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Does capital adequacy moderate the credit-risk effect of profit-and-loss-sharing financing in Islamic banks? A contract-level risk framework and cross-country evidence

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Islamic financing risk is frequently analyzed as a single undifferentiated category, despite substantial heterogeneity in how ownership, control, payment obligation, and loss are allocated across financing modes. This paper develops a contract-level risk-mitigation framework across ten Islamic financing instruments and empirically tests a hypothesis motivated by that framework: whether regulatory capital adequacy (CAR) dampens the relationship between profit-and-loss-sharing (PLS) financing share and non-performing financing (NPF) at the country-banking-system level, using a quarterly six-country panel drawn from the Islamic Financial Services Board's Prudential and Structural Islamic Financial Indicators (PSIFI) database (256 country-quarter observations, 2014–2024). After confirming non-stationarity in the levels data via Augmented Dickey-Fuller tests and re-specifying the model in first differences with entity and time fixed effects and Driscoll-Kraay standard errors, we find no statistically significant CAR × PLS interaction effect on credit risk across three specifications and five robustness checks (including annual GDP-growth and inflation controls), the point estimate's sign is inconsistent across specifications, and the models explain little of the within-country variation in credit risk (within R^2 between 0.02 and 0.06). The confidence intervals are wide and span both zero and economically meaningful effects of either sign, so the results reflect limited estimation precision at the country-banking-system level: they cannot distinguish a true effect close to zero from a modest effect estimated imprecisely. The paper's contribution is therefore twofold: a reusable conceptual framework for contract-specific Islamic finance risk analysis, and a methodologically transparent demonstration of the limits of country-level macro panels for this class of question.

KEYWORDS
capital adequacy, IFSB, Islamic banking, Mudarabah, Musharakah, non-stationarity, panel data, profit-and-loss sharing

1 Introduction

Islamic banks are exposed to the same broad risk categories as conventional banks—credit, market, liquidity, and operational risk—but the contractual structures through which these risks arise differ substantially, because Islamic financing is organized around sale, lease, and partnership contracts rather than interest-bearing debt. This structural difference has consequences that the literature has documented separately but rarely integrated into a single testable framework. Ahmed and Khan (1) identify risk management as a central challenge for Islamic banking precisely because Islamic contracts combine conventional financial risks with risks specific to their contractual structure, a point reinforced by broader evidence that Islamic banks' overall risk and stability profile differs measurably from that of conventional banks (2). At the same time, the Islamic Financial Services Board's revised capital adequacy standard, IFSB-23, provides explicit—and in some cases substantially more conservative—capital treatment for profit-and-loss-sharing (PLS) exposures relative to debt-like Islamic financing contracts. We treat this differentiated capital treatment as prudential background that motivates our empirical question, not as a regulatory intervention whose causal effect we test directly; the panel design below can speak only to association, a distinction we return to in Section 3.

This raises a specific, testable question that motivates the empirical portion of this paper: is the strength of the empirical association between PLS financing exposure and realized credit risk lower where capital adequacy is higher? A dampening pattern—banking systems with higher CAR showing a weaker link between PLS financing share and non-performing financing (NPF) would be consistent with capital adequacy providing a genuine buffer. Its absence would suggest that current capital treatment, however conservative on paper, is not associated with observably lower realized risk at the system level, a descriptive finding that may inform, but does not itself evaluate, the calibration of PLS-specific capital requirements such as those in IFSB-23. We are explicit throughout the paper that our unit of analysis is the country-level banking system, not the individual bank: PSIFI data are reported as national aggregates, so any relationship we estimate describes how system-wide PLS exposure and system-wide capital adequacy co-move with system-wide asset quality and does not speak directly to risk-taking or capital buffers at any individual institution. This distinction matters for interpretation throughout, and we return to it explicitly when relating our results to the bank-level literature in Section 6.

The paper proceeds in two stages. Section 2 develops a conceptual, contract-level risk-mitigation framework across ten Islamic financing modes, providing the theoretical basis for treating PLS and debt-like contracts as structurally distinct risk categories, and Section 2 also makes explicit how the three-component empirical PLS-share measure used in Sections 4–7 relates to that ten-mode taxonomy. Sections 3 through 6 then test the capital-adequacy moderation hypothesis empirically, using a transparent, fully diagnosed cross-country panel design. We report the result honestly: a robust null finding, five robustness checks deep, which we interpret carefully rather than either dismiss or oversell.

2 Conceptual framework: a contract-level risk-mitigation matrix

Table 1 maps the principal risk exposures and reported mitigation tools across ten Islamic financing modes, organized loosely along a debt-like/profit-and-loss-sharing spectrum, drawing on the general Islamic finance risk taxonomy developed by Khan and Ahmed (3) and Akkizidis and Khandelwal (4), and on contract-level risk assessments of Murabaha and Ijarah exposures specifically (5). We note at the outset that Basel III and IFSB-23 are not interchangeable frameworks: Basel III's conventional architecture has no native treatment for most Islamic contract structures, and the capital treatment reported in Table 1's final column is, in practice, almost entirely IFSB-23's Islamic-specific adaptation rather than a direct Basel analogue—we retain the combined label for brevity but flag this distinction explicitly, since it bears directly on this paper's argument about whether conventional prudential logic captures Islamic contract-specific risk. Fixed-return, asset-backed contracts (Murabaha, Ijarah, installment sale) map onto conventional credit and market risk categories closely enough that standard mitigation tools—collateral, guarantees, insurance/Takaful—apply with only minor adaptation. Profit-and-loss-sharing contracts (Musharakah, Mudarabah) generate agency, valuation, and capital-impairment risks that are structurally distinct from conventional lending risk, which is precisely why IFSB-23 introduced Islamic-specific capital treatment for these exposures—including, for certain private commercial Musharakah exposures under the simple risk-weight method, a 400% risk weight on the contributed amount, net of applicable specific provisions (6). This built on the Board's earlier foundational risk-management guidance (7), which first established that Islamic financial institutions require risk-management processes recognizing contract-specific, rather than generic, risk architecture. Table 1 also reflects contract-specific evidence on Mudarabah credit-risk heterogeneity (8), Qard Hasan's distinct prudential treatment (9), and Tawarruq's Shari'ah-compliance risk, which has no Basel analogue (10).

Linking the framework to the empirical measure. The empirical PLS-share variable used from Section 4 onward is constructed as (Musharakah + Diminishing Musharakah + Mudarabah) / Total Financing. Of the ten contract modes in Table 1, these three are the only ones organized as partnership-based, profit-and-loss-sharing structures in the PSIFI reporting taxonomy; the remaining seven (Murabaha, Salam, Istisna', Ijarah, Musaqah/Muzara'a, Qard Hassan, Bay bi-Taqsit, Tawarruq) are debt-like, fee-based, or benevolent-loan structures that do not share the agency and capital-impairment risk channel that motivates this paper's hypothesis, and are therefore excluded from the PLS aggregate by construction, not by data availability. Diminishing Musharakah is the one component of the aggregate that sits closer to the debt-like end of the spectrum—it amortizes on a defined schedule rather than carrying open-ended profit-and-loss exposure—and we treat its inclusion as a simplifying assumption, tested explicitly as a robustness check in Section 5.2 and revisited as a limitation in Section 7.

3 Literature and hypothesis development

The empirical Islamic finance risk literature has established two relevant facts separately, but rarely tested their interaction directly. First, PLS financing carries measurably different—and in several studies, nonlinear—credit risk relative to debt-based financing.

TABLE 1 Contract-level risk-mitigation matrix across ten Islamic financing modes.

Financing mode	Principal risk sub-types	Reported mitigation tools	Prudential treatment (primarily IFSB-23)
Murabaha	Credit/counterparty risk; fixed-margin market risk; operational risk in acquisition/delivery	Collateral and guarantees; earnest money (hamish jiddiyah)	Explicit, closely analogous to conventional credit exposure
Salam	Delivery/performance risk; commodity price risk; storage/quality-degradation risk	Parallel Salam; performance guarantees; quality specifications	Explicit IFSB treatment
Istisna'	Performance risk; non-binding enforceability risk; cost-overrun risk	Parallel Istisna'; milestone-based payments; penalty clauses	Explicit IFSB treatment
Ijarah	Asset residual-value risk; non-payment; obsolescence; asset damage/loss	Takaful; rent guarantees; sale-and-leaseback structuring	Explicit, treated similarly to conventional lease exposure
Musharakah	Agency/moral hazard; valuation risk; liquidity mismatch; capital impairment	Partner due diligence; independent audit; staged capital release	Explicit; certain private commercial exposures attract 400% risk weight (6)
Mudarabah	Agency risk; profit-recognition risk; asymmetric capital-provider loss exposure	Restricted vs. unrestricted structuring; profit-equalization reserves	Explicit capital treatment; empirical evidence indicates contract-specific heterogeneity in credit-risk effects rather than a uniform PLS risk premium (8)
Musaqah/ Muzara'a	Weather/catastrophic risk; agricultural price risk; weak collateralization	Takaful/agricultural insurance; crop diversification	Limited—sector-specific risk not well captured by generic categories
Qard Hassan	Full credit/non-repayment risk with no compensating return	Zakat-fund backing; character-based screening; capped exposure	Explicit but distinct prudential treatment; economically not equivalent to commercial PLS or trade-financing exposures (9)
Bay bi-Taqsit	Payment-default risk; inflation/value-erosion risk over installment period	Retention of title in some jurisdictions; guarantors	Explicit; behaves similarly to conventional installment credit
Tawarruq	Price risk in two-step resale; Shari'ah-compliance/reputational risk	Verified commodity delivery; independent Shari'ah Board sign-off	Adequate for credit risk; no Basel analogue for Shari'ah-compliance risk (10)

Warninda et al. (8), using a ten-year unbalanced panel of 63 Islamic banks across the Middle East, South Asia, and Southeast Asia, found that Musharakah financing has a nonlinear relationship with bank credit risk, with estimated maximum credit risk occurring when Musharakah represents approximately 37–39% of total financing, and that Mudarabah was not riskier than Musharakah—a more nuanced finding than the common assumption that all PLS contracts are uniformly riskier than debt-based ones.

Second, prudential regulation has evolved specifically to address PLS risk: IFSB-23 (6) provides explicit, often more conservative, capital treatment for Musharakah and Mudarabah exposures relative to Murabaha or Ijarah. Separately, the conventional banking literature on Basel III capital regulation finds that higher capital adequacy is generally associated with more conservative credit risk-taking behavior (11, 12). Belkhaoui et al. (13), studying GCC Islamic banks, similarly find that financing-mode composition—profit-sharing versus profit-margin contracts—is directly linked to bank risk-taking and profitability through distinct channels, reinforcing that financing mode, not just aggregate financing volume, is the relevant unit of risk analysis.

A third strand of the literature examines the broader determinants of Islamic bank credit risk beyond financing-mode composition. Wiryono and Effendi (14) and Sobarsyah et al. (15) both find that Islamic bank credit risk responds to a combination of bank-specific factors (capitalization, financing growth) and macroeconomic conditions, reinforcing the case for treating CAR as a moderator rather than assuming financing-mode composition is the sole driver of credit risk. Abedifar et al. (16) survey the wider Islamic banking risk literature and identify profit-and-loss-sharing exposure, deposit-insurance design, and religiosity-driven depositor behavior as structurally distinctive sources of risk not present in conventional banking.

A fourth strand addresses risks specific to the profit-sharing investment account (PSIA) structure underlying much Islamic bank funding: displaced commercial risk (DCR), the risk that a bank forgoes part of its own profit share to maintain competitive returns to investment account holders and avoid deposit withdrawal (17, 18). DCR is conceptually adjacent to, but distinct from, the credit-risk transmission mechanism tested in this paper: it concerns funding-side risk-sharing rather than asset-side financing risk, and IFSB's own capital adequacy framework addresses it separately through the "alpha" coefficient applied to risk-weighted assets funded by investment accounts (7).

Finally, a growing literature connects Shari'ah governance quality to bank risk-taking through an agency-theoretic lens. Grais and Pellegrini (19) first identified the distinctive governance and agency challenges facing institutions offering Islamic financial services, given the layered oversight required across Shari'ah boards, boards of directors, and prudential regulators. Subsequent empirical work links Shari'ah board characteristics directly to risk outcomes: Hamza (20) examines Shari'ah governance effectiveness and supervision models across jurisdictions, while AlAbbad et al. (21) find that Shari'ah board characteristics measurably influence Islamic bank risk-taking behavior. This governance dimension is not directly tested in our empirical model but is a natural candidate moderator, alongside CAR, for future bank-level extensions of this framework (see Section 6). Related empirical work has examined the determinants of Islamic bank profitability relative to conventional banks (22) and withdrawal and bankruptcy risk formulation in Islamic banking (23).

Why capital adequacy should moderate this relationship. The literature above establishes that PLS exposure carries distinctive agency and valuation risk (first strand) and that capital adequacy is generally associated with more conservative credit risk-taking (second strand), but rarely connects the two mechanistically. We propose two complementary channels. First, a capital-buffer channel: a banking system holding a larger capital cushion relative to risk-weighted assets can absorb a given realization of PLS-related valuation or agency losses without those losses immediately propagating into reported non-performing status—impaired PLS exposures can be provisioned, restructured, or carried through a capital buffer rather than crystallizing as NPF in the same reporting period. Second, a discipline channel: because IFSB-23 assigns PLS exposures materially higher risk weights than debt-like contracts (including the 400% risk weight noted in Section 2), banks operating with higher capital adequacy are, by construction, more likely to have already absorbed the regulatory cost of PLS risk-taking into their capital planning, which plausibly coincides with more conservative underwriting and partner-selection practices for PLS contracts specifically. Both channels predict the same directional pattern: the positive association between PLS share and NPF documented at the bank level (8) should be attenuated—not necessarily eliminated—in banking systems with higher capital adequacy. This is the mechanism our interaction term is designed to detect, and its absence in our results (Section 5) is interpreted against this specific mechanistic prediction in Section 6.

No study we are aware of directly tests whether capital adequacy moderates the specific relationship between PLS financing share and realized credit risk using cross-country, cross-time variation. This motivates the following hypothesis:

> *H1*: Higher capital adequacy is associated with a weaker (less positive) association between changes in PLS financing share and changes in non-performing financing—that is, we expect the estimated coefficient on the PLS-share × CAR interaction term to be negative.

We deliberately state H1 in associational rather than causal terms, but we do commit to a directional prediction, consistent with the capital-buffer and discipline channels set out above: a negative interaction coefficient. The hypothesis is tested using country-level panel data with first-differenced variables and fixed effects, which controls for time-invariant country characteristics and common time shocks but does not constitute a causal identification strategy for the capital-adequacy mechanism itself—there is no exogenous source of variation in CAR isolated from other country-level developments. The empirical test below should therefore be read as testing whether the direction and magnitude of the association between changes in PLS share and changes in NPF differs systematically with changes in CAR, not as establishing that capital adequacy causally moderates the underlying structural risk of PLS financing.

4 Data and methodology

4.1 Data source and coverage

Data are drawn from the IFSB's Prudential and Structural Islamic Financial Indicators (PSIFI) database (24), which publishes quarterly country-level indicators for Islamic banking sectors across member jurisdictions. We initially examined nine reporting countries (Bahrain, Indonesia, Kuwait, Malaysia, Oman, Pakistan, Saudi Arabia, Turkey, and the United Arab Emirates) and verified, by direct inspection of each country's raw data file, whether the structural indicator for "financing by type of Shari'ah-compliant contract" was populated. Three countries—Bahrain, Turkey, and the UAE—report core prudential indicators (NPF, CAR) but do not populate the contract-type breakdown at all, and were excluded. Algeria, notably, is not an IFSB PSIFI reporting jurisdiction and could not be included regardless of data availability from other sources.

The final sample comprises six countries—Indonesia, Kuwait, Malaysia, Oman, Pakistan, and Saudi Arabia—observed quarterly from 2013Q4/2014Q1 through 2023Q4/2024Q3 depending on country, yielding 256 usable country-quarter observations after dropping one annual-only observation per country that predates quarterly reporting (retained annual and quarterly data cannot be validly pooled in the same time series without an interpolation step we chose not to perform, for reasons discussed in Section 4.3).

Although the panel contains 256 country-quarter observations, the effective cross-sectional sample consists of only six independent banking systems. Statistical precision in estimating a moderating (interaction) effect depends primarily on variation across these six entities, not on the total observation count. Accordingly, the empirical analysis in this paper is exploratory and should not be interpreted as a high-precision cross-country test of the moderation hypothesis; a retrospective assessment of the precision of this design is given at the end of Section 4.3, and the limitation is discussed further in Sections 6 and 7.

4.2 Variable construction

NPF ratio: gross non-performing financing as a share of total financing (PSIFI indicator CP04). CAR: capital adequacy ratio under the applicable IFSB formula (PSIFI indicator CP01b). PLS share: (Musharakah + Diminishing Musharakah + Mudarabah financing)/Total financing, constructed from the PSIFI structural indicator on financing by contract type; see Section 2 for how this three-component measure maps onto the ten-mode conceptual framework.

Diminishing Musharakah is structurally closer to an amortizing, debt-like instrument than pure risk-sharing Musharakah; its inclusion in the PLS aggregate is a simplifying assumption we revisit in Section 7 (Limitations) and test as a robustness alternative in Section 5.2.

4.3 Stationarity, model specification, and interaction construction

Augmented Dickey-Fuller (ADF) tests were run per country per variable prior to any regression. NPF, CAR, and PLS share showed unit roots (non-stationary in levels) for the majority of countries. Running a regression on non-stationary levels risks the classic spurious-regression problem (25), in which two independently trending series appear strongly related purely as an artifact of shared drift. We therefore first-differenced all three series; ADF tests on the differenced series confirmed stationarity for the dependent variable (ΔNPF) in all six countries, and for the regressors in the large majority of country-variable combinations.

The primary specification is a panel regression of the change in NPF ratio on the change in PLS share, the change in CAR, and their interaction, with entity and time fixed effects and Driscoll-Kraay standard errors (26), implemented following Hoechle (27)—appropriate for a panel with a small number of entities (six countries) and a comparatively long time dimension (up to 44 quarters), and robust to both serial correlation and cross-sectional dependence:

$$\Delta NPF_{it} = \alpha + \beta_1 \Delta PLS_Share_{it} + \beta_2 \Delta CAR_{it} + \beta_3 \Delta(PLS_Share \times CAR)_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

A point we make fully explicit here because it affects how β_3 should be read: the interaction regressor $\Delta(PLS_Share \times CAR)_{it}$ is constructed by first multiplying PLS_Share and CAR in levels within each country-quarter, and only then first-differencing the resulting product series. This is not algebraically equivalent to the product of the two already-differenced series, $\Delta PLS_Share_{it} \times \Delta CAR_{it}$—the two quantities differ by cross-terms involving the lagged levels of each variable (specifically, $\Delta(XY)_{it} = X_{it-1}\Delta Y_{it} + Y_{it-1}\Delta X_{it} + \Delta X_{it}\Delta Y_{it}$). We use $\Delta(PLS_Share \times CAR)$, the differenced-product construction, throughout, because it is the quantity whose stationarity we verified via ADF testing on the differenced series (Section 4.3, first paragraph); the alternative product-of-differences construction was not separately stationarity-tested and is not used in any specification reported in this paper.

Two additional specifications were pre-specified to test whether the relationship is dynamic or lagged: (i) a dynamic specification adding ΔNPF lagged one quarter, to test whether unmodeled persistence explains the result; and (ii) a lagged-interaction specification, testing whether last quarter's PLS share × CAR predicts this quarter's change in NPF, motivated by the plausible economic mechanism that credit losses from risk-sharing exposures may take time to materialize rather than appearing contemporaneously.

All results reported in Section 5 were independently cross-validated in R using the plm package's within estimator with two-way fixed effects and Driscoll-Kraay standard errors (vcovSCC), in addition to the Python implementation (linearmodels) used as the primary analysis pipeline. Point estimates matched to at least four decimal places across both independent implementations; see Section 5.2.

Retrospective precision assessment. Because the design's central limitation is the six-entity cross-section (Section 4.1), we report what this design can and cannot distinguish. The contemporaneous interaction coefficient has an estimated standard error of 0.085 (Table 2), giving a 95% confidence interval of approximately −0.05 to +0.29. With this precision, a true coefficient would need to be approximately $2.8 \times SE \approx 0.24$ in absolute value—about twice our point estimate (0.12)—to be detected with 80% power at the 5% level. This describes the estimation precision of the design; it is not evidence that a true effect of that size, or any non-zero effect, exists, and a true effect close to zero would produce the same results.

5 Results

5.1 Descriptive statistics

Table 3 reports pooled descriptive statistics for the three core variables across all 256 country-quarter observations. The average NPF ratio is 2.4% (median 1.8%), right skewed, with a maximum of 7.5%. The average CAR is 19.3%, but the distribution shows extreme skewness and kurtosis driven by a small number of very early quarters in Oman's data (CAR as high as 78.2%), which we address explicitly as an outlier-sensitivity check in Section 5.3. PLS share averages 18.6% of total financing but ranges from 0 to 61.2%, reflecting substantial cross-country heterogeneity in the use of risk-sharing contracts.

Country-level means (Table 4) reveal a clear three-way segmentation. Pakistan and Indonesia combine the highest PLS shares (49.1 and 37.8% respectively) with the highest NPF ratios (4.8 and 3.6%). Kuwait and Saudi Arabia show near-zero PLS adoption (0.6 and 0.7%) alongside comparatively low NPF ratios. Malaysia and Oman combine low PLS shares with the lowest NPF ratios in the sample (1.4 and 1.1%).

TABLE 2 PLS share × CAR interaction effect on ΔNPF, three specifications.

Variable	(1) Contemporaneous	(2) Dynamic	(3) Lagged interaction
ΔPLS Share × CAR (interaction)	0.1193 (0.0850)	0.1199 (0.0817)	–
ΔNPF t-1 (lagged NPF)	–	0.0096 (0.0971)	–
ΔPLS Share	−0.0209 (0.0255)	−0.0220 (0.0254)	0.0132 (0.0216)
ΔCAR	0.0115 (0.0104)	0.0132 (0.0107)	0.0079 (0.0119)
Lagged PLS Share × CAR	–	–	−0.0943 (0.0784)
Entity (country) fixed effects	Yes	Yes	Yes
Time (quarter) fixed effects	Yes	Yes	Yes
Observations	250	244	244
R^2 (within)	0.029	0.032	0.018

Driscoll-Kraay standard errors robust to serial correlation and cross-sectional dependence in parentheses. No coefficient reaches conventional significance ($p < 0.05$) in any specification.

TABLE 3 Pooled descriptive statistics ($N = 256$).

Variable	Mean	Median	Std. dev.	Min	Max	Skewness	Kurtosis
NPF ratio	0.024	0.018	0.016	0.000	0.075	0.858	0.166
CAR ratio	0.193	0.179	0.078	0.129	0.782	5.165	31.906
PLS share	0.186	0.094	0.196	0.000	0.612	0.565	−1.309

TABLE 4 Country-level means.

Country	NPF ratio (mean)	PLS share (mean)	CAR ratio (mean)
Indonesia	0.036	0.378	0.202
Kuwait	0.022	0.006	0.178
Malaysia	0.014	0.088	0.170
Oman	0.011	0.149	0.249
Pakistan	0.048	0.491	0.162
Saudi Arabia	0.011	0.007	0.201

This descriptive pattern is consistent with—though, given the non-stationarity already established, cannot on its own be read as confirming—a positive association between PLS reliance and asset-quality risk at the country level.

Visual inspection of NPF trajectories over time shows a rising pattern in Indonesia, Oman, Pakistan, and Saudi Arabia, and a declining pattern in Kuwait and Malaysia. We note explicitly that regressing a non-stationary series on a linear time trend can mechanically produce strong statistical association regardless of any genuine underlying predictive relationship (25); these trends are reported as descriptive context only and are not used to support any causal or predictive claim.

5.2 Main regression results

Table 2 reports full coefficient estimates across the three pre-specified panel specifications, all estimated with entity and time fixed effects and Driscoll-Kraay standard errors (Bartlett kernel, 4-quarter bandwidth) on first-differenced variables. Standard errors are reported in parentheses.

None of the three specifications yields a statistically significant interaction effect at conventional levels. We interpret this insignificance cautiously rather than as proof that no relationship exists: as the retrospective precision assessment in Section 4.3 shows, the design would struggle to detect an effect even at roughly twice the magnitude of our own point estimate, so the absence of significance here is weak evidence given the width of the confidence intervals. The interaction coefficient's sign is also not stable across specifications: it is positive in the contemporaneous specification (0.1193) and the dynamic specification (0.1199)—the opposite sign to the negative, dampening effect predicted by H1—but negative in the lagged-interaction specification (−0.0943), which is directionally consistent with H1 though, like the other two, statistically indistinguishable from zero. We discuss what should and should not be inferred from this sign instability in Section 6. The dynamic specification's lagged-ΔNPF term is itself insignificant ($p = 0.921$), indicating that first-differencing had already adequately absorbed the serial correlation present in the levels data, rather than a dynamic effect being masked by model misspecification.

As an independent cross-validation, all three specifications were re-estimated in R using the plm package (within estimator, two-way fixed effects) with Driscoll-Kraay standard errors via vcovSCC. Point estimates for every coefficient matched the Python (linearmodels) results to at least four decimal places. This agreement confirms computational consistency between two independent software implementations of the same model; it does not, by itself, validate the model specification or the substantive conclusion, which rest on the diagnostic and robustness work reported separately in this section.

As a further robustness check on the PLS share definition itself (see Section 4.2 and Section 7): re-estimating the contemporaneous specification with Diminishing Musharakah excluded from the PLS aggregate—i.e., PLS share defined as pure Musharakah plus Mudarabah only—does not materially change the result (interaction coefficient = −0.033, $p = 0.841$, $N = 250$); if anything the estimate moves further from significance and, notably, flips sign relative to the main specification—a further illustration of the sign instability discussed above rather than evidence for either directional account.

5.3 Robustness checks

Five robustness checks were conducted to test whether the null result in Section 5.2 is fragile to specific modeling choices; the fifth (macroeconomic controls) was added in response to review.

Multicollinearity: Variance inflation factors for the three regressors in the contemporaneous specification (ΔPLS share, ΔCAR, and their interaction) were 2.25, 1.30, and 2.60, respectively—all comfortably below conventional concern thresholds (VIF < 5).

Outlier sensitivity (Oman): Oman's earliest quarters (2014Q1–Q3) show CAR values of 68.8–78.2%, coinciding with a nascent, near-zero-financing Islamic banking sector. Excluding these four extreme observations changes the interaction coefficient only marginally (β = 0.120, $p = 0.145$) and does not alter the substantive conclusion.

Cross-sectional dependence: A Pesaran (28) CD test on the contemporaneous specification's residuals indicates statistically significant cross-sectional dependence (CD = −3.92, $p < 0.001$; average pairwise residual correlation = −0.154), consistent with shared regional or global shocks across the six banking systems. This finding supports, rather than undermines, the choice of Driscoll-Kraay standard errors, which are explicitly robust to cross-sectional dependence as well as serial correlation.

COVID-period exclusion: Excluding 2020–2021 observations (48 country-quarters) leaves the interaction coefficient of similar magnitude and still insignificant (β = 0.143, $p = 0.267$), indicating the null result is not an artifact of pandemic-period disruption.

Macroeconomic controls (added in response to review): to reduce the risk of omitted-variable bias, we re-estimated all three specifications adding annual real GDP growth and annual consumer-price inflation for each country [World Bank. World Development Indicators; (29)]. Consistent quarterly series are not available from a single source for all six countries, so each annual value is assigned to the four quarters of its year; the controls therefore capture between-year, country-specific macroeconomic conditions but not within-year variation. Both variables are growth rates and enter in levels (entering them in first differences

leaves the conclusions for the interaction unchanged: contemporaneous 0.1201, SE 0.0831; dynamic 0.1208, SE 0.0800; lagged −0.1029, SE 0.0699; all $p > 0.14$). As Table 5 shows, the contemporaneous and dynamic interaction coefficients remain positive and statistically insignificant (0.0875, $p = 0.312$; 0.0897, $p = 0.271$), with 95% confidence intervals of about −0.08 to +0.26 and −0.07 to +0.25. The lagged-interaction coefficient becomes more negative (−0.1336, SE 0.0711, $p = 0.062$; 95% CI − 0.27 to +0.01): directionally consistent with H1 and significant at the 10% but not the 5% level. It is one of six interaction estimates reported across the baseline and macro-controlled specifications, it was not designated in advance as the preferred specification, and the sign of the interaction remains specification-dependent; we therefore do not treat it as evidence in favor of H1. Inflation has a small positive coefficient (p between 0.03 and 0.08 across specifications; unadjusted for multiple comparisons) and GDP growth is indistinguishable from zero. Within R^2 rises only to 0.049–0.062.

6 Discussion

The central empirical finding of this paper is a null: across three specifications and five robustness checks, we find no statistically significant evidence that capital adequacy is associated with a weaker relationship between PLS financing share and non-performing financing at the country level. We consider how this null should be read.

The first reading is that no such moderating association exists at the country-banking-system level: higher system-wide capital adequacy is not accompanied by a measurably weaker link between system-wide PLS share and system-wide NPF. This is a statement about these data, not an evaluation of IFSB-23 or of any other regulation, whose effectiveness would have to be assessed with bank-level data and a design capable of identifying regulatory effects; IFSB-23 is prudential background to our question, not the object of the test.

The second reading is that a modest effect exists but is estimated too imprecisely to detect. The data support this reading no more than the first. Our interaction estimates have standard errors of roughly 0.07–0.09, and 95% confidence intervals of approximately −0.05 to +0.29 (contemporaneous specification) and −0.25 to +0.06 (lagged specification); these include zero, effects of the sign predicted by H1, and effects of the opposite sign. The retrospective calculation in Section 4.3 shows that only a true coefficient of about 0.24 in absolute value—roughly twice our point estimate—would be reliably distinguished from zero. We therefore describe the results as reflecting limited estimation precision rather than attributing them to low statistical power: a low-power account presupposes a true effect of non-trivial size that the test fails to detect, whereas our estimates are equally consistent with a true effect that is small or close to zero. Bank-level studies with larger cross-sections, such as Warninda et al. (8) (63 banks), do detect statistically significant (nonlinear) relationships between PLS financing and credit risk; we do not treat their finding as directly generalizable to the country-aggregate relationship tested here—the two are related but distinct empirical objects—and cite it only to illustrate that larger cross-sections offer greater precision, not to predict the sign or magnitude of our own estimates.

A further piece of evidence bears on this question directly: the interaction coefficient's sign is not stable across our three specifications. It is positive—opposite to the dampening direction predicted by H1—in both the contemporaneous (0.1193) and dynamic (0.1199) specifications, but negative—consistent with H1's predicted direction—in the lagged-interaction specification (−0.0943), and it flips again (to −0.033) under the alternative PLS-share construction reported in Section 5.2. None of these estimates is individually distinguishable from zero. We read this pattern as more consistent with sampling noise around a true value close to zero than with a stable, correctly signed effect that specification choice merely obscures: a genuine, moderately sized negative moderation effect should not flip sign as readily as it does here across closely related specifications estimated on overlapping data. We flag this explicitly, rather than reporting only the specification most favorable to our hypothesis, because a positive point estimate in two of our three baseline specifications is a result any honest reading of this paper must confront directly, not a detail to be smoothed over by selective emphasis on the lagged specification's more theory-consistent sign. Adding annual macroeconomic controls (Section 5.3) leaves the contemporaneous and dynamic coefficients positive (0.0875 and 0.0897) and moves the

TABLE 5 Robustness to annual macroeconomic controls: PLS share × CAR interaction effect on ΔNPF.

Variable	(1) Contemporaneous	(2) Dynamic	(3) Lagged interaction
ΔPLS Share × CAR (interaction)	0.0875 (0.0862)	0.0897 (0.0813)	–
Lagged ΔPLS Share × CAR	–	–	−0.1336 (0.0711)
ΔNPF t-1 (lagged NPF)	–	−0.0149 (0.1020)	–
ΔPLS Share (lagged in col. 3)	−0.0150 (0.0280)	−0.0163 (0.0282)	0.0175 (0.0194)
ΔCAR (lagged in col. 3)	0.0132 (0.0100)	0.0149 (0.0102)	0.0104 (0.0096)
GDP growth (annual, %)	0.00002 (0.00006)	0.00000 (0.00006)	0.00000 (0.00007)
Inflation (annual, %)	0.00014 (0.00007)	0.00012 (0.00007)	0.00016 (0.00008)
Entity and time fixed effects	Yes	Yes	Yes
Observations	250	244	244
R^2 (within)	0.049	0.053	0.062

Across all five checks, the absence of a statistically significant CAR × PLS interaction effect is robust; the sign, as already noted, is not. Driscoll-Kraay standard errors in parentheses; entity and time fixed effects in all columns. In column (3) all PLS, CAR and interaction regressors are lagged one quarter. GDP growth and inflation are annual rates in percentage points (World Bank WDI), assigned to the four quarters of each year; the dependent variable is in ratio units. No interaction coefficient is significant at the 5% level.

lagged coefficient to −0.1336 ($p = 0.062$); this marginal result is directionally consistent with H1 but, as one of several estimates and with the sign still specification-dependent, we do not interpret it as support.

Other explanations remain equally plausible and cannot be distinguished from limited estimation precision using this data alone: capital adequacy may genuinely not moderate PLS-related credit risk at the mechanism level; CAR may be endogenous to bank risk-taking decisions in ways that first-differencing and fixed effects do not fully address; our PLS share construction may measure the underlying contract-mix concept imperfectly (Section 7); country-specific, time-varying macroeconomic conditions may confound the PLS–NPF relationship—annual GDP-growth and inflation controls (Section 5.3) do not change the conclusion, but they are coarse, and we treat residual omitted-variable bias as a limitation (Section 7); NPF as a single aggregate ratio may be too coarse to detect risk concentrated in specific PLS sub-products; or the true relationship may operate over a longer lag structure than the one-quarter horizons tested here. We do not have the identification strategy or sample size to adjudicate between these explanations, and we do not claim to.

This distinction matters for how the finding should be used. We do not present this null result as evidence that capital adequacy is irrelevant to PLS risk management—the bank-level literature suggests otherwise. We present it as evidence that country-level macro panels of the kind constructed from publicly available IFSB PSIFI data offer limited precision for testing this class of interaction hypothesis, and that researchers considering similar designs should either secure bank-level data, include quarterly macroeconomic controls where available, or explicitly account for the resulting imprecision in their expected effect sizes.

This has a direct implication for data policy beyond "use different data": the underlying limitation is one of public data granularity, not researcher access alone. We recommend that IFSB and national central banks consider making bank-level (rather than only country-aggregated) PSIFI-equivalent data available to external researchers, subject to appropriate confidentiality safeguards. This would allow the research community to examine how capital adequacy and PLS exposure relate to asset quality with greater precision than aggregated data, whose precision this paper shows to be limited, can provide.

The models also have limited explanatory power. Within R^2 is 0.018–0.032 in the baseline specifications and 0.049–0.062 once macroeconomic controls are added, so the models account for only a few percent of the within-country variation in quarterly changes in NPF. Even a statistically significant interaction would therefore describe a small part of the variation in credit-risk changes, and the coefficients should be read as partial associations, not as a predictive or explanatory account of Islamic bank credit risk. Low explanatory power is expected for first-differenced ratios, which are noisy, and is not only a matter of omitted macroeconomic variables: changes in NPF also reflect bank-level underwriting, sectoral shocks and classification practices that national aggregates do not reveal.

The conceptual framework in Section 2 remains useful independent of this empirical result: it does not depend on the CAR × PLS interaction being statistically confirmed at the country level to establish that PLS and debt-like contracts generate structurally different risk profiles, a claim already well supported by the bank-level literature and by IFSB-23's own differentiated capital treatment.

7 Limitations

Several limitations should inform how this paper's findings are interpreted and used.

Aggregation level and estimation precision: as discussed in Sections 4.3 and 6, the six-country panel yields wide confidence intervals for the interaction coefficient, and our retrospective calculation shows that only an effect roughly twice our point estimate could be reliably detected. This paper cannot distinguish a true effect close to zero from a modest effect estimated imprecisely.

Residual omitted-variable bias and low explanatory power: Section 5.3 adds annual GDP growth and inflation, which leaves the conclusion unchanged, but these controls are coarse—they are annual (each value repeated across four quarters), cover only two macroeconomic dimensions, and omit exchange-rate movements, oil-price exposure (relevant for the GCC members of the sample), policy interest rates, and regulatory or accounting changes in NPF classification. Country and time fixed effects absorb time-invariant country characteristics and shocks common to all six countries but not these. The models also explain little of the within-country variation in ΔNPF (within R^2 of 0.02–0.06; Section 6), so the interaction coefficients should be read as descriptive partial associations. Richer quarterly controls (for example from IMF International Financial Statistics) are the first extension we recommend.

PLS share construction: Diminishing Musharakah, included in our main PLS aggregate, is structurally closer to an amortizing debt-like instrument than pure Musharakah or Mudarabah. As reported in Section 5.2, re-estimating the model with Diminishing Musharakah excluded does not materially change the null result, but the sign flip under that alternative construction (Section 5.2, 6) is itself a reason for caution about the underlying construct validity of a single aggregate PLS measure, which somewhat mitigates but does not eliminate this concern.

Cross-sectional dependence: confirmed present via the Pesaran CD test; while Driscoll-Kraay standard errors are designed to be robust to this, six entities is a small number over which to estimate cross-sectional dependence structure reliably.

Data coverage: three otherwise-relevant IFSB-reporting countries (Bahrain, Turkey, UAE) could not be included because they do not populate the contract-type financing breakdown, and Algeria—despite being a substantial Islamic banking market—is not an IFSB PSIFI reporting jurisdiction at all.

Conceptual framework validation: the risk-mitigation matrix in Section 2 is a structured narrative synthesis of the existing literature and regulatory standards, not a full PRISMA-protocol systematic review; a fully reproducible systematic review is a natural next step.

8 Conclusion

This paper set out to test whether regulatory capital adequacy is associated with a weaker relationship between profit-and-loss-sharing financing and credit risk in Islamic banking systems, motivated by a contract-level risk-mitigation framework showing that PLS and debt-like Islamic financing instruments generate structurally different risk profiles. Using a transparent, fully diagnosed six-country panel drawn from IFSB's PSIFI database, we find no statistically

significant interaction across three specifications and five robustness checks, including annual macroeconomic controls; the sign of the point estimate is unstable across specifications, and the models explain little of the within-country variation in changes in NPF (within R^2 of 0.02–0.06). Because the confidence intervals are wide, the results are best read as reflecting limited estimation precision: they are compatible with a true effect close to zero and with a modest effect measured imprecisely, and we do not claim to distinguish between them. IFSB-23 provides the prudential background for the question, not a policy whose effectiveness we have tested. The methodological lesson for researchers considering similar macro-level designs in Islamic finance is that country-level aggregates offer limited precision for interaction hypotheses of this kind, and we recommend that future work use bank-level panel data and quarterly macroeconomic controls.

Data availability statement

The datasets analyzed in this study are from the Islamic Financial Services Board's Prudential and Structural Islamic Financial Indicators (PSIFI) database, publicly available at https://www.ifsb.org, and from the World Bank World Development Indicators (https://data.worldbank.org). The cleaned panel dataset and analysis code are available from the corresponding author upon reasonable request.

Author contributions

SB: Conceptualization, Data curation, Validation, Visualization, Writing – original draft. KM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Writing – original draft, Writing – review & editing.

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