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# The Reciprocal Relationship between Bank Capital and Risk and Testing the Partial Adjustment Hypothesis Using a Simultaneous Equations System: An Applied Study of a Sample of Iraqi Private Commercial Banks Listed on the Iraq Stock Exchange for the Period 2012–2024

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**Abstract:** This study is designed to investigate the relationship between capital and risk in private commercial banks of Iraq and how each adjust to their target under the partial adjustment hypothesis. The study relies on data from six banks listed on the Iraq Stock Exchange for the time period 2012 to 2024 (69 annual observations after differencing, obtained from the audited financial statements). Capital is defined as the percentage of equity in total assets, and risk is defined as the percentage of non-performing loans over gross loans. An estimation method that uses three-stage least squares (3SLS) and bank fixed effects is used to estimate a two-equation simultaneous system.

The results showed that there is a unidirectional relationship between the variables between capital and credit risk, where a rise in capital would lead to a decrease in credit risk with a coefficient of −0.841 (p = 0.036), and a rise in risk would have no effect on book capital (p = 0.301). The annual adjustment to banks' capital is 75% of the gap, and their adjustment of risk is 60%, so half of the gap will be closed in about six months for capital and nine months for risk. The effect of the capital adequacy buffer in both equations over the Central Bank of Iraq minimum requirement (12%) is not significant, due to the average of the sample was about 113% as capital adequacy ratio. The negative association of capital with risk persists with the same negative sign in all robustness specifications based on non-performing loans, and is significant at the 10% level in five of the nine specifications. The study suggests that capital requirement needs to be related to the credit quality, and not just size.

**Keywords:** bank capital, credit risk, partial adjustment hypothesis, simultaneous equations, 3SLS, Iraqi banks.

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## INTRODUCTION

Capital is the first line of defence for a bank against unexpected losses. Accordingly, the Basel Accords have based their requirements on the assumption that better-capitalised banks are less inclined to take risks. However, this assumption is neither theoretically nor empirically conclusive. The "skin in the game" hypothesis predicts that higher capital reduces shareholders' incentives to gamble, whereas the regulatory hypothesis predicts that a bank increases its capital in response to higher risk. Thus, each of the two variables may simultaneously be both a cause and an outcome.

Two equations are estimated simultaneously, as suggested by Shrieves and Dahl, as discussed in [1], so that a bank does not reach its target level of capital or risk at once, but gradually until it reaches the target due to adjustment costs. This framework, developed by Jacques and Nigro [1] employed three stage least squares. The model has been used in the United States and the Eurozone [2], Indonesia [3], Bangladesh [4], and Jordan [5], with results differing depending on the nature of each banking system.

Iraqi private banks have three special characteristics. First, their capital adequacy ratios are much higher than the minimum regulatory level of 12%, so there is virtually no pressure from the regulators. [6] Secondly, they have a relatively small credit portfolio with high default rates. Third, they have been through significant shocks and especially military operations during 2014-2016 that have led to a reduction in assets. Under these conditions, the relation between capital and risk will remain open: is excess capital a protective function, or is it idle capital which is not related to risk-taking behaviour?

The researcher has found that most studies conducted on Iraq focus on measuring the capital adequacy and comparing it to the regulatory limits [6] or testing the impact of risks in one direction [7]. Estimating the equation in both directions in a simultaneous equations system and measuring the speed of adjustment to the level of the target do not seem to be paid enough attention in the Iraq banking environment to the extent of the published studies available to the researcher. This study seeks to contribute to filling this gap.

The study is divided into three parts: the first part deals with the methodology and previous studies, the second part deals with the theoretical part and the third part deals with the practical aspects of the study, with the findings and recommendations.

## METHOD

### First: Research Problem

Iraqi private banks maintain capital levels several times higher than regulatory requirements; nevertheless, their non-performing loan ratios remain high. This raises questions about the actual relationship between the two variables. The research problem is formulated through the following questions:

1. Does a change in capital affect a change in credit risk, and what is the direction of this effect?
2. Does a change in risk affect a change in capital?
3. Do banks gradually adjust their capital and risk toward target levels, and at what speed?
4. Does the capital adequacy buffer above the minimum requirement alter this behaviour?

### Second: Significance of the Study

1. Scientific significance: The study contributes to applying the Shrieves and Dahl model, using simultaneous equations, to Iraqi banks. To the best of the researcher's knowledge, this approach has been rarely used in Iraqi studies. It also tests the regulatory and moral hazard hypotheses in an environment characterised by very high capitalisation.
2. Practical significance: The study provides bank management and the Central Bank of Iraq with a quantitative estimate of the effect of capital increases on credit quality and the speed at which banks respond to any regulatory adjustment.

### Third: Research Objectives

1. To measure the effect of changes in capital on changes in credit risk and determine the direction and magnitude of this effect.
2. To measure the effect of changes in credit risk on changes in capital.
3. To determine whether banks partially adjust their capital and risk toward target levels, and to measure the speed of this adjustment and the half-life of the gap.
4. To test the effect of the capital adequacy buffer above the minimum requirement on capital and risk adjustment behaviour.

### Fourth: Research Hypotheses

1. H1: Changes in capital have a statistically significant effect on changes in credit risk.
2. H2: Changes in credit risk have a statistically significant effect on changes in capital.

3. H3: Banks partially adjust their capital toward its target level ($0 < \lambda < 1$).
4. H4: Banks partially adjust their risk toward its target level.
5. H5: The capital adequacy buffer above the minimum requirement has a significant effect on capital and risk adjustment.

**Fifth: Population, Sample, and Data Sources**

The research population consists of Iraqi private commercial banks listed on the Iraq Stock Exchange. The sample was selected purposively according to three criteria:

1. The bank remained listed on the Iraq Stock Exchange and continued operating throughout the research period (2012–2024).
2. Its audited financial statements and annual reports were published regularly throughout the entire period.
3. It conducted actual lending activities for which the non-performing loan ratio serves as a meaningful measure of credit risk.

The banks that fulfilled these requirements were: Bank of Baghdad, Ashur International Bank, Mosul Bank for Development and Investment, Al-Mansour Investment Bank, National Bank of Iraq, and Iraqi Middle East Investment Bank. The research period is from 2012 to 2024. The data are unbalanced panel data for the year 2013-2024 with 69 annual observations. To test the sensitivity of the results to sample size, Iraqi Credit Bank was added to the robustness tests.

The data were collected from the banks' audit annual statements and banks published annual reports and data published by Iraq Stock Exchange. These were assets, shareholders' equity, net profit, deposits, loans, capital adequacy ratios, non-performing loans and liquidity.

The ratio of non-performing loans to gross loans was adopted as the risk measure because it reflects realised credit risk and portfolio quality. It is the most widely used measure in emerging-market studies [8], Zheng et al. [4]. Furthermore, Iraqi banks do not regularly disclose detailed risk-weighted asset data.

**Sixth: Research Model and Variables**

The partial adjustment model assumes that, each year, a bank closes part of the gap between its target level and the level recorded in the previous year, in addition to the effect of external shocks:

$$\Delta CAP_{it} = \lambda_c\left(CAP^*_{it} - CAP_{i,t-1}\right) + \varepsilon_{it}, \qquad \Delta NPL_{it} = \lambda_r\left(NPL^*_{it} - NPL_{i,t-1}\right) + u_{it}$$

Substituting the determinants of the target level yields a system of two simultaneous equations:

$$\Delta CAP_{it} = \alpha_0 + \alpha_1 \Delta NPL_{it} - \lambda_c CAP_{i,t-1} + \alpha_2 ROA_{it} + \alpha_3 SIZE_{i,t-1} + \alpha_4 BUF_{it} + \alpha_5 LIQ_{it} + \alpha_6 DEP_{it} + \alpha_7 WAR_t + \mu_i + \varepsilon_{it}$$

$$\Delta NPL_{it} = \beta_0 + \beta_1 \Delta CAP_{it} - \lambda_r NPL_{i,t-1} + \beta_2 LTA_{i,t-1} + \beta_3 SIZE_{i,t-1} + \beta_4 BUF_{it} + \beta_5 LIQ_{it} + \beta_6 DEP_{it} + \beta_7 WAR_t + \eta_i + u_{it}$$

where μ and η represent bank fixed effects. The adjustment speed is derived from the coefficient of the lagged level, and the half-life of the gap is calculated using the following formula: Half-life = $\ln(0.5) \div \ln(1 - \lambda)$.

| Symbol | Variable | Measurement | Role |
|---|---|---|---|
| ΔCAP | Change in capital | Equity ÷ total assets, first difference | Endogenous (dependent variable in the first equation) |
| ΔNPL | Change in credit risk | Non-performing loans ÷ gross loans, first difference | Endogenous (dependent variable in the second equation) |
| CAP(t−1), NPL(t−1) | Lagged level | Value in the previous year | Measures adjustment speed |
| ROA | Profitability | Net profit ÷ total assets | Control (first equation) |
| SIZE(t−1) | Size | Natural logarithm of total assets, lagged one year | Control |
| BUF | Capital adequacy buffer | Capital adequacy ratio (t−1) − 12% | Regulatory pressure |

| Symbol | Variable | Measurement | Role |
|---|---|---|---|
| LIQ | Liquidity | Published liquidity ratio | Control |
| DEP | Funding structure | Deposits ÷ total assets | Control |
| LTA(t−1) | Credit exposure | Loans ÷ total assets, lagged one year | Control (second equation) |
| WAR | Years of military operations | 1 for 2014–2016, and 0 otherwise | Dummy variable |

Source: Prepared by the researcher based on the cited literature.

The system is identified through exclusion restrictions: NPL(t−1) and LTA(t−1) are excluded from the capital equation, while CAP(t−1) and ROA are excluded from the risk equation. Thus, each equation is overidentified by one restriction, allowing the validity of the instruments to be tested using the Sargan test. The 3SLS method was selected because it exploits the correlation between the residuals of the two equations and is therefore more efficient than separate 2SLS estimation when such correlation exists [1].

**Seventh: Previous Studies**

The following table summarises the most prominent studies that examined the relationship between capital and risk, arranged from the most recent to the oldest:

| Study | Setting and Period | Method | Main Finding |
|---|---|---|---|
| Al-Husainy et al. [9] | 18 Iraqi commercial banks, 2005–2024 | Pooled OLS (POLS) | Capital adequacy and size increase credit risk, while liquidity reduces it |
| Abusharbeh [10] | Banking sectors in 10 Arab countries, 2017–2023 | FMOLS + Granger | Bidirectional causality between credit risk and capital adequacy |
| Zheng et al. [4] | 44 Bangladeshi banks, 2010–2021 | System GMM, 2SLS | Nonlinear relationship in both directions, affected by competition and ownership |
| Alrwashdeh et al. [5] | Jordanian banks, 2010–2019 | FE, RE, GMM, 3SLS | Strong negative relationship between capital and risk |
| Hendrawan et al. [11] | Indonesian banks, 2010–2020 | Two-step system GMM | Capital buffers absorb losses but reduce profitability |
| Mujtaba et al. [12] | Emerging Asian economies | Dynamic GMM | Regulatory capital increases risk, with a reciprocal effect between the two |
| Abbas et al. [13] | US banks, 2002–2019 | Two-step GMM | The conventional capital ratio is positively associated with risk, while the risk-weighted ratio is negatively associated |
| Mateev et al. [14] | More than 225 banks in 18 Middle East and North African countries | Panel data | Banks increase their capitalisation when risk rises |

| Study | Setting and Period | Method | Main Finding |
|---|---|---|---|
| Lutfi et al. [3] | Indonesian banks | Simultaneous adjustment | Simultaneous adjustment of capital and risk |
| Kolia and Papadopoulos [2] | Eurozone and United States | 3SLS | Capital and risk move together in a positive direction |
| Abu Hamad Al Ali and Al-Tufaili [6] | Iraqi private banks, 2010–2020 | Ratio analysis | Capital adequacy considerably exceeds both Basel III and Central Bank requirements |

Source: Prepared by the researcher based on the cited literature.

**Research gap:** There is some disagreement in the international literature about the direction of the relationship, as outlined in the following section. Most of the studies conducted in Iraq that the researcher reviewed are descriptive or study the relationship in one direction. No study has been found that tests simultaneity and measures the speed of adjustment. This study aims at integrating both in an environment of about nine times the regulatory minimum capital adequacy ratio.

## RESULT AND DISCUSSION

### First: Bank Capital and Its Functions

In a bank, there are 3 roles of capital. First, it serves as a buffer that absorbs losses before depositors' money is impacted. Second, it is a source of financing that does not pose any risk of default and is permanent in nature, aiding the growth of credit. Third, it is a governance tool which connects shareholders' value and management decisions. It is expressed in two ways: book capital (equity / total assets); regulatory capital adequacy ratio (regulatory capital / risk-weighted assets). The studies have shown that the two indicators can have a reverse relationship: On one hand, the book ratio is positively correlated with risk, and on the other hand, the risk-weighted ratio is negatively correlated with risk [13].

In Iraq, the minimum capital adequacy ratio imposed by the Central Bank is 12%, which is higher than the Basel III threshold of 10.5%. Nevertheless, the ratios of private banks exceed this threshold by a wide margin. This is attributable to capital growing at a rate higher than the growth of risk-weighted assets [6]. The sample data show that paid-up capital remained stable at IQD 250 billion for most banks from 2014 onward, while loans averaged less than one-quarter of total assets. Accordingly, capital in these banks is more the outcome of a regulatory decision than a response to the level of risk.

### Second: Banking Risk and Its Measures

Credit risk is the largest source of losses in commercial banks and is measured in the literature using three indicators:

1. Risk-weighted assets ÷ total assets: a forward-looking measure that reflects portfolio composition, used by Jacques and Nigro [1].
2. Non-performing loans ÷ gross loans: a measure of realised risk that reflects credit portfolio quality, used by Shrieves and Dahl, as discussed in [1]. It is the most common measure in emerging markets [8], Abusharbeh [10].
3. Loans ÷ total assets: a measure of the scale of credit exposure rather than its quality [15].
4. Credit risk in Iraqi banks is associated with both internal factors and political and economic conditions [9], and it affects their financial stability [7], Alothman & Alktrani [16].

### Third: Theoretical Hypotheses on the Relationship between Capital and Risk

The literature presents four hypotheses that differ in their expected direction of the relationship:

| Hypothesis | Direction of Causality | Expected Sign | Mechanism |
|---|---|---|---|
| Regulation (supervisory pressure) | Risk → Capital | Positive | The bank raises its capital to remain above the minimum requirement when risk increases |
| Moral hazard | Capital → Risk | Negative | An undercapitalised bank gambles because its losses are transferred to depositors and the protection system |
| Skin in the game | Capital → Risk | Negative | The greater the owners' contribution, the more carefully they select borrowers |
| Capital sheltering | Capital → Risk | Positive | A highly capitalised bank feels secure and expands into higher-risk assets |

Source: Prepared by the researcher based on the cited literature.

Recent studies support all these hypotheses in different settings. The regulatory hypothesis is supported by the findings of Mujtaba et al. [12] and Mateev et al. [14], while the moral hazard hypothesis is supported by Abbas et al. [8] when risk is measured by non-performing loans. This behaviour is also influenced by the economic freedom environment: economic freedom reduces risk-taking by well-capitalised banks and increases it among poorly capitalised banks [17]. Kundid Novokmet and Pavić [18] found that better-capitalised Croatian banks tend to make riskier investments during recessions to meet shareholders' expectations. Alzoubi et al. [19] found that, among Jordanian banks, the diversification effect in larger banks outweighs risk-taking incentives, and both size and capital are associated with lower risk.

**Fourth: The Partial Adjustment Hypothesis**

Trade-off theory assumes that each bank has a target capital structure that balances the cost of capital against the expected cost of insolvency. However, reaching this target is costly: issuing shares requires approvals and entails information costs, while reducing non-performing loans requires settlements and legal proceedings. Therefore, a bank closes only part of the gap each year; this proportion is referred to as the speed of adjustment, λ.

The more that λ approaches one, the quicker the adjustment and the less expensive it is. Mohammad and Khan [20] estimated the speed of leverage adjustment in South Asian banks to be 25% per quarter (43% during COVID-19). In a study by Lutfi et al. [3], it was found that Indonesian banks do not adjust capital and risk one after another. This framework is good for an environment like Iraq, where planned changes are on the path of adjustment towards the target, while random changes are caused by shocks.

**Fifth: Determinants of Adjustment**

1. Profitability: Retained earnings are the least costly source of capital increases; however, higher capital buffers may reduce returns [11], Rajha [21], Saleh & Abu Afifa [22].
2. Size: Larger banks are more diversified and have easier access to financing. Therefore, they need lower capital ratios to face the same level of risk, and the literature associates size with lower risk [19].
3. Regulatory pressure: The closer a bank is to the minimum requirement, the greater its incentive to increase capital or reduce risk [23].
4. Liquidity and funding structure: The deposit ratio directly affects leverage. Al-Husainy et al. [9] found that liquidity reduces credit risk in Iraqi banks. Funding structure and liquidity are associated with capital adequacy and financial stability [24], while regulatory capital reduces both funding costs and risk [25].

## Section Three: Empirical Analysis

### First: Descriptive Statistics

The average equity-to-assets ratio is 38.3%, a very high level by international standards. The average non-performing loan ratio is 18.1%, while loans account for no more than 18.5% of total assets on average. The average capital adequacy buffer above the minimum requirement is 101 percentage points, meaning that the average capital adequacy ratio itself is approximately 113%.

| Variable | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| ΔCAP | −0.013 | 0.080 | −0.327 | 0.188 |
| ΔNPL | 0.014 | 0.124 | −0.401 | 0.298 |
| CAP(t−1) | 0.383 | 0.166 | 0.127 | 0.707 |
| NPL(t−1) | 0.181 | 0.151 | 0.024 | 0.722 |
| LTA(t−1) | 0.185 | 0.110 | 0.012 | 0.476 |
| ROA | 0.017 | 0.019 | −0.025 | 0.087 |
| SIZE(t−1) | 6.661 | 0.555 | 5.591 | 8.290 |
| BUF | 1.012 | 0.596 | 0.090 | 2.550 |
| LIQ | 1.507 | 0.660 | 0.440 | 3.430 |
| DEP | 0.478 | 0.190 | 0.144 | 0.816 |

Source: Prepared by the researcher based on the statistical data.
Note: The number of observations is 69, and size is the logarithm of assets measured in billions of dinars.

### Second: Testing the Stationarity of the Series

The Im-Pesaran-Shin test was used for the panel data. Since the series are short (10–13 years per bank), the Monte Carlo simulation (5,000 replications) was used to compute p-values, instead of the asymptotic distribution. The results show that neither of the two dependent variables has any unit roots, while the null hypothesis of a unit root cannot be rejected for the levels. This result is in line with the model specification, where the lagged levels are used as error-correction terms indicating the speed of convergence to the target.

| Variable | t-bar Statistic | p-value | Decision |
|---|---|---|---|
| ΔCAP | −3.134 | < 0.001 | Stationary |
| ΔNPL | −3.183 | < 0.001 | Stationary |
| LIQ | −2.220 | 0.048 | Stationary |
| CAP | −1.984 | 0.114 | Non-stationary at 5% |
| NPL | −1.807 | 0.231 | Non-stationary at 5% |
| DEP | −1.292 | 0.698 | Non-stationary at 5% |

Source: Prepared by the researcher based on the statistical data.

### Third: Diagnostic Tests for the Simultaneous Equations System

The tests confirm the validity of the instruments and the usefulness of jointly estimating the two equations:

| Test | Capital Equation | Risk Equation | Interpretation |
|---|---|---|---|
| First-stage F (instrument strength) | 11.68 (p < 0.001) | 7.45 (p = 0.001) | The instruments are significant, but relatively weaker in the second equation |
| Sargan (validity of exclusion restrictions) | 0.31 (p = 0.576) | 0.02 (p = 0.888) | Instrument validity is not rejected |

| Test | Capital Equation | Risk Equation | Interpretation |
|---|---|---|---|
| Durbin-Wu-Hausman (endogeneity of the variable) | t = −0.81 (p = 0.420) | t = 1.87 (p = 0.067) | Evidence of endogeneity at the 10% level in the second equation |
| Correlation between equation residuals | 0.302 (Breusch-Pagan LM = 6.29, p = 0.012) | | Justifies joint estimation using 3SLS |

Source: Prepared by the researcher based on the statistical data.

The significant positive correlation between the residuals of the two equations means that the same shocks affect capital and risk simultaneously. This is the main justification for preferring 3SLS over 2SLS. The variance inflation factor for CAP(t−1) is approximately 10.8 because of its correlation with size (−0.92); therefore, the model was re-estimated without the size variable in the robustness tests.

**Fourth: Estimation Results of the Simultaneous Equations System**

The main finding is that the relationship runs in one direction, from capital to risk. A one-percentage-point increase in the equity-to-assets ratio is associated with a 0.84-point decrease in the non-performing loan ratio in the same year, whereas changes in non-performing loans do not affect capital.

First Equation (Dependent Variable: ΔCAP)

| Variable | Coefficient | Standard Error | t | p |
|---|---|---|---|---|
| ΔNPL | 0.130 | 0.125 | 1.04 | 0.301 |
| CAP(t−1) | −0.747 | 0.181 | −4.13 | < 0.001 |
| ROA | −0.510 | 0.465 | −1.10 | 0.278 |
| SIZE(t−1) | −0.093 | 0.044 | −2.12 | 0.039 |
| BUF | 0.001 | 0.019 | 0.04 | 0.968 |
| LIQ | 0.016 | 0.016 | 1.00 | 0.321 |
| DEP | −0.142 | 0.064 | −2.23 | 0.030 |
| WAR | 0.046 | 0.020 | 2.32 | 0.024 |
| $R^2$ | 0.355 | | | |

Source: Prepared by the researcher based on the statistical data.

Second Equation (Dependent Variable: ΔNPL)

| Variable | Coefficient | Standard Error | t | p |
|---|---|---|---|---|
| ΔCAP | −0.841 | 0.392 | −2.15 | 0.036 |
| NPL(t−1) | −0.602 | 0.126 | −4.79 | < 0.001 |
| LTA(t−1) | 0.037 | 0.169 | 0.22 | 0.827 |
| SIZE(t−1) | 0.047 | 0.043 | 1.08 | 0.283 |
| BUF | 0.044 | 0.032 | 1.39 | 0.170 |
| LIQ | 0.052 | 0.025 | 2.07 | 0.043 |
| DEP | −0.235 | 0.097 | −2.43 | 0.019 |
| WAR | 0.024 | 0.038 | 0.62 | 0.535 |
| $R^2$ | 0.244 | | | |

Source: Prepared by the researcher based on the statistical data.

Note: 3SLS estimation with bank fixed effects (not reported), 69 observations, and all exogenous variables in the system used as instruments.

The other results can be interpreted as follows:

1. Capital adjustment speed: λ = 0.747, meaning that the bank closes 75% of its capital gap in one year, with a half-life of approximately 0.50 years. This is a high speed, reflecting the relative stability of paid-up capital and the fact that most changes in the ratio arise from the denominator (total assets).
2. Risk adjustment speed: λ = 0.602, with a half-life of approximately 0.75 years. Reducing non-performing loans is slower than adjusting capital because it involves settlements, write-offs, and legal proceedings.
3. Size: Larger banks reduce their capital ratio (−0.093), which is consistent with the diversification hypothesis and easier access to financing.
4. Funding structure: An increase in the deposit ratio reduces book capital (−0.142) and also reduces non-performing loans (−0.235), because new deposits are converted into new loans that are not yet non-performing, thereby lowering the ratio.
5. Liquidity: Higher liquidity is associated with an increase in non-performing loans (0.052). This reflects defensive behaviour: a bank whose portfolio deteriorates halts lending and accumulates cash.
6. Years of military operations: The capital ratio increased by an additional 4.6 percentage points during 2014–2016 because assets contracted while capital remained constant.
7. Capital adequacy buffer and profitability: Neither is statistically significant in either equation.

**Fifth: Robustness Tests**

This system was re-estimated with 10 different specifications. The overall negative association between capital and non-performing loans was significant at the 5% level in five specifications and at the 10% level in six of the ten specifications that express risk with the use of NPLs (baseline and nine alternatives). In all specifications both adjustment speeds were still important at the 1% level.

| Specification | n | Effect of Risk on Capital (p) | Effect of Capital on Risk (p) | λ Capital | λ Risk |
|---|---|---|---|---|---|
| Baseline: 3SLS with fixed effects | 69 | 0.130 (0.301) | −0.841 (0.036) | 0.747 | 0.602 |
| Pooled 3SLS without fixed effects | 69 | 0.092 (0.599) | −0.772 (0.110) | 0.588 | 0.375 |
| 2SLS for each equation | 69 | 0.130 (0.355) | −0.830 (0.064) | 0.745 | 0.593 |
| OLS for each equation | 69 | 0.036 (0.632) | −0.187 (0.317) | 0.688 | 0.550 |
| Adding Iraqi Credit Bank | 81 | 0.123 (0.329) | −0.557 (0.049) | 0.796 | 0.559 |
| Excluding 2014–2016 | 54 | 0.192 (0.173) | −1.552 (0.036) | 0.665 | 0.734 |
| Excluding Ashur Bank | 57 | 0.201 (0.125) | −0.718 (0.040) | 0.963 | 0.578 |
| Removing size from the capital equation | 69 | 0.038 (0.751) | −1.098 (0.005) | 0.414 | 0.585 |
| Period 2012–2022 only | 57 | 0.252 (0.043) | −0.317 (0.267) | 1.114 | 0.589 |
| Capital = capital adequacy ratio | 69 | 1.378 (0.013) | −0.197 (0.112) | 0.347 | 0.713 |
| Risk = loans ÷ total assets | 69 | −0.293 (0.430) | 0.698 (0.007) | 0.776 | 0.355 |

Source: Prepared by the researcher based on the statistical data.

Three observations emerge from the table:

1. The coefficient of OLS falls to −0.187, a value less than a quarter of the 3SLS coefficient. As already stated, this bias towards zero is what is predicted when simultaneity is not considered, since the common shocks to the two equations are positively correlated (0.302), which is why simultaneous equations are used.
2. The opposite trend is observed when capital is defined by the regulatory capital adequacy ratio (CAR), a higher level of non-performing loans corresponds to a higher ratio of capital

to loans (1.378, p = 0.013). This is likely because banks are inclined to decrease risk-weighted assets in the event that credit deteriorates, but not increase shareholders' equity. This helps to support the regulatory hypothesis if the supervisory measure is being used, in Mateev et al. [14].

3. The impact of capital is positive (0.698, p = 0.007) when risk is measured in terms of lending volume; that is, banks that increase their capital also make more loans, and their portfolios are cleaned up in the process. This is consistent with Dang et al. [15].

The capital adjustment speed >1 in the specification 2012-2022 (1.114) means that the target was over-shooting in some years. The lowest confidence specification as it does not include the significant profits in 2023-2024.

**Sixth: Discussion of Results and Hypothesis Testing**

| Hypothesis | Evidence | Decision |
|---|---|---|
| H1: Capital affects risk | −0.841, p = 0.036 | Accepted (negative effect) |
| H2: Risk affects capital | 0.130, p = 0.301 | Rejected using the book measure; accepted using the regulatory measure |
| H3: Partial adjustment of capital | λ = 0.747, p < 0.001 | Accepted |
| H4: Partial adjustment of risk | λ = 0.602, p < 0.001 | Accepted |
| H5: Effect of the capital adequacy buffer | p = 0.968 and 0.170 | Rejected |

Source: Prepared by the researcher based on the statistical data.

The results support the "skin in the game" hypothesis rather than the capital sheltering hypothesis: an increase in owners' contributions is accompanied by a cleaner portfolio. This finding is consistent with Alrwashdeh et al. [5] in Jordan, as well as with Le et al. [25], who found that capitalisation reduces risk in Vietnamese banks. It differs from Al-Husainy et al. [9], who found that capital adequacy increases risk in 18 Iraqi banks. This difference may be due to their use of a single equation estimated by pooled OLS, which does not distinguish between the two directions, and their measurement of capital using the regulatory rather than the book ratio.

The absence of a response of book capital to risk is attributable to Iraqi banks operating very far above the regulatory minimum. When the capital adequacy ratio is approximately nine times the minimum requirement, a bank has no reason to increase its capital when non-performing loans rise. This also explains the insignificance of the capital adequacy buffer and is consistent with Iraqi studies documenting that capital adequacy exceeds the regulatory thresholds by a wide margin [6], Salim & Al-Hashemi [26].

**Seventh: Research Limitations**

1. Geographical scope: Six Iraqi private commercial banks listed on the Iraq Stock Exchange that met the sample selection criteria.
2. Time scope: The period 2012–2024, which covers varying economic and regulatory conditions, including the military operations of 2014–2016 and subsequent regulatory developments.
3. Subject scope: The reciprocal relationship between book capital and credit risk, measured by the non-performing loan ratio, and the speed at which both adjust toward their target levels, using a simultaneous equations system estimated by 3SLS with bank fixed effects. This method is appropriate for the number of banks and the length of the period.

## CONCLUSION

### First: Conclusions

1. The relationship between book capital and credit risk in Iraqi private banks is unidirectional: a one-percentage-point increase in capital reduces the non-performing loan ratio by approximately 0.84 points, while non-performing loans do not affect capital.
2. The findings support the "skin in the game" hypothesis: owners who increase their contributions become more selective in choosing borrowers. No evidence is found to support capital sheltering as a means of expanding risk-taking.
3. Banks adjust their capital rapidly and partially (75% of the gap annually, with a half-life of approximately six months), while risk adjustment is slightly slower (60%, or approximately nine months).
4. The capital adequacy buffer above the minimum requirement does not change banks' behaviour because the average ratio is approximately 113%, compared with a minimum requirement of 12%; therefore, there is no effective regulatory pressure.
5. The regulatory capital adequacy ratio responds to an increase in non-performing loans by rising, but this occurs through a reduction in risk-weighted assets rather than an increase in shareholders' equity. In other words, banks contract credit when their portfolios deteriorate.
6. Banks that increase their capitalisation expand lending and reduce non-performing loans at the same time; additional capital is therefore directed toward higher-quality credit.
7. Bank size and the deposit ratio reduce book capital, deposit growth reduces non-performing loans, while higher liquidity is associated with higher non-performing loans.
8. Ignoring simultaneity substantially weakens the estimates: the OLS coefficient is less than one-quarter of the 3SLS coefficient, which partly explains the conflicting findings of previous studies.

### Second: Recommendations

**For the Central Bank of Iraq:**

1. Link capital requirements to credit portfolio quality rather than relying solely on the absolute minimum requirement, because the current threshold is far below banks' actual capital levels and does not affect their behaviour.
2. Monitor banks that increase their capital adequacy ratios by reducing lending after non-performing loans rise, because this behaviour improves the ratio superficially and weakens the financial intermediation role.
3. Require banks to provide standardised annual disclosures of risk-weighted assets and the monetary amounts of non-performing loans, enabling regulators and researchers to measure risk accurately.

**For Bank Management:**

1. Deploy excess capital in carefully selected lending, as the results indicate that higher capitalisation is accompanied by cleaner portfolios rather than greater risk.
2. Accelerate the resolution of non-performing loans through settlements and collateral, because risk adjustment is slower than capital adjustment.
3. Use excess liquidity for new secured lending rather than keeping it idle, because liquidity accumulation was associated with higher non-performing loans.

**For Researchers:**

1. Expand the sample to include all listed banks in order to apply dynamic GMM and test the nonlinear relationship between capital and risk.
2. Introduce efficiency as a third variable in the system, following the approach of Kolia and Papadopoulos [2].

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