that identification comes from within-bank variation over time. This strengthens the credibility of the estimated relationships, as the model asks how changes in the policy rate affect the same bank across different years, rather than comparing profitability levels across banks with different structures. Although a difference-in-differences framework is commonly used to evaluate policy interventions, it is less appropriate in this context, as the NIRP was applied uniformly across all banks within Japan, limiting the availability of a credible control group. This constraint is widely recognised in the NIRP literature and supports the use of a fixed-effects panel approach. However, while fixed effects remove time-invariant heterogeneity, they do not address endogeneity arising from time-varying shocks, which remains an important limitation of the empirical strategy.

4.3 Identification Challenges

Although the panel framework strengthens identification, several challenges remain that shape the interpretation of the results. Monetary policy is not exogenous: the BOJ adjusts interest rates in response to macroeconomic conditions, such as inflation, output, and financial stability, that will likely influence bank profitability. This creates the possibility of reverse causality or omitted variable bias. While fixed effects absorb time-invariant heterogeneity, they cannot eliminate endogeneity arising from macroeconomic shocks. As a result, the empirical strategy prioritises careful interpretation rather than strong causal claims.

Bank profitability is also influenced by factors such as loan composition, credit demand, and exposure to international markets. Some of these variables are not observable at the bank-year level, creating the potential for omitted variable bias. The inclusion of size and capital controls mitigates, but does not fully eliminate, this concern. Profitability tends to be persistent over time due to retained earnings, strategic decisions, and long-term customer relationships and the baseline model does not include lagged dependent variables, meaning dynamic effects may be imperfectly captured. Serial correlation presents an additional challenge as profitability shocks may persist within banks across years, leading to correlated errors. This is accounted for in the estimation strategy through clustered standard errors. Finally, the introduction of NIRP in 2016 represents a discrete policy shift, but the effects may be gradual and non-linear. To address this, the analysis incorporates both a continuous policy rate measure and subsample splits around the introduction of NIRP.

4.4 Estimation Strategy

The empirical analysis uses pooled OLS as a benchmark, but this approach assumes a common intercept across banks which is unlikely in practice. Formal F-tests reject this restriction, supporting the use of a fixed effects specification.

The fixed-effects estimator permits unobserved bank characteristics to be correlated with the regressors, which makes it the appropriate specification for this analysis. Identification therefore relies on within-bank variation over time, which is appropriate given the research question.

To ensure valid inference, standard errors are clustered at the bank level, accounting for both heteroskedasticity and serial correlation. This is particularly important in banking data, where shocks to profitability may persist across period. Total assets are log-transformed to reduce skewness and to capture the diminishing returns to scale. This transformation also improves interpretability and model fit.

4.5 Diagnostics & Robustness Plan

A comprehensive set of diagnostic checks and robustness tests assess the sensitivity of the results and strengthen the credibility of the findings. These tests are essential for ensuring that

the results are not guided by model specification or sample selection, which is a key requirement for credible empirical analysis.

Clustering standard errors at the bank level addresses concerns about serial correlation and heteroskedasticity, ensuring that inference remains valid even when profitability shocks persist over time. Robustness is further evaluated through alternative model specifications. Estimating the model with NIM as the dependent variable provides a direct test of the proposed transmission mechanism. Heterogeneity is examined by interacting the policy rate with a megabank dummy, allowing the analysis to assess whether the effects of monetary policy differ across bank types. This provides insight into the distributional consequences of NIRP across the banking system.

Finally, subsample analysis is conducted by splitting the sample into pre- and post-NIRP periods. This helps identify potential structural breaks and assesses whether the relationship between interest rates and profitability changes once policy rates fall below zero. This directly links the empirical strategy to the theoretical concept of the reversal rate and regime change.

These diagnostics and robustness checks ensure that the results are not shaped by a particular specification, sample period, or profitability measure, and provide a rigorous assessment of the impact of negative interest rates on Japanese bank profitability.

5. Results

5.1 Baseline Results

Table 3 summarises the baseline estimates examining the link between the interest-rate environment and bank profitability. The coefficients across all specifications point to a statistically significant association between lower policy rates and reduced profitability. The POST_NIRP indicator is negative and strongly significant (-0.048 , $p < 0.01$), suggesting that ROAA fell after negative rates were introduced. These results provide preliminary support for the view that NIRP weakened bank profitability.

Table 3: Baseline and Policy Rate Models (ROAA)

VARIABLE	(1) OLS	(2) OLS (CLUSTERED SE)	(3) POLICY RATE
POST_NIRP	-0.048*** (0.011)	-0.048*** (0.012)	
POLICY_RATE			0.336*** (0.074)
LOG_ASSETS	0.035*** (0.003)	0.035*** (0.008)	0.035*** (0.008)
CAPITAL_RATIO	1.427*** (0.134)	1.427 (1.280)	1.462 (1.283)
CONSTANT	-0.357*** (0.051)	-0.357** (0.162)	-0.395** (0.159)
OBSERVATIONS	2132	2132	2132
R ²	0.087	0.087	0.086

Notes: Standard errors in parentheses, clustered at the bank level.

*** p<0.01, ** p<0.05, * p<0.1.

Replacing the regime dummy with a continuous measure of the policy rate yields a positive and highly significant coefficient (0.336, $p < 0.01$), suggesting that higher interest rates are linked to higher profitability. However, given the identification strategy, this relationship should be interpreted as capturing the effect of broader monetary conditions rather than the causal impact of policy changes in isolation.

Control variables report mostly as expected. Bank size is positively associated with profitability in OLS specifications, consistent with economies of scale and diversification benefits, although this effect weakens when fixed effects are introduced. The capital ratio is positive but not consistently significant, reflecting the varied evidence in the literature on the relationship between capitalisation and profitability. Overall, the baseline results provide strong evidence that negative interest rates reduce bank profitability, with the effect operating primarily through NIM compression.

5.2 Diagnostics

Table 4 presents the fixed effects estimates used to account for unobserved heterogeneity across banks. The coefficient on the policy rate is positive and highly significant, indicating that the relationship between interest rates and profitability is not determined only by cross-sectional differences between institutions, but reflects how individual banks adjust to changes in monetary conditions over time.

Table 4: Fixed Effects Results (ROAA)

VARIABLE	FIXED EFFECTS
POLICY_RATE	0.343***
	(0.071)
LOG_ASSETS	0.045*
	(0.025)
CAPITAL_RATIO	2.584**
	(1.099)
OBSERVATIONS	2132
WITHIN R ²	0.043

Notes: Bank fixed effects included. Standard errors clustered by bank and reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Several diagnostic checks support the validity of the empirical strategy. Standard errors are clustered at the bank level to account for heteroskedasticity and serial correlation, which are common in bank-level panel data. Formal tests also reject the pooled OLS specification in favour of fixed effects, confirming the presence of substantial unobserved heterogeneity across banks. This is consistent with the Japanese banking literature, which emphasises persistent structural differences between megabanks and regional banks (Harrison et al., 2023).

The relatively low R^2 values in the ROAA regressions are typical in profitability studies, where earnings are influenced by a wide range of macroeconomic factors. By contrast, the higher explanatory power of the NIM regressions (within $R^2 = 0.187$) suggests that interest rates are more directly linked to margins than to overall profitability, reinforcing the proposed transmission mechanism.

While fixed effects improves the credibility of the estimates by controlling for time-invariant heterogeneity, it does not fully eliminate endogeneity arising from broader macroeconomic conditions. The results should therefore be interpreted as evidence of a robust relationship, rather than a purely causal estimate of NIRP in isolation.

5.3 Robustness Checks

A variety of robustness checks were undertaken to examine whether the core findings are reactive to alternative specifications, and to provide further insight into the mechanisms at work. Across all tests, the central conclusion remains unchanged: negative interest rates exert downward pressure on bank profitability, primarily through the compression of NIM.

Re-estimating the model using NIM as the dependent variable provides further insight into the transmission mechanism underlying the profitability effects of NIRP. As shown in Table 5, the policy rate has a large and highly significant effect on NIM (1.054 in OLS; 1.005 in FE), with coefficients substantially larger than those observed in the ROAA regressions. This indicates that the relationship between interest rates and bank profitability operates primarily through compression of interest margins. The findings support the theoretical prediction that deposit rate rigidity constrains banks' ability to reduce funding costs when policy rates fall. This pattern aligns closely with international evidence, where margins have been found to respond more strongly than aggregate profitability under negative rate regimes (Heider et al., 2017; Altavilla et al., 2018).

Table 5: Mechanism – Net Interest Margins (NIM)

VARIABLE	(1) OLS	(2) FIXED EFFECTS
POLICY_RATE	1.054***	1.005***
	(0.140)	(0.149)
LOG_ASSETS	-0.158***	-0.279**
CAPITAL_RATIO	1.682	1.496
OBSERVATIONS	1995	1995
WITHIN R ²		0.187

Notes: Bank fixed effects included. Standard errors clustered by bank and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Heterogeneity across bank types is assessed using an interaction term between the policy rate and a megabank dummy. Table 6 shows a pronounced asymmetry where megabanks exhibit a stronger profitability response to interest rate movements, with the total effect (1.281) more than quadruple that of regional banks. This finding is intuitive given the structural differences between the two groups and is consistent with their greater exposure to market-based funding, securities portfolios and international operations, which are more sensitive to interest rate movements (Lopez et al., 2018).

Table 6: Heterogeneity by Bank Type

VARIABLE	(1) ROAA (FE)	(2) NIM (FE)
POLICY_RATE (REGIONAL)	0.323***	1.019***
	(0.072)	(0.152)
POLICY_RATE × MEGABANK	0.958***	-0.561
	(0.109)	(0.348)
LOG_ASSETS	0.045*	-0.279**
	(0.026)	(0.117)
CAPITAL_RATIO	2.552**	1.543
	(1.088)	(2.660)
OBSERVATIONS	2132	1995
WITHIN R²	0.046	0.188

Notes: Standard errors in parentheses, clustered at the bank level.

*** p<0.01, ** p<0.05, * p<0.1.

Effect for megabanks (ROAA) = 0.323 + 0.958 = 1.281.

However, when NIM is used as the dependent variable, the megabank interaction term becomes statistically insignificant (Table 6, Column 2). This suggests that the heterogeneity in profitability is not driven solely by differences in margin sensitivity. Instead, it points to additional channels, such as fee income, trading activities, or balance sheet composition, that may amplify the effect of monetary policy for larger institutions. This nuance is rarely highlighted in the existing literature and represents a meaningful contribution of this study.

Further evidence is provided by splitting the sample into pre- and post-NIRP periods (Appendix Tables A2 and A3). Prior to 2016, higher interest rates are correlated to lower profitability, a result consistent with Japan's prolonged low-growth environment. Following the introduction of NIRP, this relationship weakens and becomes statistically insignificant. This suggests that the sensitivity of bank profitability to interest rates weakens once policy rates approach or fall below zero, consistent with the theoretical concept of the reversal rate (Brunnermeier & Koby, 2018). It also reflects the binding nature of the deposit rate floor, which limits further adjustment in funding costs.

The results indicate that the profitability effects of NIRP are not driven by model choice, sample composition, or the specific profitability metric used. Instead, they reflect a structural feature of banking under negative rates where they are unable to pass negative rates through to depositors and the resulting compression of NIM. The stronger response observed for megabanks underscores the role of business model heterogeneity, while the subsample

analysis highlights the non-linear nature of monetary transmission once policy rates approach or fall below the zero lower bound.

5.4 Discussion

The results provide consistent evidence that lower interest rates are linked to reduced bank profitability in Japan, with the primary transmission channel operating through NIM compression. This aligns closely with theoretical predictions and international empirical findings, reinforcing the central role of deposit rate rigidity in shaping bank responses to negative interest rates.

The results also highlight the importance of heterogeneity across banks. The stronger profitability response observed for megabanks suggests that institutions with greater exposure to market-based activities are more sensitive to changes in the interest rate environment. However, the absence of corresponding heterogeneity in NIM indicates that differences in non-interest income and balance sheet composition also play a significant role. This points to a more complex transmission mechanism than is often assumed in the literature.

While the results provide strong evidence of a relationship between interest rates and profitability, they should not be interpreted as strictly causal. The introduction of NIRP coincided with broader macroeconomic conditions, including weak growth and low inflation, which may also have influenced bank performance. However, the consistency of the findings across alternative specifications, measures and sample periods, together with their alignment with well-established theoretical mechanisms, suggests that monetary policy is integral in determining bank profitability.

Overall, the findings provide strong support for the hypothesis that lower interest rates are linked to reduced bank profitability. They also highlight important trade-offs for policymakers. While negative interest rates may support macroeconomic objectives, they impose costs on the banking sector, particularly for institutions more exposed to interest rate movements. This underscores the need to consider financial sector implications when designing and implementing unconventional monetary policy.

6. Conclusion & Recommendations

6.1 Summary of findings

This dissertation examined how Japan's NIRP affected bank profitability, with particular attention to the role of NIM and differences across bank types. The results provide consistent evidence that lower interest rates are linked to weaker bank profitability.

Across specifications, the relationship between the policy rate and profitability is positive and statistically significant, indicating that declines in interest rates are linked to reductions in bank earnings. This relationship remains robust when controlling for unobserved heterogeneity and alternative model specifications. The effect is substantially stronger when profitability is measured using NIM, suggesting that changes in bank performance are primarily driven by movements in core intermediation activity.

The analysis also identifies important heterogeneity across institutions. Megabanks exhibit a stronger response of profitability to interest rate movements than regional banks, although this difference is not reflected in NIM. In addition, subsample analysis indicates that the relationship between interest rates and profitability weakens after the introduction of NIRP, suggesting that monetary transmission becomes less effective in a negative rate environment.

6.2 Interpretation

The findings align closely with theoretical predictions regarding the transmission of monetary policy through the banking sector. Specifically, they support the deposit rate rigidity mechanism, whereby banks are unable to fully transfer the impact of negative rates to retail depositors, resulting in compression of lending–deposit spreads. The stronger response observed for NIM reinforces the central role of this channel.

More broadly, the results are consistent with the reversal rate framework (Brunnermeier & Koby, 2018), which predicts that sufficiently low interest rates may weaken bank profitability and reduce the effectiveness of monetary policy. The weakening of the relationship between interest rates and profitability in the post-NIRP period provides empirical support for this non-linearity.

At the same time, the findings highlight that the effects of NIRP are not uniform across banks. While the transmission mechanism appears broadly shared, differences in overall profitability reflect variation in business models, income diversification and balance sheet

composition. This suggests that monetary policy operates through multiple channels, and that its impact depends on institutional characteristics.

The results indicate that NIRP operates through a combination of mechanical margin compression and adaptive responses by banks. This provides a more nuanced interpretation than a simple negative effect on profitability, and helps explain why the strength of the impact varies across institutions and over time.

6.3 Limitations and Policy Implications

These findings should be interpreted with caution. The empirical strategy does not fully isolate the causal effect of NIRP, as policy rates respond to broader macroeconomic conditions such as weak growth and low inflation. As a result, the estimates capture the impact of the interest rate environment more broadly rather than a purely exogenous policy shock. In addition, the use of annual data and relatively aggregated balance sheet variables limits the ability to capture more granular dynamics, including changes in loan composition, risk-taking behaviour and non-interest income. These limitations imply that the results should be interpreted as evidence of robust empirical relationships rather than definitive causal estimates.

Despite these caveats, the findings carry important implications for monetary policy and financial stability. If negative interest rates compress bank profitability through sustained margin pressure, this may weaken banks' capacity to supply credit over time, particularly for institutions that rely on deposit funding. In the Japanese context, this raises concerns for regional banks, which play an important role in financing small business and supporting local economies.

At the same time, the stronger response observed for megabanks suggests that institutions with greater exposure to market-based activities may be more sensitive to interest rate movements, potentially leading to increased divergence within the banking system. Policymakers therefore face a trade-off between maintaining accommodative monetary conditions and preserving the resilience of the banking sector. This highlights the importance of considering the affect on the financial sector into the design of unconventional monetary policy.

6.4 Conclusion and Future Research

This dissertation contributes to the literature by providing evidence from a single-country setting with a structurally segmented banking system. The results highlight the central role of the interest margin channel, the importance of heterogeneity across institutions, and the limitations of monetary transmission in a low-rate environment.

While negative interest rates may support broader macroeconomic objectives, their effects on bank profitability are complex, gradual, and unevenly distributed across the banking sector. It is essential to understand these dynamics for evaluating the long-term implications of unconventional monetary policy.

Future research could extend this analysis by using more detailed data on loan composition and lending behaviour, allowing for a clearer distinction between changes in credit supply and risk allocation under NIRP. Cross-country comparisons could also provide stronger causal identification by exploiting variation in policy implementation. Finally, the use of higher-frequency data may offer additional insight into the short-term adjustment of bank balance sheets following policy changes.

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Appendices

Appendix A: Supplementary Statistics

Table A1: Correlation Matrix

Variable	ROAA_CLEAN	NIM	LOG_ASSETS	CAPITAL_RATIO	POLICY_RATE
ROAA_CLEAN	1.000	0.224	0.165	0.171	-0.009
NIM	0.224	1.000	-0.506	0.116	0.121
LOG_ASSETS	0.165	-0.506	1.000	-0.276	0.012
CAPITAL_RATIO	0.171	0.116	-0.276	1.000	0.003
POLICY_RATE	-0.009	0.121	0.012	0.003	1.000

Table A2: Pre-NIRP Fixed Effects Results (ROAA)

Variable	Fixed Effects
POLICY_RATE	-2.601**
	(1.127)
LOG_ASSETS	0.166**
	(0.076)
CAPITAL_RATIO	6.934**
	(3.380)
CONSTANT	-2.382*
	(1.232)
Observations	677
Cross-sectional units	141
Within R ²	0.149

Table A3: Post-NIRP Fixed Effects Results (ROAA)

Variable	Fixed Effects
POLICY_RATE	0.205
	(0.126)
LOG_ASSETS	0.120
	(0.094)
CAPITAL_RATIO	2.665*
	(1.355)
CONSTANT	-1.694
	(1.405)
Observations	1455
Cross-sectional units	168
Within R ²	0.026

Table A4: Fixed Effects Diagnostic Tests

Model	Test	Statistic	p-value	Interpretation
FE ROAA Model	Joint significance of regressors	$F(3,167) = 8.135$	<0.001	Regressors jointly significant
FE ROAA Model	Common intercept test	Welch $F(167,589.3) = 17.797$	<0.001	Reject pooled OLS in favour of fixed effects
FE NIM Model	Joint significance of regressors	$F(3,164) = 34.432$	<0.001	Regressors jointly significant
FE NIM Model	Common intercept test	Welch $F(164,471.5) = 49.340$	<0.001	Reject pooled OLS in favour of fixed effects