“Internal audit under Kazakhstan’s 2019 risk-management and internal control requirements: A continuous-treatment difference-in-differences analysis of commercial banks’ financial stability”

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INTERNAL AUDIT UNDER KAZAKHSTAN'S 2019 RISK-MANAGEMENT AND INTERNAL CONTROL REQUIREMENTS: A CONTINUOUS-TREATMENT DIFFERENCE-IN-DIFFERENCES ANALYSIS OF COMMERCIAL BANKS' FINANCIAL STABILITY

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Abstract

Weak risk governance and legacy non-performing loans have repeatedly destabilized banks in emerging markets, making the payoff from regulatory strengthening of internal control and internal audit a first-order policy question. This study aims to determine whether Kazakhstan's 2019 risk-management and internal control requirements (National Bank Resolution No. 188), whose core assurance mechanism is a strengthened internal audit function, improved the financial stability of the country's commercial (second-tier) banks, and to identify the channel of this effect. The analysis applies a continuous-treatment difference-in-differences design to an annual panel of 37 banks over 2015–2025 (287 bank-years), interacting each bank's pre-intervention (2016–2019) weakness with the post-intervention period and measuring stability by the log Z-score. The results show that the stabilizing effect is concentrated in the asset-quality channel: banks that entered the post-2020 period with a one-standard-deviation greater non-performing-loan weakness recorded a 0.38-0.41 log-point (roughly 40-50%) larger post-intervention increase in the Z-score ($p < 0.01$), whereas composite pre-intervention weakness yields no robust effect under any weighting scheme. The effect emerges with a multi-year lag, becoming statistically detectable only toward the end of the sample period, and operates through capital rebuilding. Because pre-intervention weakness strongly predicts market exit (Cox hazard ratio ≈ 3.95), the estimates are a lower bound on the intervention's full association with sector stability. The findings imply that supervisors should target credit-risk governance, loan classification, timely recognition of problem loans, and provisioning, where strengthened internal control and audit yield the largest stability gains.

Keywords bank stability, internal audit, internal control, risk management, difference-in-differences, non-performing loans, Z-score, Kazakhstan

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INTRODUCTION

Kazakhstan operates a two-tier banking system in which the National Bank of Kazakhstan (NBK) and, since 2020, the Agency for Regulation and Development of the Financial Market supervise a small, bank-dominated financial sector (IMF, 2024). For most of the past decade, that sector has been defined by a legacy asset-quality problem: the share of non-performing loans – loans overdue by more than ninety

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days – peaked above 30% in early 2014 before a prolonged clean-up brought it down to roughly 8-9% by 2019–2020 (U.S. Department of State, 2020; World Bank, 2024). The adjustment was as much institutional as statistical: the number of operating banks fell from 37 in 2009 to about 21 by 2022 (Asian Development Bank, 2023), as several institutions – including the then-second-largest bank – required state rescue or lost their licenses. Crucially, rating agencies attributed these failures primarily to asset quality and to weak risk management, governance and related-party lending behind it, rather than to macroeconomic shocks alone (Fitch Ratings as cited in AzerNews, 2018; U.S. Department of State, 2020).

This diagnosis placed bank-level risk governance, and the internal-audit function in particular, at the center of the policy response. International supervisory standards already framed internal audit as the third line of defense: the Basel Committee's guidance The Internal Audit Function in Banks is built around twenty principles requiring an independent, adequately resourced internal audit function as a precondition for a sound internal control system (BCBS, 2012). Kazakhstan followed in late 2019, when the NBK adopted Resolution No. 188 (12 November 2019), obliging every commercial (second-tier) bank to establish a formal risk-management and internal-control system – with distinct risk, compliance and internal-audit units – and to bring it into compliance by 1 October 2020 (National Bank of Kazakhstan, 2019). The regulatory change is thus deliberately broader than internal audit alone: Resolution No. 188 restructures a bank's entire risk-management and internal-control architecture. Within that architecture, however, internal audit is the function charged with independently assuring that the remaining elements (risk limits, loan classification, provisioning, and compliance) actually operate. This study therefore treats the strengthened internal audit function as the core assurance mechanism of the new requirements, while referring to the intervention itself, precisely, as the 2019 risk-management and internal control requirements. In the same year, the regulator completed an asset-quality review of the fourteen largest banks, together holding about 87% of system assets, attaching an individual risk-management remediation plan to each (U.S. Department of State, 2020; S&P Global Ratings, 2019). Whether such governance requirements actually translate into measurable financial stability – and through which balance-sheet channel – remains, however, an open empirical question, particularly in emerging-market systems where supervisory data and enforcement are uneven.

1. LITERATURE REVIEW

Research on what makes banks stable has progressed through three overlapping phases. The earliest strand tied solvency and failure risk to fundamental balance-sheet traits – size, capitalization, and exposure to the macroeconomic cycle – and showed that these relationships are neither simple nor uniform. Larger institutions, contrary to a naive too-big-to-fail logic, displayed no greater distance to default – if anything, they failed somewhat more often – and earned lower returns on assets (Boyd & Runkle, 1993), while problem loans and cost inefficiency proved tightly and dynamically intertwined (Berger & DeYoung, 1997). Later work confirmed that macroeconomic conditions – growth, inflation, and the policy environment – remain powerful determinants of bank performance (Gižienė et al., 2024; Klein, 2013). A second phase reframed these fundamentals as outcomes of institutional quality, placing corporate governance, internal control, and ethical leadership at the center of distress prevention (Laeven & Levine, 2009; Soussou & Hbaieb, 2026). A third, more recent phase has absorbed digital finance, information asymmetry, and formal risk-management architectures as forces that reshape asset quality and resilience in emerging markets (Anton & Afloarei Nucu, 2024; Nsekela et al., 2026). This trajectory motivates the present focus on one specific governance instrument – the internal-audit and risk-management function – and its measurable consequences for bank stability.

A substantial and largely emerging-market literature now connects the internal-audit and risk-management function directly to institutional outcomes. Studies of the public and corporate sectors find that internal audit, internal control, and audit quality jointly strengthen fraud prevention and the integrity of reporting (Nurgaliyeva et al., 2025; Zurika Lubis et al., 2024), an effect that in-

tensifies when audit is organized on a risk-based footing (Juwita Sari Harahap & Erlina, 2024). The benefit is not automatic: the effectiveness of internal-control systems hinges on implementation quality and can be undercut by digitalization that introduces algorithmic opacity and fresh vulnerabilities (Alarcon et al., 2026). Complementary evidence shows that modern accounting infrastructure mediates the link between audit leadership and audit quality (Alabdullah et al., 2025; Prokopenko et al., 2024), that corporate governance paired with sound investment decisions lifts financial performance and firm value in banking (Noor et al., 2024), and that the cultural setting conditions how credibly investors read internal-control disclosure (Alqaraleh, 2024). Across these studies, the recurring message is that internal audit matters for stability chiefly through its effect on the quality of information and the discipline of risk recognition – precisely the margin formal regulatory requirements are designed to tighten.

At the system level, reporting and prudential regulation are repeatedly associated with stronger performance and resilience. IFRS adoption and improved governance practices raise firm performance across the Gulf region, with effects robust to instrumental-variable and dynamic-panel estimation (Alruwaili et al., 2023). For banks specifically, regulatory financial indicators explain a large share of variation in financial stability – close to forty-five percent in one recent sample – with a bank's equity maneuverability emerging as the single strongest positive determinant (Mursalov et al., 2025). Comparative work across regions and income groups confirms that profitability, and therefore stability, is highly persistent and sensitive to the macroeconomic cycle (Sitnicka et al., 2025), while multi-criteria assessments of deposit banks show that conventional financial ratios still rank institutions reliably by soundness (Tutar et al., 2025). Taken together, this evidence establishes that regulation and governance can move stability, yet it stops short of identifying the channel through which a discrete internal-audit mandate would do so.

That channel runs predominantly through asset quality. Non-performing loans are deeply persistent and respond to the macroeconomy, their lagged values explaining most of their own dynamics while unemployment, inflation, and exchange-rate depreciation push them upward (Klein, 2013). Their roots, however, are also internal: deteriorating cost efficiency and weak underwriting precede increases in problem loans – evidence for a "bad management" dynamic rather than mere "bad luck" – and thin capitalization predicts higher future NPLs (Berger & DeYoung, 1997; Rakhimzhanova et al., 2025). Asset-quality deterioration in turn impairs profitability, especially during crises (Nguyen, 2024), and transmits macroeconomic shocks through retail and consumer portfolios (Keliuotyte-Staniuleniene et al., 2023). Crucially for the present study, higher NPLs translate directly into weaker solvency: in international evidence, a rise in non-performing loans lowers the bank Z-score with a significant negative coefficient of roughly –0.23 (Anton & Afloarei Nucu, 2024). The accounting Z-score and composite systemic-stress indices have become the standard instruments for capturing such vulnerabilities and generating early-warning signals (Kaya, 2025; Klochan & Filipov, 2023; Yildirim, 2025), even as the rapid spread of digital and buy-now-pay-later lending adds new credit risk in turbulent periods (Waliszewski et al., 2024). Notably, banks that remain focused on traditional intermediation appear to carry lower systemic risk than diversified ones (Szüle, 2023).

This consensus is qualified by several robust counter-currents. Governance does not lower risk unconditionally: stringent capital rules can interact with concentrated ownership to encourage greater risk-taking, and the cash-flow rights of a bank's largest owner are negatively associated with its Z-score (Laeven & Levine, 2009). Even sound board structures can be neutralized, since pre-disclosure information leakage distorts oversight and elevates future credit risk (Nsekela et al., 2026), and the value of governance improvements is itself moderated by firm size and age (Amanamah, 2024). The exit margin matters as much as the survival of incumbents: competing-risks evidence shows that productive inefficiency raises the probability of failure while lowering the chance of rescue by acquisition (Wheelock & Wilson, 2000), and machine-learning models in adjacent domains likewise identify operational efficiency as a powerful predictor of impending bankruptcy (Letkovsky et al., 2023). Risk gover-

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nance also operates inside a wider environment. Macroeconomic and fiscal-monetary conditions shape bank earnings and the exchange-rate setting in which banks lend (Gižienė et al., 2024; Ahmed, 2025), and broader corporate stability is itself sensitive to macro resilience (Mehrotra & Chadha, 2025). Institutional integrity is a further conditioning factor: cyber threats, corruption, and money laundering jointly destabilize the business environment (Lyeonov, Yarovenko, et al., 2025), while technological capacity helps curb corruption and reinforce transparency (Yefimenko et al., 2025), and tailored anti-money-laundering regimes improve the quality of oversight (Kuzior et al., 2025). Operational and technological exposures such as AI-enabled money laundering are increasingly treated as core risk-management concerns Lyeonov, Hrytsenko, et al., 2025).

Two gaps follow from this literature. First, evaluations of risk-management and internal-control regulation in emerging markets rest largely on broad cross-country panels and generalized regulatory indices rather than design-based tests of specific, datable interventions (Anton & Afloarei Nucu, 2024; Sitnicka et al., 2025), leaving the causal effect of a concrete internal-audit mandate on bank stability essentially untested. Second, because the weakest banks routinely leave the market through failure or acquisition, stability estimates are exposed to a survivorship bias that standard models seldom confront (Wheelock & Wilson, 2000; Boyd & Runkle, 1993). This study aims to determine whether Kazakhstan's 2019 risk-management and internal control requirements improved the financial stability of the commercial (second-tier) banks that entered the post-2020 period weaker and to identify the component of pre-intervention weakness through which this differential effect operates using a continuous-treatment difference-in-differences design on the full population of banks over 2015–2025 and treating surviving-sample estimates as a lower bound.

2. DATA AND METHODOLOGY

This study uses an annual, bank-level panel constructed from the supervisory and prudential reporting of Kazakhstan's banking regulator (the National Bank of Kazakhstan and, from 2020, the Agency for Regulation and Development of the Financial Market). The panel comprises 37 second-tier banks observed over 2015–2025, for a total of 287 bank-years. It is unbalanced: the number of active banks falls from 34 in 2015 to 26 in 2020 and then holds at 21-23 from 2021 onward, as institutions leave the sample through license revocation, merger or the withdrawal of a foreign parent. The full list of the 37 banks and their treatment status is provided in Appendix A. The intervention studied is the 2019 tightening of risk-management and internal-control requirements for second-tier banks (National Bank Resolution No. 188), whose compliance deadline fell on 1 October 2020; the post-intervention period is accordingly dated from 2021. Because every bank was subject to the same regulatory change at the same time, the design does not rely on a never-treated control group; instead, it exploits cross-bank variation in pre-intervention fragility, asking whether banks that entered the post-2020 period weaker improved their stability differentially more – a continuous-treatment (dose-response) difference-in-differences strategy. Identification accordingly rests on a dose-response parallel-trends assumption: absent the intervention, the stability of banks with different pre-intervention weakness would have evolved along parallel paths – an assumption probed directly through the pre-intervention leads of the event-study specification below. Table 1 defines the variables used in the analysis and their sources.

The outcome is the Z-score, a standard accounting measure of a bank's distance to default, defined in equation (1) as the sum of the return on assets and the equity-to-assets ratio divided by the bank-specific standard deviation of return on assets, the latter computed over the full sample period. Because the Z-score is strongly right-skewed, the headline specifications use its natural logarithm, while the untransformed level enters as a robustness check. A higher Z-score denotes a larger buffer of capital and earnings relative to earnings volatility, and hence greater stability.

$$Z_{it} = \frac{ROA_{it} + \left(E / A\right)_{it}}{\sigma_i\left(ROA\right)}, \quad y_{it} = \ln Z_{it}. \tag{1}$$

Treatment intensity is a bank-specific index of pre-intervention weakness, measured over 2016–2019 – before the intervention was announced – so that it

Table 1. Variable definitions and sources

Variable	Definition	Source
Z-score	(ROA + equity/assets) divided by the bank-specific full-sample standard deviation of ROA; accounting distance to default	Authors' calculations (NBK/ARDFM)
ln Z-score	Natural logarithm of the Z-score; headline dependent variable	Authors' calc.
Post	Indicator = 1 in 2021–2025, 0 in 2015–2020 (Resolution No. 188; deadline 1 Oct 2020)	NBK
Pre-intervention weakness (composite)	Equal-weighted mean of the five standardized components below, measured 2016–2019; standardized to unit cross-bank SD	Authors' calculations
– NPL weakness	Standardized share of loans overdue 90+ days, 2016–2019	NBK/ARDFM
– Low capital	Standardized (inverse) capital-adequacy ratio k1, 2016–2019	NBK/ARDFM
– ROA volatility	Standardized standard deviation of ROA, 2016–2019	Authors' calculations
– Provision gap	Standardized shortfall of loan-loss provisions relative to NPLs, 2016–2019	Authors' calculations
– Illiquidity	Standardized (inverse) current-liquidity ratio k4, 2016–2019	NBK/ARDFM
Controls (X)	k1, k3, log k4, NPL ratio, provision coverage, loan-to-assets, deposit-to-assets, NIM, log assets (time-varying); ROA and equity/assets excluded as Z-score components	NBK/ARDFM
Fixed effects	Bank and year	–

Note: Pre-intervention weakness components are oriented so that higher values denote greater weakness. NBK = National Bank of Kazakhstan; ARDFM = Agency for Regulation and Development of the Financial Market.

is predetermined with respect to the intervention. The index aggregates five dimensions of fragility: asset-quality (NPL) weakness, low capitalization, earnings (ROA) volatility, a provisioning gap, and illiquidity. Each component is the corresponding bank indicator standardized across banks over the pre-intervention window and oriented so that higher values denote greater weakness; the composite is their equal-weighted average, as in equation (2), and is itself standardized to unit cross-bank standard deviation for estimation. The index is formative rather than reflective: its components are constituent causes of fragility, not interchangeable manifestations of a single latent trait, so a low internal consistency coefficient is expected and is not a defect of measurement. Cronbach's alpha is accordingly low (0.32 across the five components, 0.35 across four), which is reported for transparency, while the aggregation rests on construction and face validity rather than on reflective-scale reliability. Equal weights serve as the transparent benchmark for aggregating such a formative index: the five dimensions are conceptually distinct constituents of fragility, and neither theory nor the design supplies a prior for ranking their relative importance, so any data-driven weighting would impose exactly the structure that the disaggregated specifications are meant to uncover. A principal-component analysis of the five components reinforces this choice – the first component captures only about 35% of the cross-bank variance and loads with opposite signs on the asset-quality and capital-liquidity dimensions, so no single latent factor exists whose loadings could serve as weights. Alternative weighting schemes – first-principal-component weights, rank-based aggregation, and leave-one-out variants of the composite – are nevertheless examined as a robustness check and reported in Appendix E. The disaggregated specifications below let each dimension act separately, which is what ultimately isolates the operative channel.

$$W_{id} = \frac{w_{id} - \mu_d}{s_d}, \quad Weakness_i = \frac{1}{5}\sum_{d=1}^{5} W_{id}. \quad (2)$$

The estimating equation is a two-way fixed-effects regression with bank and year effects. In the composite specification, equation (3), the coefficient of interest multiplies the interaction of the post-intervention indicator with the time-invariant weakness index; the level of the post indicator is absorbed by the year effects and the level of the weakness index by the bank effects, so the coefficient identifies the differential change in log stability after the intervention across banks of differing pre-intervention weakness. The disaggregated specification, equation (4), replaces the single index with its five standardized components entered jointly. Time-varying controls X comprise the capital-adequacy ratio k1, the ratio k3, log liquidity (k4), the NPL ratio, provision coverage, the loan-to-assets and deposit-to-assets ratios, the net interest margin, and bank size (log assets); return on assets and the equity-to-assets ratio are deliberately excluded because they are mechanical

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components of the Z-score. Because these time-varying balance-sheet controls are themselves plausible channels of the intervention – capital, provisioning and asset-quality ratios adjust as governance improves – the headline specifications enter the treatment interaction without them, and estimates that add the full control set are read as conservative, mediation-adjusted bounds rather than as the preferred specification. Standard errors are clustered by bank throughout. Because the design imposes fixed effects by construction, the fixed- versus random-effects choice is not at issue and a formal Hausman test is therefore not the operative diagnostic; heteroskedasticity and within-bank serial correlation are addressed through clustering, and multicollinearity is immaterial, with all control variance-inflation factors at or below 2.37. Pairwise correlations among the control variables are reported in Appendix B. The robustness checks reported in the Results re-estimate equations (3) and (4) with the untransformed Z-score as the dependent variable, with log k1 as an alternative capital-buffer outcome, and on subsamples that drop foreign-owned subsidiaries, the 2020 transition year, and the four largest banks, as well as under alternative weighting schemes for the composite index (Appendix E) and with the full time-varying control set added to the asset-quality specification (Appendix D).

$$y_{it} = \alpha_i + \delta_t + \beta \cdot \left(Post_t \cdot Weakness_i \right) + \gamma' X_{it} + \varepsilon_{it}, \quad (3)$$

$$y_{it} = \alpha_i + \delta_t + \sum_{d=1}^{5} \beta_d \cdot \left(Post_t \cdot W_{id} \right) + \gamma' X_{it} + \varepsilon_{it}. \quad (4)$$

To examine timing and to probe the parallel-trends assumption, equation (5) replaces the single post indicator with a full set of year indicators interacted with pre-intervention weakness, taking 2020 as the omitted base year; the resulting path of coefficients (Figure 1) displays the pre-intervention leads, and the post-intervention lags separately. Appendix C confirms that high- and low-weakness banks are broadly balanced on observables before the intervention. Two features of the data complicate conventional inference. First, the number of treated clusters is small – 28 banks carry a measured NPL-weakness component and 32 a composite – so cluster-robust asymptotic standard errors may under-cover. The key coefficients are therefore corroborated with a wild-cluster bootstrap using Rademacher weights and 9,999 replications, resampling at the bank level. Second, the post-intervention window is short relative to the multi-year transmission from governance to credit risk, a point taken up among the limitations below.

$$y_{it} = \alpha_i + \delta_t + \sum_{k \neq 2020} \theta_k \cdot \left(D_{tk} \cdot Weakness_i \right) + \varepsilon_{it}. \quad (5)$$

Because the difference-in-differences estimates are conditional on a bank's survival, and because the weakest banks are the most likely to exit, the surviving-sample estimates are subject to selection. This selection is characterized with two exit models that take pre-intervention weakness as the principal regressor: a cross-sectional logit for the probability that a bank exits at any point over the sample (equation 6), and a Cox proportional-hazards model for the timing of exit (equation 7), in both cases conditioning on baseline bank covariates. These models do not correct the difference-in-differences estimates; rather, they establish the sign and strength of the selection, which in turn pins down the direction of the resulting bias.

$$\Pr\left(Exit_i = 1 \right) = \Lambda\left(a + b \cdot Weakness_i + c' X_i \right), \quad (6)$$

$$h_i\left(t\right) = h_0\left(t\right) \cdot \exp\left(b \cdot Weakness_i + c' X_i \right). \quad (7)$$

Throughout, i indexes banks and t years; α_i and δ_t are bank and year fixed effects; X_{it} is the vector of time-varying controls (X_i its time-invariant baseline counterpart) with coefficient vectors γ' and c'; β (and the component-specific β_d) is the difference-in-differences coefficient of interest and ε_{it} the idiosyncratic error clustered by bank; in equation (2), μ_d and s_d are the cross-bank mean and standard deviation of dimension d; in equations (6)-(7), $\Lambda(\cdot)$ is the logistic CDF, a is the intercept, $h_i(t)$ is the exit hazard and $h_0(t)$ is the baseline hazard.

Several limitations should be borne in mind. First, the data are annual and administrative, and the post-intervention window (2021–2025) is short relative to the loan-cycle horizon over which an

internal-audit mandate plausibly affects credit risk; consistent with this, the effect becomes statistically detectable only toward the end of the sample, so the estimates likely understate the long-run association. Second, because all banks were treated simultaneously, the design identifies the differential effect of the intervention across banks of differing pre-intervention weakness, not the average effect of the intervention itself; the coefficients are dose-response estimates and should not be read as a clean average treatment effect on the treated. Third, attrition is non-random – the most NPL-laden banks left the sample, predominantly through acquisition or the withdrawal of a foreign parent rather than license revocation – so the surviving-sample estimates are a lower bound on the intervention's full association with sector stability. Fourth, the weakness index is formative and equally weighted, and the Z-score is normalized by a full-sample standard deviation; alternative weightings are examined in Appendix E and leave the conclusions unchanged, while rolling-window normalizations remain possible and the estimates are correspondingly sensitive to them, as reported in the robustness analysis.

3. RESULTS

Table 2 reports descriptive statistics for the unbalanced panel of 287 bank-years covering 37 second-tier banks of Kazakhstan over 2015–2025. The panel thins over time – from 34 active banks in 2015 to 26 in 2020 and 21-23 from 2021 onward – a contraction that itself reflects the wave of license revocations, mergers and foreign exits examined below. The Z-score is strongly right-skewed, with a mean of 17.0 against a median of 11.1 and a maximum of 204.9; this skew, driven by a handful of small and foreign-owned banks holding very high capital ratios, motivates using the natural logarithm of the Z-score as the headline dependent variable, which is well-behaved (mean 2.32, median 2.42, standard deviation 1.09). On average the sector is moderately profitable and amply capitalized: return on assets averages 2.1%, the equity-to-assets ratio 19.9%, and the regulatory capital ratio k1 0.39, though each varies widely – equity-to-assets ranges from 5.5% to 97.5%, and total assets in logs span 15.3 to 23.7, more than three orders of magnitude in scale. Funding is predominantly deposit-based (deposits average 71.6% of assets) and intermediation margins are healthy (net interest margin 6.1%). Asset quality carries by far the heaviest tail: the average ratio of loans overdue by more than 90 days is 6.7% but reaches 98% in the most distressed institutions, and provision coverage is similarly dispersed (mean 2.86). The pre-intervention weakness index, measured over 2016–2019 and defined for the 32 banks with sufficient history, is standardized across banks and therefore centered near zero (mean −0.09, ranging from −0.92 to 1.13).

Columns 1-3 of Table 3 present the continuous-treatment difference-in-differences estimates that use the composite pre-intervention weakness in-

Table 2. Descriptive statistics

Variable	N	Mean	SD	Min	Median	Max
Z-score	283	16.99	23.90	−1.99	11.13	204.88
ln Z-score	279	2.32	1.09	−3.32	2.42	5.32
Return on assets (ROA)	287	0.021	0.041	−0.278	0.022	0.169
Equity-to-assets	287	0.199	0.168	0.055	0.138	0.975
NPL ratio (90+ days)	251	0.067	0.099	0.000	0.047	0.984
Provision coverage	245	2.86	6.57	0.01	1.46	67.80
Loans-to-assets	287	0.526	0.222	0.001	0.562	1.003
Deposits-to-assets	284	0.716	0.187	0.014	0.756	0.995
Capital adequacy (k1)	287	0.390	0.442	0.067	0.191	3.351
Current liquidity (k4)	287	2.13	2.78	0.04	1.39	22.39
Net interest margin	285	0.061	0.035	0.005	0.057	0.269
ln(Total assets)	287	19.96	1.71	15.30	19.98	23.73
Pre-intervention weakness index	281	−0.089	0.474	−0.917	−0.146	1.125

Note: N = bank-years; the sample covers 37 banks over 2015–2025 (287 bank-years). The pre-intervention weakness index is time-invariant, standardized across banks, and defined for the 32 banks with 2016–2019 data. Source: authors' calculations based on National Bank of Kazakhstan / ARDFM data.

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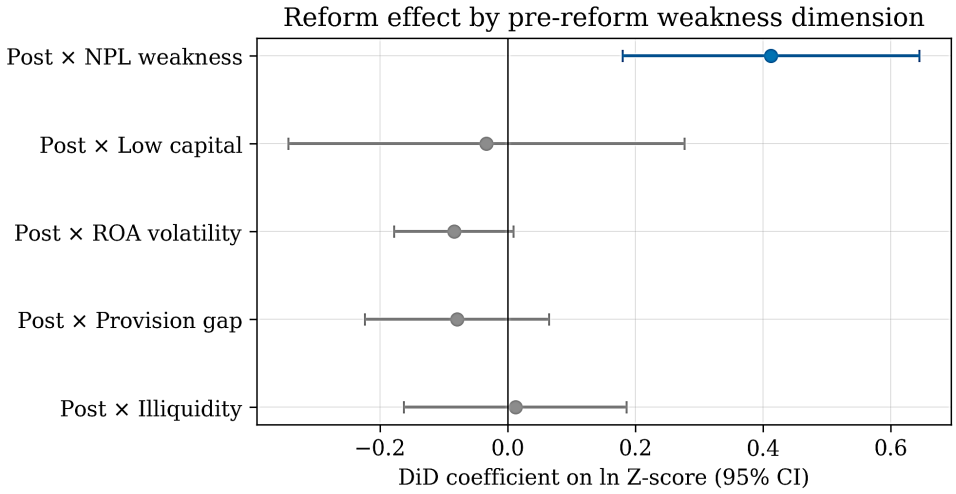
dex. The interaction of Post with composite weakness is positive but statistically imprecise: the baseline coefficient is 0.232 (clustered standard error 0.152), implying that a bank entering the post-2020 period one standard deviation weaker recorded a larger post-intervention increase in the log Z-score, yet the estimate falls short of conventional significance ($t \approx 1.5$). Adding bank size leaves a similar, now marginally significant point estimate (0.189, SE 0.100), while the full set of time-varying controls attenuates it to 0.070 (SE 0.089). Two features of this sequence are informative. First, the coefficient on bank size is consistently negative and significant (−0.375 with size alone, −0.233 under full controls), indicating that larger banks recorded smaller stability gains–consistent with the weakest improvers being mid-sized institutions rather than the systemic leaders. Second, the attenuation of the composite term under full controls is driven almost entirely by the capital ratio k1 (0.884, SE 0.441), which is itself one of the channels through which weak banks stabilized; the pattern is therefore read as partial mediation rather than as evidence against the effect, and the size-only specification in column 2 is treated as the relevant composite benchmark. Model fit is high throughout, with R^2 between 0.87 and 0.92. At the level of aggregate weakness, then, the intervention's stabilizing association carries the expected sign but cannot be pinned down precisely-a result that the disaggregation below directly explains.

Disaggregating the composite into its five standardized components localizes the effect entirely in asset quality (columns 4-6 of Table 3; Figure 1). Entered on its own, the interaction of Post with pre-intervention NPL weakness is 0.383 and highly significant (SE 0.115, $p < 0.01$); it is essentially unchanged when all five dimensions are entered jointly (0.413, SE 0.119) and remains significant after controlling for size (0.327, SE 0.126). The other four dimensions-low capital, earnings volatility, the provisioning gap, and illiquidity-are individually indistinguishable from zero, a pattern Figure 2 makes immediately visible: only the NPL-weakness interval lies entirely to the right of zero, while the remaining four straddle it. In economic terms, a one-standard-deviation higher pre-intervention NPL weakness is associated with

Table 3. 2019 requirements and bank stability: continuous-treatment difference-in-differences

DV: ln Z-score	(1)	(2)	(3)	(4)	(5)	(6)
	base	+ size	+ controls	NPL	all dims	+ size
Post × Weakness (composite)	0.232	0.189*	0.070			
	(0.152)	(0.100)	(0.089)			
Post × NPL weakness				0.383***	0.413***	0.327**
				(0.115)	(0.119)	(0.126)
Post × Low capital					−0.033	0.024
					(0.158)	(0.128)
Post × ROA volatility					−0.084*	−0.088**
					(0.048)	(0.042)
Post × Provision gap					−0.079	0.075
					(0.074)	(0.079)
Post × Illiquidity					0.012	−0.095
					(0.089)	(0.076)
ln(Total assets)		−0.375**	−0.233*			−0.345*
		(0.142)	(0.133)			(0.186)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Full time-varying controls	No	No	Yes	No	No	No
Observations	277	277	233	242	242	242
R^2	0.871	0.888	0.916	0.892	0.893	0.902

Note: Two-way (bank and year) fixed-effects estimates; standard errors clustered by bank in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the natural logarithm of the Z-score. Post = 1 from 2021 onward. Treatment intensity (composite pre-intervention weakness and its components) is measured over 2016–2019, standardized across banks, and time-invariant; the level terms of Post and of the intensity measures are absorbed by the year and bank fixed effects, respectively. Full controls in column (3) comprise k1, NPL ratio, provision coverage, log k4, loan ratio, deposit ratio, NIM, k3, and ln assets.



Note: Markers are point estimates with 95% confidence intervals clustered by bank; only the NPL-weakness dimension is statistically distinguishable from zero.

Figure 1. Difference-in-differences coefficients by pre-intervention weakness dimension (dependent variable: log Z-score)

a 0.33-0.41 log-point larger post-intervention increase in the Z-score, equivalent to a roughly 40-50% larger proportional improvement relative to banks without such weakness. The small negative coefficient on Post × ROA volatility (−0.084, marginally significant) is a partialling artifact rather than a substantive result: earnings volatility correlates 0.61 with NPL weakness, so once the latter absorbs their common signal the residual volatility term turns slightly negative, and it should not be read as a deterioration of earnings-volatile banks. Because the asset-quality specification is identified off only 28 treated clusters, inference is reinforced with a wild-cluster bootstrap (9,999 replications, resampling by bank): it confirms the NPL channel ($p = 0.023$), whereas the composite remains insignificant under the same procedure ($p = 0.133$). The asset-quality dimension is thus the single component carrying the aggregate result.

Figure 2 traces the dynamics of the effect through an event study with 2020 as the base year. The coefficients in the immediate pre-intervention years are flat – essentially zero in 2018, 2019 and 2020 – indicating no differential pre-trend along the asset-quality gradient where it matters most for identification. The effect then emerges gradually rather than as a jump at the compliance deadline: it remains small and imprecise in 2021–2022 and becomes statistically significant only from 2023 onward, reaching about 0.42-0.43 in 2024–2025 ($t \approx 2.2$-2.7). This multi-year lag is consistent with the underlying transmission, which runs from stronger governance and internal audit, through more conservative recognition and active workout of problem loans, to a higher distance to default – a chain that operates over loan cycles rather than quarters. The negative coefficients in the distant leads of 2015–2016 (around −0.30) reflect the post-crisis recovery of the weakest banks during the 2015–2017 asset-quality review and NPL clean-up, a process largely completed by 2018; they cannot represent anticipation of requirements adopted only at the end of 2019. Figure 3 corroborates the same dynamics descriptively: the gap in mean log Z-score between high- and low-NPL-weakness banks, having widened before the intervention, narrows markedly afterwards – roughly halving by 2025 – as the weaker group catches up. The composite event-study path is visibly noisier, dipping sharply in 2022 before recovering, which again points to NPL as the clean channel and to the composite as a diluted aggregate. The full numerical event-study coefficients underlying Figure 2, together with a variant taking 2019 as the base year, are reported in Appendix F.

The asset-quality channel is stable across alternative specifications. It survives using the level Z-score rather than its logarithm (5.24, SE 1.76), excluding foreign-owned subsidiaries (0.426, SE 0.103), excluding the 2020 transition year (0.423,

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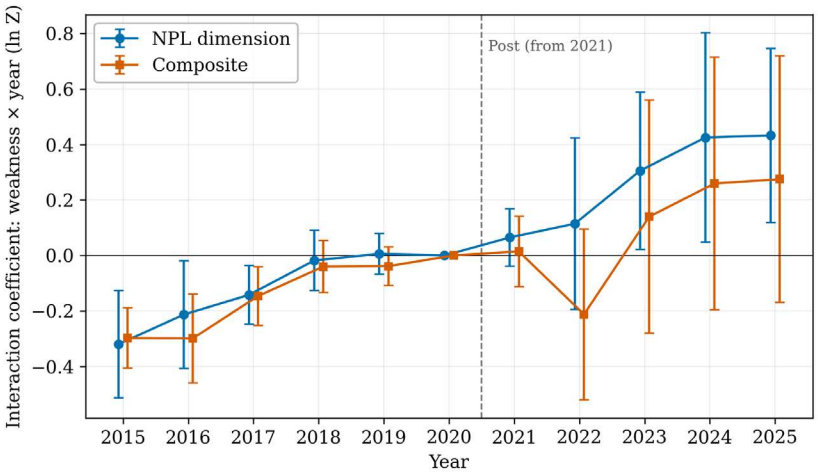
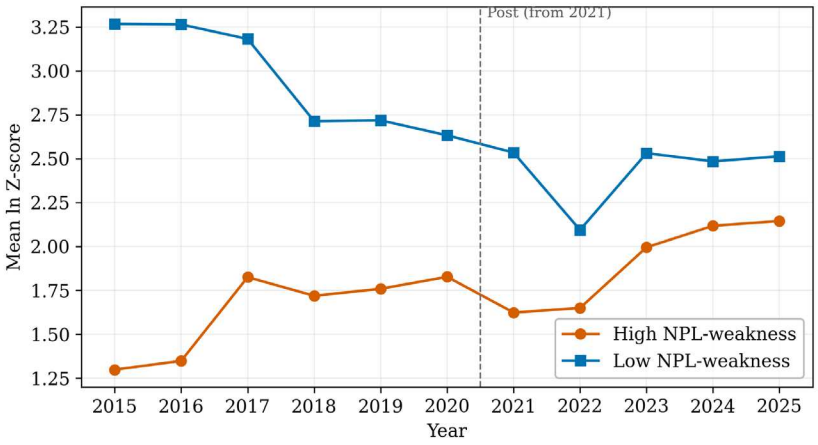


Note: Markers are interaction coefficients of the weakness measure × year on the log Z-score; whiskers are 95% confidence intervals clustered by bank. The dashed line marks the start of the post-intervention period (Post = 1 from 2021).

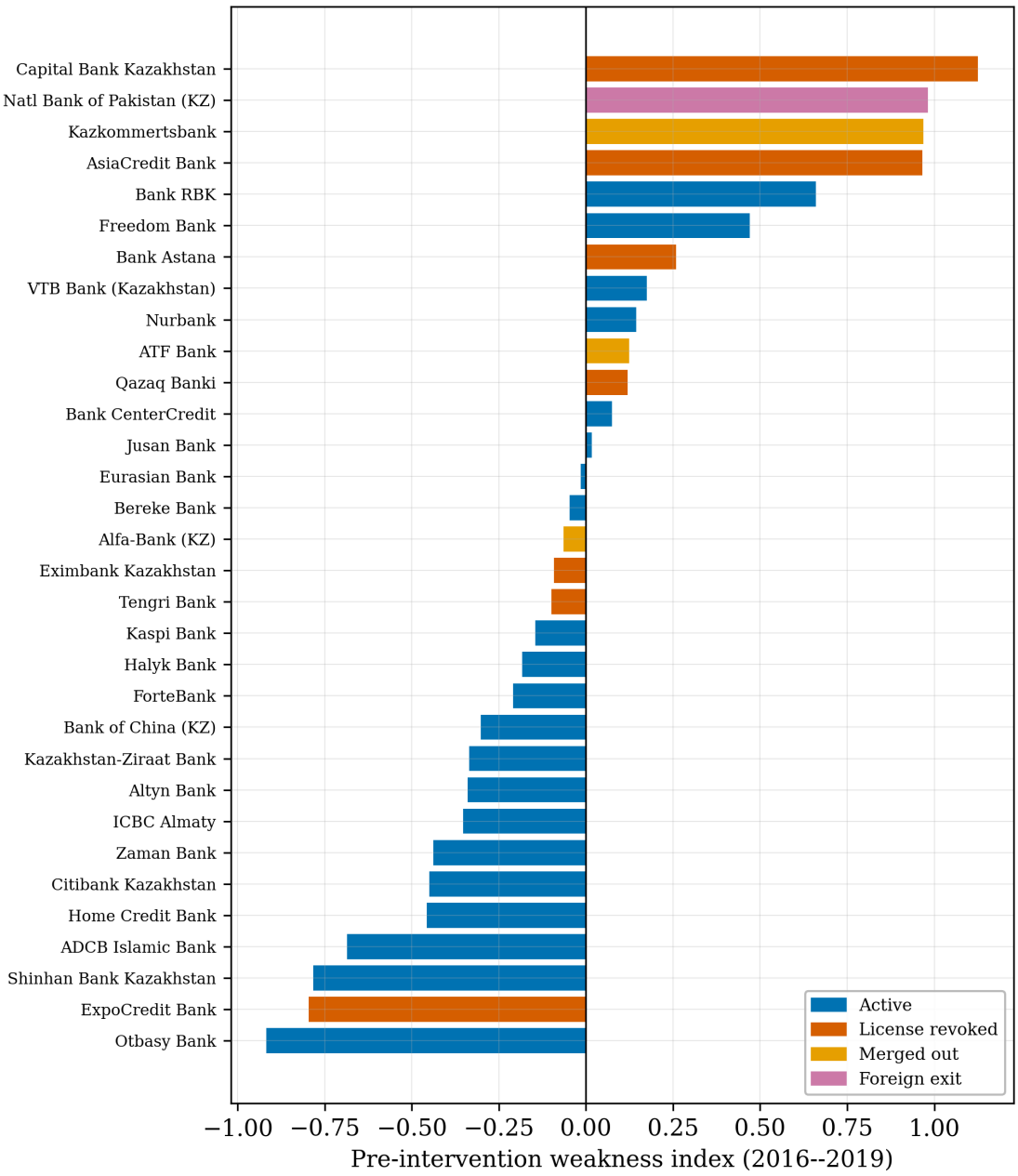
Figure 2. Event-study estimates of the intervention effect, by pre-intervention weakness measure (base year 2020)



Note: The dashed line marks the start of the post-intervention period.

Figure 3. Stability trajectory of high- versus low-NPL-weakness banks (mean log Z-score by year)

SE 0.122), and excluding the four largest banks by assets – Halyk, Kazkommertsbank, Kaspi and Bank CenterCredit (0.361, SE 0.127) – so the result is not an artifact of the systemic institutions, the pandemic year, or the functional form of the outcome. Adding the full set of time-varying controls roughly halves the point estimate while leaving it marginally significant (0.196, SE 0.100, $p \approx 0.06$; Appendix D) – exactly the pattern the mediation logic above predicts, since the controls absorb part of the capital and provisioning adjustment through which the effect travels. Replacing the dependent variable with the capital buffer ln k1 yields a coefficient of 0.447 ($t \approx 4.8$), direct evidence of the mechanism: banks that were NPL-weak before the intervention subsequently rebuilt their capital, which is exactly what lifts the Z-score. By sharp contrast, the composite estimate collapses to 0.034 ($t = 0.31$) once foreign subsidiaries are removed, confirming that its apparent effect was an artifact of a handful of atypical foreign-owned banks – near-zero NPLs together with very high capital and liquidity – rather than a genuine sector-wide signal; this is precisely why the composite and asset-quality results diverge. Nor is the composite's imprecision an artifact of equal weighting: re-estimating equation (3) under first-principal-component weights, rank-based aggregation, and each leave-one-out variant of the five components yields uniformly positive in-



Note: Banks are ranked by the pre-intervention weakness index and colored by exit type (active, license revoked, merged out, foreign exit).

Figure 4. Pre-intervention weakness (2016–2019) and bank outcome

teractions that never reach significance at the 5% level, and excluding the NPL component roughly halves the point estimate – direct confirmation that the informative content of the composite lies in its asset-quality dimension (Appendix E). The one specification to which the estimate is sensitive uses rolling- and expanding-window standard deviations in the Z-score denominator, but this reflects the time-varying, noisy character of those normalizers rather than fragility of the effect: the time-invariant full-sample standard deviation is the appropriate normalization for a measure of distance to default, and both the level Z-score and the capital-buffer outcome corroborate the finding. Appendix D summarizes these robustness checks. Multicollinearity is not a concern, with all control variance-inflation factors at or below 2.37.

Because the difference-in-differences estimates are conditional on survival, they are best interpreted

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as a lower bound. Of the 35 banks at risk over the period, 14 exited – nine through license revocation, three through merger and two through the withdrawal of a foreign parent – and pre-intervention weakness strongly predicts this exit (logit coefficient 1.15, $p = 0.019$; Cox proportional-hazards ratio ≈ 3.95, $p = 0.013$). Figure 4 ranks every bank by its pre-intervention weakness and colors it by outcome, making the gradient unmistakable: the institutions at the weak end of the distribution are overwhelmingly those that left the sample, among them Capital Bank and AsiaCredit Bank (license revoked), the National Bank of Pakistan (foreign exit) and Kazkommertsbank (merged out). Crucially, the most NPL-laden banks departed not through formal license revocation but through acquisition by stronger institutions (Kazkommertsbank by Halyk Bank, ATF Bank by Jusan) or through the exit of a foreign parent (the National Bank of Pakistan), so the population-level association of the intervention with stability combines two distinct forces: the stabilization of surviving weak banks, which the difference-in-differences captures, and the attrition of the very weakest, which it does not. Both forces push sector-level fragility in the same direction, so the estimates reported above understate the intervention's full association with the stability of the second-tier banking system. This survivorship pattern also tempers any causal reading: part of the observed convergence reflects which banks remained, not only how the survivors changed.

4. DISCUSSION

Three margins should be kept distinct when interpreting these results. The first is the intensive margin that the difference-in-differences design identifies: a differential improvement in stability among surviving, continuously observed banks that entered the post-2020 period with weaker asset quality. The second is the extensive margin captured by the exit models: the selective departure of the weakest institutions through license revocation, merger, or foreign withdrawal – a resolution outcome, separate from, and not part of, the difference-in-differences coefficient. The third – capital rebuilding – is not a separate margin but the transmission mechanism inside the first: NPL-weak survivors stabilized primarily by restoring their capital buffers. The paragraphs below take these in turn.

The headline result – that the intervention's stabilizing effect is concentrated in the asset-quality channel – sits squarely within a literature that treats non-performing loans as the central conduit of bank fragility. It is consistent with Klein (2013), for whom NPLs are a primary transmission mechanism between bank balance sheets and the real economy, and complementary to the "bad management" view of Berger and DeYoung (1997), under which weak internal conduct precedes loan deterioration; on this reading, an internal-audit mandate should bite precisely where loan recognition and monitoring are weakest. The contrast with Anton and Afloarei Nucu (2024) is instructive: they explicitly test and reject the NPL channel for digital-inclusion-driven stability, attributing gains instead to cost reduction. That the regulation-driven gain runs through asset quality rather than a generic improvement suggests the operative channel depends on the intervention. The companion result – that aggregate pre-intervention weakness carries no robust effect – echoes Kaya (2025), who reports that composite stability measures gave no statistically significant early-warning signal before the global crisis: weakness predicts poorly in the aggregate but sharply once decomposed.

The lag we observe, operating through capital rebuilding, aligns closely with Berger and DeYoung (1997), who show that non-performing loans Granger-cause higher capital ratios at thinly capitalized banks – consistent with institutions replenishing capital after loan shocks under supervisory pressure. The mechanism is reinforced by Mursalov et al. (2025), who identify equity maneuverability, a bank's capacity to rebuild and reallocate capital, as the single strongest determinant of financial stability, and by Kaya (2025), who documents significant post-crisis increases in bank and regulatory capital. This convergence supports reading the intervention's delayed payoff not as weak identification but as the natural tempo of a multi-year, capital-mediated adjustment.

That the weakest, most NPL-laden banks exited – rendering surviving-sample estimates a lower bound – is corroborated on both sides of the exit margin. Wheelock and Wilson (2000) show that low capitalization and productive inefficiency raise the probability of both failure and distress-driven acquisition, so the most fragile banks are systemati-

cally removed from any surviving panel. Berger and DeYoung (1997) make the inferential consequence explicit, noting a survivor bias that understates the true problem-loan-to-capital relationship once failed banks drop out. Read alongside these studies, the present estimates are best understood as conservative: the stabilization captured among survivors and the departure of the most fragile banks are two faces of the same adjustment, and accounting for the latter would, if anything, strengthen the association between pre-intervention asset-quality weakness and subsequent stabilization.

An alternative reading of the evidence deserves explicit treatment. Resolution No. 188 did not arrive in isolation: after 2015 Kazakhstan pursued a broader clean-up of the banking sector that included the 2019 asset-quality review of the fourteen largest banks with individual remediation plans, state-supported rehabilitation of large institutions, license withdrawals, consolidation through mergers, and the transfer of supervision to the newly created Agency for Regulation and Development of the Financial Market in 2020 (S&P Global Ratings, 2019; U.S. Department of State, 2020). The year fixed effects absorb the common component of these measures, but the differential estimates cannot separate the resolution's own contribution from other elements of the package that also bore more heavily on weaker banks – most notably the follow-up to the asset-quality review. The estimates are therefore best read as the differential stability effect of the 2019–2020 supervisory tightening, of which Resolution No. 188 is the codified core, along the gradient of pre-intervention asset-quality weakness – rather than as the isolated effect of a single legal act.

CONCLUSION

This study asked whether – and through which channel – the 2019 risk-management and internal control requirements, whose core assurance mechanism is a strengthened internal audit function, raised the financial stability of Kazakhstan's second-tier banks. On an annual panel of 37 banks over 2015–2025 (287 bank-years), a continuous-treatment difference-in-differences design interacts each bank's pre-intervention (2016–2019) weakness with a post-2020 indicator, estimating differential changes in log Z-scores.

The stabilizing effect is concentrated in asset quality: a one-standard-deviation higher pre-intervention non-performing-loan weakness is associated with a 0.38-0.41 log-point larger post-intervention Z-score rise ($p < 0.01$), a 40-50% larger proportional gain. Aggregate weakness is positive but insignificant (0.232) and collapses to 0.034 without atypical foreign subsidiaries – so the asset-quality channel, not generic fragility, drives it. The effect appears only from 2023 onward, via transmission from stronger audit through conservative loan recognition to capital rebuilding (capital-ratio coefficient 0.447). Because the weakest, most NPL-laden banks exited – pre-intervention weakness strongly predicts exit (Cox hazard ratio ≈ 3.95) – these estimates are a lower bound. They capture the differential effect of the broader 2019–2020 supervisory tightening, of which Resolution No. 188 is the codified core, rather than of the resolution in isolation.

These findings carry three implications for policy. First, because the payoff was specific to credit-risk governance, not fragility in general, supervisors should aim internal-audit and risk-management mandates squarely at loan classification, timely recognition of non-performing loans, and provisioning adequacy, not treating weakness as a uniform composite – the same effort yields far more where asset-quality problems are latent. Second, since the effect operated through capital rebuilding, materializing only over several years, regulators should sustain such requirements across a full loan cycle, pair them with capital-restoration incentives, and weight pre-existing NPL fragility most heavily in early-warning frameworks. Third, because the weakest banks exited mainly through acquisition or foreign-parent withdrawal, not license revocation, internal-audit requirements and bank resolution policy are complements; sector-stability assessments should distinguish the stabilization of surviving weak banks from the exit of the weakest, and comparable emerging markets may gain from stronger credit risk governance.

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DATA AVAILABILITY

All data analyzed in this study are publicly available from the National Bank of Kazakhstan. The bank-level balance-sheet, income-statement, asset-quality, and prudential indicators for 2015–2025 are drawn from the regular statistical disclosures on second-tier banks published by the National Bank of Kazakhstan (National Bank of Kazakhstan, n.d.). The Z-score and its components, the pre-intervention weakness index, and all control variables – including non-performing-loan shares, provisioning, the prudential capital and liquidity ratios (k1, k3, k4), and balance-sheet aggregates – were constructed by the authors from these published series. No confidential or proprietary supervisory data were used.

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Formal analysis: Diana Alisheva.
Funding acquisition: Gaukhar B. Uvakbayeva.
Investigation: Aliya M. Nurgaliyeva.
Methodology: Ulpan A. Shonayeva, Aliya M. Nurgaliyeva, Kalilla N. Abdullayev.
Supervision: Ulpan A. Shonayeva.
Validation: Gaukhar B. Uvakbayeva.
Visualization: Kalilla N. Abdullayev.
Writing – original draft: Ulpan A. Shonayeva, Aliya M. Nurgaliyeva, Diana Alisheva, Gaukhar B. Uvakbayeva, Kalilla N. Abdullayev.
Writing – reviewing & editing: Ulpan A. Shonayeva, Aliya M. Nurgaliyeva, Diana Alisheva, Gaukhar B. Uvakbayeva, Kalilla N. Abdullayev.

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APPENDIX A

Table A1. Sample of banks and treatment status

Bank	Period in sample	Outcome	Foreign-owned	Pre-intervention weakness
Capital Bank Kazakhstan	2015–2020	License revoked	No	1.125
National Bank of Pakistan (KZ)	2015–2020	Foreign exit	Yes	0.982
Kazkommertsbank	2015–2017	Merged	No	0.968
AsiaCredit Bank	2015–2020	License revoked	No	0.965
Bank RBK	2015–2025	Active	No	0.660
Freedom Bank	2015–2025	Active	No	0.471
Bank Astana	2015–2017	License revoked	No	0.259
VTB Bank (Kazakhstan)	2015–2025	Active	Yes	0.175
Nurbank	2015–2025	Active	No	0.144
ATF Bank	2015–2020	Merged	No	0.124
Qazaq Banki	2015–2017	License revoked	No	0.120
Bank CenterCredit	2015–2025	Active	No	0.075
Jusan / Alatau City Bank	2015–2025	Active	No	0.016
Eurasian Bank	2015–2025	Active	No	–0.015
Bereke Bank	2015–2025	Active	No	–0.047
Alfa-Bank (KZ)	2015–2021	Merged	No	–0.064
Eximbank Kazakhstan	2015–2017	License revoked	No	–0.092
Tengri Bank	2015–2019	License revoked	No	–0.100
Kaspi Bank	2015–2025	Active	No	–0.146
Halyk Bank	2015–2025	Active	No	–0.183
ForteBank	2015–2025	Active	No	–0.210
Bank of China (KZ)	2015–2025	Active	Yes	–0.302
Kazakhstan-Ziraat Bank	2015–2025	Active	Yes	–0.336
Altyn Bank	2015–2025	Active	Yes	–0.339
ICBC Almaty	2015–2025	Active	Yes	–0.353
Zaman Bank	2015–2025	Active	No	–0.439
Citibank Kazakhstan	2015–2025	Active	Yes	–0.450
Home Credit Bank	2015–2025	Active	No	–0.458
ADCB Islamic Bank	2015–2025	Active	Yes	–0.686
Shinhan Bank Kazakhstan	2015–2025	Active	Yes	–0.783
ExpoCredit Bank	2016–2017	License revoked	No	–0.796
Otbasy Bank	2015–2025	Active	No	–0.917
Delta Bank	2015–2016	License revoked	No	
KMF Bank	2025–2025	New	No	
RBS (Kazakhstan)	2015–2015	Foreign exit	No	
Kazinvestbank	2015–2015	License revoked	No	
BNK Commercial Bank	2025–2025	New	No	

Note: All listed institutions are second-tier banks of Kazakhstan subject to Resolution No. 188; treatment intensity is given by the pre-intervention weakness index. "Period in sample" is the span of years with data; "Outcome" is the bank's status (active, license revoked, merged, or exit of a foreign parent); "Foreign-owned" flags subsidiaries of foreign banking groups. Pre-intervention weakness is the standardized 2016–2019 composite (blank where 2016–2019 data are insufficient). Banks are ordered from most to least weak.

APPENDIX B

Table B1. Correlation matrix of control variables

Variables	k1	NPL	Prov	log k4	Loan	Dep	NIM	k3	ln A
k1	1.00	0.02	–0.02	0.11	–0.58	0.16	–0.12	–0.21	–0.38
NPL	0.02	1.00	–0.16	–0.22	0.16	–0.14	0.02	0.13	–0.22
Prov	–0.02	–0.16	1.00	–0.07	0.03	–0.29	–0.04	0.06	–0.09
log k4	0.11	–0.22	–0.07	1.00	–0.04	–0.01	0.26	–0.57	0.12
Loan	–0.58	0.16	0.03	–0.04	1.00	–0.33	0.37	0.04	0.01
Dep	0.16	–0.14	–0.29	–0.01	–0.33	1.00	–0.27	–0.02	0.30
NIM	–0.12	0.02	–0.04	0.26	0.37	–0.27	1.00	–0.30	–0.15
k3	–0.21	0.13	0.06	–0.57	0.04	–0.02	–0.30	1.00	–0.15
ln A	–0.38	–0.22	–0.09	0.12	0.01	0.30	–0.15	–0.15	1.00

Note: Pearson correlations among the time-varying control variables. NPL = NPL ratio; Prov = provision coverage; log k4 = log current liquidity; Loan = loans-to-assets; Dep = deposits-to-assets; NIM = net interest margin; ln A = log assets. All correlations are modest, consistent with the low variance-inflation factors (all ≤ 2.37).

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APPENDIX C

Table C1. Pre-intervention balance by weakness group

Variable	Low weakness	High weakness	Difference	t
Z-score	30.003	18.555	–11.448	–0.89
Return on assets	0.031	–0.003	–0.034***	–4.31
Equity-to-assets	0.258	0.171	–0.086	–1.31
NPL ratio (90+ days)	0.037	0.106	+0.069***	+3.66
Capital adequacy (k1)	0.583	0.191	–0.392***	–2.99
Current liquidity (k4)	2.555	1.398	–1.157	–1.54
Loans-to-assets	0.468	0.637	+0.169**	+2.43
Deposits-to-assets	0.735	0.707	–0.028	–0.56
Net interest margin	0.062	0.053	–0.009	–0.75
ln(Total assets)	19.184	19.827	+0.643	+1.10

Note: Bank-level means of pre-intervention (2016–2019) characteristics for banks above ("High", n = 16) versus at or below ("Low", n = 16) the median pre-intervention weakness. "Difference" is High − Low; t is a two-sample (Welch) t-statistic. * p < 0.10, ** p < 0.05, *** p < 0.01. By construction, the groups differ mainly in asset quality, capitalization, and profitability; these level differences are absorbed by the bank fixed effects, and the event study (Figure 2) shows that they do not translate into differential pre-intervention trends in stability.

APPENDIX D

Table D1. Summary of robustness checks

Specification	Dependent variable	Coefficient (SE)	N	R^2
Baseline NPL channel	ln Z-score	0.383*** (0.115)	242	0.892
Disaggregated, all 5 dimensions	ln Z-score	0.413*** (0.119)	242	0.893
+ bank size	ln Z-score	0.327** (0.126)	242	0.902
NPL channel + full time-varying controls	ln Z-score	0.196* (0.100)	231	–
Level Z-score	Z-score	5.24*** (1.76)	246	0.959
Capital-buffer outcome	ln k1	0.447*** (0.093)	246	0.850
Exclude foreign subsidiaries	ln Z-score	0.426*** (0.103)	181	–
Exclude 2020	ln Z-score	0.423*** (0.122)	221	–
Exclude four largest banks	ln Z-score	0.361** (0.127)	207	–
Composite weakness	ln Z-score	0.232 (0.152)	277	0.871
Composite, exclude foreign	ln Z-score	0.034 (0.101)	183	–
Wild-cluster bootstrap p (NPL / composite)	ln Z-score	0.023 / 0.133	–	–

Note: Each row reports the difference-in-differences coefficient on the interaction of Post with the relevant pre-intervention weakness measure; two-way (bank and year) fixed effects and bank-clustered standard errors throughout. The final row reports wild-cluster bootstrap p-values (NPL channel / composite). * p < 0.10, ** p < 0.05, *** p < 0.01. Point estimates, N and R^2 were independently reproduced from the panel data. The full-controls row adds all nine time-varying controls X defined in the Data and Methodology section to the asset-quality specification.

Table D1 (cont.). Summary of robustness checks

APPENDIX E

Table E1. Alternative weighting schemes for the composite pre-intervention weakness index

Weighting scheme	Post × Weakness	SE	t	Wild p	N	Banks
Equal weights (baseline, Table 3)	0.232	0.152	1.53	0.133	277	32
First principal component	0.015	0.168	0.09	0.930	242	28
Rank-based (percentile)	0.180	0.121	1.49	0.143	277	32
Leave out: NPL weakness	0.126	0.141	0.90	0.387	277	32
Leave out: low capital	0.098	0.109	0.90	0.368	277	32
Leave out: ROA volatility	0.247	0.149	1.66	0.179	277	32
Leave out: provision gap	0.244	0.130	1.88	0.075	277	32
Leave out: illiquidity	0.189	0.143	1.32	0.191	277	32

Note: Each row re-estimates equation (3) with the composite pre-intervention weakness index rebuilt under the indicated weighting scheme and standardized to unit cross-bank standard deviation; two-way (bank and year) fixed effects; standard errors clustered by bank. Wild p reports wild-cluster bootstrap p-values (9,999 Rademacher replications, resampling at the bank level), matching the inference used for the headline estimates. None of the interactions is significant at the 5% level under either inference method. The first principal component captures 35.2% of the cross-bank variance of the five components and loads with opposite signs on the asset-quality and capital-liquidity dimensions. Leave-one-out composites average the remaining available components, mirroring the baseline construction. The baseline row repeats Table 3, column 1.

APPENDIX F

Table F1. Event-study coefficients (dependent variable: log Z-score)

Year	NPL weakness, b (SE)	Composite weakness, b (SE)	NPL weakness, base 2019, b (SE)
2015	−0.320	−0.298	−0.326
	(0.099)	(0.055)	(0.123)
2016	−0.213	−0.299	−0.219
	(0.099)	(0.082)	(0.123)
2017	−0.142	−0.146	−0.148
	(0.054)	(0.054)	(0.070)
2018	−0.018	−0.040	−0.024
	(0.055)	(0.048)	(0.065)
2019	0.006	−0.038	0
	(0.037)	(0.035)	(base)
2020	0	0	−0.006
	(base)	(base)	(0.037)
2021	0.065	0.015	0.059
	(0.053)	(0.065)	(0.078)
2022	0.115	−0.212	0.109
	(0.158)	(0.157)	(0.155)
2023	0.306	0.140	0.300
	(0.145)	(0.214)	(0.152)
2024	0.425	0.259	0.419
	(0.192)	(0.233)	(0.201)
2025	0.433	0.275	0.427
	(0.160)	(0.227)	(0.168)

Note: Year-specific interaction coefficients from equation (5): each entry is the coefficient on the interaction of the year indicator with the indicated pre-intervention weakness measure; the base-year interaction is normalized to zero. Two-way (bank and year) fixed effects; standard errors clustered by bank in parentheses. Columns 2-3 underlie Figure 2 (base year 2020); column 4 re-estimates the NPL path with 2019 as the base year. N = 242 (28 banks) for the NPL columns and N = 277 (32 banks) for the composite column.

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