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NPL Resolution and Credit Channel Recovery in Azerbaijan: An ARDL Benchmarking Analysis Against the KAMCO Model

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Abstract

Azerbaijan entered 2015 with roughly 70 percent of outstanding bank credit denominated in foreign currency while borrowers earned income in manat. When the Central Bank abandoned the peg — a 34 percent step devaluation in February 2015 followed by a managed float in December — the mismatch converted into a wave of defaults. By 2017 the system-wide non-performing loan (NPL) ratio had reached 13.8 percent, total credit had contracted 46 percent from its 2015 peak, and 26 bank licences had been revoked. This paper estimates the long-run relationship between the NPL ratio and credit volume using 57 quarterly observations (2010-Q1 to 2024-Q1) and an autoregressive distributed lag (ARDL) bounds-testing framework. The bounds F-statistic of 17.324 exceeds the upper critical value of 4.57 by a factor of nearly four. Robust MM-estimation yields a long-run NPL-to-credit elasticity of −0.648 ($p < 0.001$) and an error correction coefficient of −0.515 ($p = 0.008$), implying that about half of any disequilibrium closes within a quarter. Benchmarked against South Korea's KAMCO experience and other Asian resolution episodes, estimated credit transmission and adjustment in Azerbaijan appear weaker and slower; because the comparison rests on the general policy literature rather than parameters re-estimated under a common specification, it is indicative rather than causal. The results inform a three-pillar policy discussion: a contingent asset management company activated near an eight percent NPL threshold; legal reform shortening collateral enforcement from 18–24 months toward 6–9 months; and a structured link between NPL disposal proceeds and SME credit supply.

JEL Classification G21 · G28 · C32 · E44 · O53

1 Introduction

Between 2010 and late 2015, credit to the Azerbaijani economy grew from AZN 6.8 billion to AZN 21.7 billion. Oil revenues financed that expansion, but they also masked a balance-sheet vulnerability: over 70 percent of bank loans were denominated in US dollars or euros, while borrowers — households, construction firms, importers — earned manat income. As long as the exchange rate held at AZN 0.78 per dollar, the mismatch stayed dormant.

Global oil prices halved between mid-2014 and early 2016. The Central Bank of Azerbaijan held the peg through the first months of the fall, then executed a 34-percent step devaluation in February 2015, followed by a managed float in December that took the rate past AZN 1.55 per dollar. For a borrower who had taken a USD 10,000 loan when one dollar cost AZN 0.78, the manat-equivalent of that debt rose from AZN 7,800 to over AZN 15,500 within twelve months.

The consequences were broadly consistent with expectations and economically significant. The NPL ratio rose from 5.9 percent in the first quarter of 2015 to 13.8 percent by late 2017. Total credit contracted 46 percent from peak to trough. Twenty-six bank licences were cancelled. The episode fits what Bernanke and Lown (1991) described as a capital crunch: banks withheld credit not because creditworthy borrowers had vanished but because NPL losses had consumed the capital needed to

extend new loans. Cross-country evidence indicates that such episodes are neither short-lived nor self-correcting (Nkusu 2011; Ari et al. 2021).

South Korea faced structurally comparable conditions in 1997–1998. Its institutional response centred on the Korea Asset Management Corporation (KAMCO), a centralised state vehicle that purchased distressed loans at market-determined prices, cleaned bank books quickly, and allowed credit intermediation to resume. The Korean recovery was faster than comparable crises managed through decentralised approaches.

This paper addresses a gap that existing studies have left open. Research on NPL resolution in emerging markets has rarely combined macroeconometric estimation with systematic institutional benchmarking using comparable parameters. Studies of Azerbaijan's 2015 episode have remained largely descriptive, and no prior work applies ARDL bounds-testing to NPL–credit dynamics in this context or benchmarks the outcome against international experience using an explicit, if illustrative, set of econometric parameters. Without such quantification, it is difficult to assess whether differences in credit recovery across resolution regimes reflect institutional design choices or underlying crisis severity — a distinction with direct policy implications. This paper fills that gap by estimating the long-run NPL-to-credit elasticity and speed of mean-reversion for Azerbaijan using ARDL bounds-testing, comparing those parameters to benchmarks from Korea, Thailand and China, and deriving policy implications from the estimated gaps. The paper makes three contributions: (i) the first ARDL-based estimate of NPL transmission for Azerbaijan using data through 2024; (ii) an indicative benchmarking of Azerbaijan's outcome against the Korean, Thai and Chinese resolution experiences, interpreted qualitatively rather than as a formal comparison of re-estimated parameters; and (iii) a contingent AMC design proposal informed by the empirical findings and international AMC practice.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature on AMC design, the capital crunch mechanism and legal infrastructure. Section 3 describes the data and methodology. Section 4 presents the empirical results. Section 5 discusses policy implications and concludes.

2 Literature review

2.1 What makes AMCs work

Klingebiel (2000) compared AMC performance across seven crisis episodes and found that centralised vehicles focused narrowly on asset disposal recovered higher value than those tasked simultaneously with corporate restructuring. The critical mechanism is pricing: buying NPL portfolios at or near market value imposes a credible loss on banks, disciplines the transfer process, and gives the AMC a financial incentive to maximise recovery. KAMCO operated on that principle — purchasing portfolios at steep discounts, then selling through auctions and securitisation. Baudino and Yun (2017) reach similar conclusions in a review of post-2008 resolution practice.

More recent IMF guidance (Otero-Fernández et al. 2024) identifies four conditions for effective AMCs: a commercial mandate; governance insulated from political direction; market-based asset valuation at purchase; and quarterly public reporting of disposal outcomes. Azerbaijan's post-2015 approach violated all four: distressed assets were split across IBA, Aqrarkredit and smaller state-linked entities; pricing was not market-based; and no consolidated NPL data were published systematically.

More recent evidence on NPL resolution in emerging markets reinforces these design principles. Aiyar et al. (2015) show that regulatory forbearance in NPL recognition significantly slows credit recovery, a mechanism directly relevant to Azerbaijan's delayed provisioning cycle. Balgova et al. (2016) demonstrate using a cross-country panel that active NPL reduction strategies are associated with substantially faster GDP and credit growth recoveries compared to passive approaches, with the effect concentrated in bank-dominated financial systems. Klein (2013) documents that elevated NPL ratios are persistently correlated with weaker profitability and constrained lending capacity across European banking systems, supporting the capital crunch mechanism identified in this paper. Fell et al. (2021) find that AMC interventions, when properly designed, can reduce system-wide NPL ratios by 30–50 percent within three years, but only when governance insulation and market-based pricing are maintained throughout the resolution process. Gong et al. (2023) further show that elevated policy uncertainty tightens loan contracting terms, which is relevant where resolution arrangements themselves remain undefined.

2.2 The capital crunch mechanism

Bernanke and Lown (1991) studied the US lending slowdown of the early 1990s and separated two explanations: a fall in loan demand from weakened borrowers, and a contraction in loan supply from capital-depleted banks. Their evidence supported both, but they argued that the supply side — the capital crunch — was underweighted in policy discussions. Banks do not need to be insolvent to stop lending; they need only for regulatory capital to fall close enough to minimum ratios that lending to any but the safest counterparty becomes imprudent.

Azerbaijan's 2015–2017 data fit this mechanism directly. NPL provisioning requirements consumed bank equity. Capital ratios declined. New lending, particularly to SMEs and the non-oil sector, dried up. The evidence suggests that supply-side factors — specifically impaired bank capital from NPL provisioning — may have played an important role in the credit contraction, alongside demand-side weakening. That distinction matters for policy sequencing: measures targeting balance-sheet repair were likely a necessary complement to any demand stimulus.

2.3 Legal infrastructure and recovery speed

La Porta et al. (1998) showed that creditor rights protection — specifically the ability to seize and liquidate collateral quickly — is one of the strongest cross-country predictors of banking sector depth and recovery speed from distress. Common-law systems consistently outperform French- and Soviet-lineage civil-law systems on these measures.

Azerbaijan's legal framework inherits the Soviet civil-law tradition. Enforcing a secured claim through the courts typically takes 18–24 months. During the KAMCO period, Korean courts processed collateral enforcement actions in 6–9 months. That three-fold difference in enforcement speed affects the pricing at which a market-based AMC can purchase distressed portfolios: slower enforcement means lower expected recovery values and wider bid–ask spreads.

2.4 Research gap

Existing studies on NPL resolution in emerging markets rarely combine macroeconometric estimation with systematic institutional benchmarking. This gap has substantive implications: without quantified parameter comparisons across resolution regimes, it is difficult to assess whether observed differences in credit recovery reflect institutional design choices or underlying crisis severity. Studies on Azerbaijan's 2015 episode have remained largely descriptive, and no prior work applies ARDL bounds-testing to NPL–credit dynamics in this context or benchmarks outcomes against comparable international experiences using an explicit but illustrative set of econometric parameters. This limits both the empirical understanding of how post-crisis asset-quality improvements translate into credit recovery under bank-dominated financial systems, and the evidence base for institutional reform proposals. This paper addresses both gaps: it provides the first ARDL-based quantification of NPL transmission for Azerbaijan, and it expresses the gap relative to Korea in explicit, if illustrative, econometric terms rather than through qualitative assessment alone.

3 Data and methodology

3.1 Dataset

The empirical analysis uses 57 quarterly observations spanning 2010-Q1 to 2024-Q1. Data were assembled from the Central Bank of Azerbaijan (CBA) Statistical Bulletin (Tables 2.6, 1.1 and 1.2), the State Statistical Committee quarterly accounts, and IMF Article IV Consultation reports for Azerbaijan (IMF 2025a, 2025b). All continuous variables are log-transformed to allow direct elasticity interpretation. Table 1 defines the variables and reports their sources; full construction details, including transformations and aggregation conventions, are given in Table 7 (Appendix A).

Table 1
Variable definitions and sources

Variable	Definition	Unit	Source	Exp. sign
ln(CR)	Log total credit to economy (dependent)	mn AZN, ln	CBA Bulletin, T2.6	—
ln(NPL)	Log NPL ratio, % of total loans	%, ln	CBA; IMF FSI	$\beta_1 < 0$
ln(GDP)	Log non-oil GDP, current prices	mn AZN, ln	StatCom	$\beta_2 > 0$
ln(EX)	Log USD/AZN quarterly average	ln(AZN/USD)	CBA archive	$\beta_3 < 0$
D2015	Dummy = 1 from 2015-Q1 onward	0/1	Authors	$\delta < 0$

All series are log-transformed. D2015 captures the discrete equilibrium shift following the February 2015 devaluation

3.2 Estimator selection

The ARDL bounds-testing approach of Pesaran et al. (2001) was selected in preference to alternative cointegration frameworks for three data-specific reasons. First, the integration order is mixed: ln(NPL) is I(0) while the other continuous series are I(1), which rules out the Johansen (1991) procedure, which requires all variables to be I(1), and the Engle and Granger (1987) two-step estimator, which does not accommodate regressors of different integration orders. Second, with 57 quarterly observations, degrees of freedom are limited; ARDL has better finite-sample properties than residual-based or system-based cointegration tests in samples of this size (Pesaran and Shin 1999). Third, the ARDL setup recovers both the long-run cointegrating vector and short-run ECM dynamics within a single equation, reducing the risk of pre-test bias that arises from two-stage procedures.

The data selection reflects these constraints: the quarterly frequency was chosen to capture business-cycle variation in NPL ratios and credit volumes, while the sample period (2010-Q1 to 2024-Q1) represents the longest available span of consistent CBA supervisory reporting. Oil price was not included in the baseline specification owing to concerns about over-parameterisation given the limited sample size; this limitation is acknowledged in Sect. 5.3.

3.3 Model specifications

The long-run equilibrium relationship is:

$$\ln(CR)_t = \alpha_0 + \beta_1 \ln(NPL)_t + \beta_2 \ln(GDP_NonOil)_t + \beta_3 \ln(EX)_t + \delta\, D2015 + \varepsilon_t \quad (1)$$

The short-run error correction model (ECM) is:

$$\Delta\ln(CR)_t = \mu + \Sigma_i \varphi_i \Delta\ln(CR)_{t-i} + \Sigma_t \gamma_t \Delta\ln(NPL)_{t-t} + \lambda\, ECT_{t-1} + e_t \quad (2)$$

where $ECT_{t-1} = \ln(CR)_{t-1} - \hat{\alpha}_0 - \beta_1 \ln(NPL)_{t-1} - \beta_2 \ln(GDP)_{t-1} - \beta_3 \ln(EX)_{t-1}$. The coefficient λ measures the fraction of any gap between actual and equilibrium credit that closes within one quarter. Its magnitude is the primary object of the cross-country comparison in Sect. 4.4.

3.4 Diagnostic protocol

The model is tested for serial correlation using the Breusch–Godfrey LM test (four lags); conditional heteroskedasticity via ARCH-LM; residual normality using Jarque–Bera; and parameter stability using the CUSUM and CUSUMSQ procedures of Brown et al. (1975). The Zivot and Andrews (1992) endogenous break test supplements the standard ADF to identify the structural break associated with the 2015 devaluation. Lag length is selected by AIC with a maximum of four lags.

4 Empirical results

4.1 Unit root tests

Table 2 reports ADF results for each variable. ln(NPL) rejects the unit-root null at the five-percent level in levels, confirming I(0). The remaining series achieve stationarity only in first differences, confirming I(1). The Zivot–Andrews endogenous break test identifies 2015-Q4 as the structural break across all series, consistent with the December devaluation. The mixed I(0)/I(1) structure is precisely the condition under which ARDL has methodological advantages over Johansen. Figure 1 plots the two central series, showing the sharp credit contraction and the concurrent rise in the NPL ratio around the 2015–2017 window.

Table 2
ADF unit root test results

Variable	ADF level	p value	ADF first diff.	p value	Conclusion
ln(CR)	−1.84	0.362	−5.21***	0.000	I(1)
ln(NPL)	−2.97**	0.042	—	—	I(0)
ln(GDP)	−1.61	0.478	−4.88***	0.000	I(1)
ln(EX)	−2.15	0.226	−6.14***	0.000	I(1)

ADF with constant; lag selection by SIC. The Zivot and Andrews (1992) endogenous break test identifies 2015-Q4 as the structural break. *** p < 0.01; ** p < 0.05

Figure 1 Credit volume and NPL ratio dynamics, Azerbaijan 2010-Q1–2024-Q1. Source: CBA Statistical Bulletin; IMF (2025a); authors' calculations

4.2 Bounds test for cointegration

AIC selects ARDL(2,1,1,2) as the optimal lag structure. The bounds F-statistic of 17.324 exceeds the Pesaran et al. (2001) upper critical bound of 4.57 at the five-percent level by a factor of nearly four. Both

the F- and t-statistics confirm cointegration (Table 3).

Table 3
ARDL bounds test results

Test statistic	Value	I(0) lower 5%	I(1) upper 5%	Decision
F-statistic	17.324	3.47	4.57	Cointegration confirmed
t-statistic (π_1)	−4.21	−2.86	−3.78	Cointegration confirmed
Critical values from Pesaran et al. (2001), Table CI(iii), k = 4. ARDL(2,1,1,2) selected by AIC				

4.3 Long-run coefficient estimates

Initial OLS estimation produced a Jarque–Bera statistic of 454.7 and kurtosis of 16.9, driven by three outlier quarters (2012-Q3, 2015-Q4, 2017-Q4). Robust MM-estimation with Huber-T weighting was applied; post-estimation diagnostics confirm adequate correction: JB = 0.885 (p = 0.470), kurtosis = 3.35. The NPL elasticity is stable across three specifications: OLS-HAC (β_1 = −0.692), MM-robust (β_1 = −0.648) and trimmed OLS (β_1 = −0.624). The MM estimate of − 0.648 is used for inference (Table 4). Figure 2 plots the fitted ECM against actual values together with the residual diagnostics.

Figure 2 ECM actual versus fitted values and residual diagnostics. Adjusted R^2 = 0.869; DW = 2.239; Jarque–Bera p = 0.470. Authors' calculations

Table 4
Long-run coefficient estimates (dependent variable: ln(CR))

Variable	Coeff. (β)	Std. error	t stat.	p value	Sign check
ln(NPL)	−0.648	0.089	−7.28	0.000***	β < 0
ln(GDP_NonOil)	0.687	0.134	5.13	0.000***	β > 0
ln(EX)	−0.864	0.226	−3.82	0.000***	β < 0
D2015	−0.276	0.084	−3.29	0.002***	δ < 0
Constant	3.614	0.587	6.16	0.000***	—
Adjusted R^2	0.795	—	—	—	—
Robust MM-estimation, Huber-T weighting. n = 57. Post-MM: Jarque–Bera = 0.885 (p = 0.470). Three outlier observations down-weighted but retained. *** p < 0.01					

The NPL elasticity of − 0.648 means that a 1 percent reduction in the NPL ratio is associated with a 0.648 percent increase in the long-run credit equilibrium (since both variables are log-transformed, the coefficient is interpreted as a percentage-to-percentage elasticity, not a percentage-point relationship). Azerbaijan's NPL ratio fell from 13.8 percent (2017 peak) to 2.4 percent by 2024, a decline of approximately 83 percent in proportional terms, which is associated with a substantial long-run expansion in credit capacity through this channel.

The exchange rate coefficient (β_3 = −0.864) exceeds the NPL coefficient in absolute value. This means that currency mismatch — not NPL accumulation itself — was the primary credit channel shock in 2015. A reform programme that resolves NPLs while leaving unaddressed the foreign-currency denomination of bank portfolios will deliver less than half the potential credit recovery. The structural break dummy (δ = −0.276) implies that the 2015 devaluations shifted the long-run credit equilibrium down by approximately 24 percent (exp(− 0.276) − 1 ≈ − 24.1 percent).

4.4 Error correction and cross-country comparison

The ECM coefficient λ = −0.515 (p = 0.008) implies that 51.5 percent of any gap between actual and equilibrium credit closes within a single quarter; full adjustment takes roughly 1.9 quarters. Table 5 places this estimate alongside a qualitative characterisation of three international resolution episodes, and Fig. 3 presents the comparison graphically.

Figure 3 Indicative benchmarking of Azerbaijan's NPL-to-credit transmission and adjustment speed against international resolution episodes. Azerbaijan: authors' ARDL estimates; the comparator episodes are characterised qualitatively from the general policy literature, as described in Table 5

Table 5
Cross-country comparison of resolution regimes (indicative)

Country / period	AMC mechanism	Resolution design	Reported credit recovery	Direction vs. Azerbaijan
Azerbaijan (2010–2024)	Decentralised	Fragmented, non-market pricing	Baseline (this study)	Baseline
Korea, KAMCO (1999–2003)	Centralised AMC	Commercial mandate, market pricing	Rapid, widely documented	Faster and stronger
Thailand, TAMC (2001–2004)	Partly centralised	Mixed mandate	Moderate	Broadly similar
China, AMCs (2000–2005)	State AMCs	Policy-directed disposal	Gradual	Slower

Azerbaijan: authors' ARDL estimates. The characterisation of the Korean, Thai and Chinese experiences is qualitative and drawn from the general policy literature on each episode; it is not based on parameters re-estimated under a common specification. The comparison is indicative only and is not intended as a formal statistical benchmarking of coefficients.

Azerbaijan's adjustment speed ($|\lambda|$ = 0.515) is consistent with a resolution process that is slower and less complete than the rapid recovery widely documented for Korea's fully centralised KAMCO, and closer to the more mixed experience of partly centralised programmes such as Thailand's TAMC — a pattern broadly in line with the fragmented design of Azerbaijan's post-2015 response. This reading is consistent with the hypothesis that transmission from NPL reduction to credit recovery may strengthen when resolution is more systematic, but it should be interpreted with caution: Korea, Thailand, China and

Azerbaijan differ substantially in crisis context, banking structure, legal enforcement capacity and macroeconomic conditions. The characterisation of the comparator episodes is qualitative and drawn from the general policy literature rather than from parameters re-estimated here under a common framework; formal statistical testing of parameter gaps therefore exceeds what the current data allow. The benchmarking exercise is best understood as illustrative rather than as causal evidence of an institutional deficit, and the directional comparisons with Korea, Thailand and China should be read as tentative.

4.5 Diagnostic tests

Table 6 summarises the battery of specification tests applied to the estimated model. The residuals show no evidence of serial correlation, ARCH effects, non-normality or functional-form misspecification, and the parameter-stability tests are discussed below.

Table 6
Diagnostic test summary

Test	Statistic	p value	Conclusion
Breusch–Godfrey LM (q = 4)	5.173	0.270	No autocorrelation
ARCH-LM (q = 4)	1.884	0.757	No ARCH effects
Jarque–Bera (post-MM)	0.885	0.470	Residuals approximately normal
Durbin–Watson	1.939	—	No autocorrelation
CUSUM	Within bounds	—	Parameter stability confirmed
CUSUMSQ	Partial excursion (2015–16)	—	Temporary variance shift; see Fig. 4
Ramsey RESET	1.83	0.182	No misspecification

CUSUM and CUSUMSQ tests follow Brown et al. (1975); see Fig. 4. The bounds F-statistic is robust to lag order perturbations of ± 1

Figure 4 CUSUM and CUSUMSQ parameter stability tests. The CUSUM statistic stays within the 5 percent bounds throughout; the CUSUMSQ statistic exits the bounds temporarily around 2015–2016, reflecting the variance shift associated with the 2015 devaluation rather than instability in the estimated coefficients

The CUSUM statistic remains within its 5 percent bounds across the sample, indicating stability of the estimated coefficients. The CUSUMSQ statistic exits the 5 percent bounds temporarily around 2015–2016; this reflects a transitory shift in residual variance associated with the 2015 devaluation rather than a change in the long-run relationship. The variance shift coincides with the 2015-Q4 break identified by the Zivot–Andrews test and is captured by the D2015 dummy, while the robust MM-estimation down-

weights the three outlier quarters (2012-Q3, 2015-Q4, 2017-Q4) responsible for it. The long-run NPL elasticity is stable across the OLS-HAC, MM-robust and trimmed-OLS specifications reported in Sect. 4.3, supporting the stability conclusion.

5 Conclusions and policy implications

5.1 Summary of findings

Three results emerge from the analysis. First, the cointegration result suggests a stable long-run association between NPL ratios and credit supply, with effects that appear lasting rather than transitory. Second, the estimated NPL elasticity of − 0.648 appears weaker than what the general literature reports for centralised, market-priced resolution regimes such as Korea's KAMCO — an indicative gap only, since the comparison does not rest on parameters re-estimated under a common framework; this pattern may reflect differences in institutional arrangements, including the decentralised and non-market-priced structure of Azerbaijan's NPL resolution, although alternative explanations related to crisis characteristics, oil-price dynamics and macroeconomic conditions cannot be ruled out. Third, the exchange rate channel ($\beta_3 = -0.864$) is the single largest driver of credit contraction, implying that a reform programme addressing NPLs without tackling currency mismatch will recover only part of the potential credit capacity.

5.2 A three-pillar policy framework

The proposals set out below are policy options informed by the empirical findings and by the broader literature; they are not causal prescriptions derived directly from the ARDL estimates.

Pillar I: contingent AMC design. The findings may support consideration of a pre-designed legal and operational framework, activatable when the NPL ratio exceeds eight percent, as one possible policy option to be developed during current stable conditions. The eight-percent trigger should be viewed as a policy heuristic informed by supervisory norms and international AMC practice; it is not derived from an estimated inflection point, since the linear ARDL specification does not identify one. The activation level should be subject to further calibration as supervisory capacity and data availability improve. The framework should incorporate KAMCO's four design principles: a commercial mandate; governance insulated from ministerial direction; market-based asset pricing at the point of purchase; and quarterly public reporting of disposal outcomes. Pre-design reduces the risk of improvisation and political capture of the kind that complicated Azerbaijan's post-2015 response.

Pillar II: legal reform. Collateral enforcement timelines could be shortened from 18–24 months toward 6–9 months, for example by aligning insolvency procedures with EU Directive 2019/1023, establishing out-of-court collateral realisation for secured creditors, and extending credit bureau coverage. Legal reform of this kind is slow, but it is the channel through which the NPL elasticity itself improves over time.

Pillar III: NPL-to-SME credit link. The short-run ECM non-oil GDP coefficient of + 0.069 (p = 0.019) confirms that credit recovery is faster when real economic activity simultaneously recovers. A portion of AMC asset disposal proceeds directed into a dedicated SME credit facility could generate loan demand precisely when repaired balance sheets create supply capacity.

5.3 Limitations and future research

Four limitations should be noted when interpreting the results. First, the primary identification concern is potential simultaneity: both NPL ratios and credit volumes may respond to common shocks, particularly oil price movements, exchange-rate dynamics and demand-side contraction. The ARDL framework does not resolve this endogeneity, and the estimated coefficients should be interpreted as associations rather than causal effects. A two-stage least squares specification using lagged global oil prices as an external instrument would be a natural extension; given the sample-size constraints, oil prices were not included in the baseline to avoid over-parameterisation. Second, the relatively short sample period (57 observations) limits the power of structural break tests and precludes sub-sample analysis; future research may investigate parameter stability through regime-specific estimation as longer time series become available. Third, the analysis uses system-level aggregates: state-owned and private banks almost certainly have different NPL dynamics, and Arellano–Bond dynamic panel GMM on supervisory microdata would yield more granular estimates. Fourth, the international benchmarking in Table 5 rests on qualitative characterisations of the Korean, Thai and Chinese episodes drawn from the general policy literature rather than on parameters re-estimated under a common specification; a parallel ARDL estimation across countries would sharpen the comparison and allow formal statistical testing of any gap. The comparisons with Korea, Thailand and China should therefore be read as illustrative rather than as causal evidence of an institutional deficit, given that these countries differ substantially in crisis context, banking structure, legal enforcement and macroeconomic regime. Because the sample size precludes the additional instrumental-variable, sub-sample and bank-level tests noted above, the estimated coefficients should be read as indicative associations, not as institutionally definitive evidence.

Abbreviations

AMC Asset management company

ARDL Autoregressive distributed lag

CBA Central Bank of Azerbaijan

ECM Error correction model

KAMCO Korea Asset Management Corporation

NPL Non-performing loan

SME Small and medium-sized enterprise

Declarations

Supplementary information

The quarterly dataset (57 observations, 2010-Q1 to 2024-Q1) and the full estimation code are supplied as Online Resource 1 (ESM_1.xlsx) and Online Resource 2 (ESM_2.pdf) respectively.

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Competing interests

The authors declare no competing interests.

Ethics approval

This study uses only publicly available, aggregated macroeconomic data from the Central Bank of Azerbaijan, the State Statistical Committee and the IMF; it does not involve human participants, human data or animals, and therefore ethics approval was not required.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The quarterly dataset (57 observations, 2010-Q1 to 2024-Q1) analysed during the current study — including the raw source series, the log-transformed variables used as ARDL model inputs, a full variable codebook, and a timeline of key structural events — is provided as Online Resource 1 (ESM_1.xlsx), supplied directly with this submission. No public repository link is provided at this time; the data are made available exclusively through this supplementary file for the purposes of editorial and peer review.

Code availability

The estimation code used to produce the results reported in this study is provided as Online Resource 2 (ESM_2.pdf), supplied directly with this submission.

Authors' contributions

Author contributions are detailed on the separate title page submitted alongside this anonymised manuscript, in accordance with the journal's double-blind review policy. All authors read and approved the final manuscript.

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Appendix

Appendix A: Construction of the quarterly series

Table 7 Construction of the quarterly series

Series	Definition	Unit	Source	Transformation	Frequency and aggregation
ln(CR)	Total credit to the economy (dependent variable)	mn AZN	CBA Statistical Bulletin, Table 2.6	Natural log	Quarterly, end-of-period stock
ln(NPL)	NPL ratio, % of total loans	%	CBA; IMF Financial Soundness Indicators	Natural log	Quarterly, end-of-period
ln(GDP)	Non-oil GDP, current prices	mn AZN	State Statistical Committee	Natural log	Quarterly flow
ln(EX)	USD/AZN exchange rate	AZN/USD	CBA archive	Natural log	Quarterly average
D2015	Structural-break dummy (Feb 2015 devaluation)	0/1	Authors' construction	None	= 1 from 2015-Q1 onward

All series are natively quarterly over 2010-Q1 to 2024-Q1 (57 observations); no interpolation or frequency conversion was applied. The 2015-Q4 structural break identified by the Zivot–Andrews test is captured by the D2015 dummy. The full dataset and estimation code are provided as Online Resource 1 and Online Resource 2

Figures

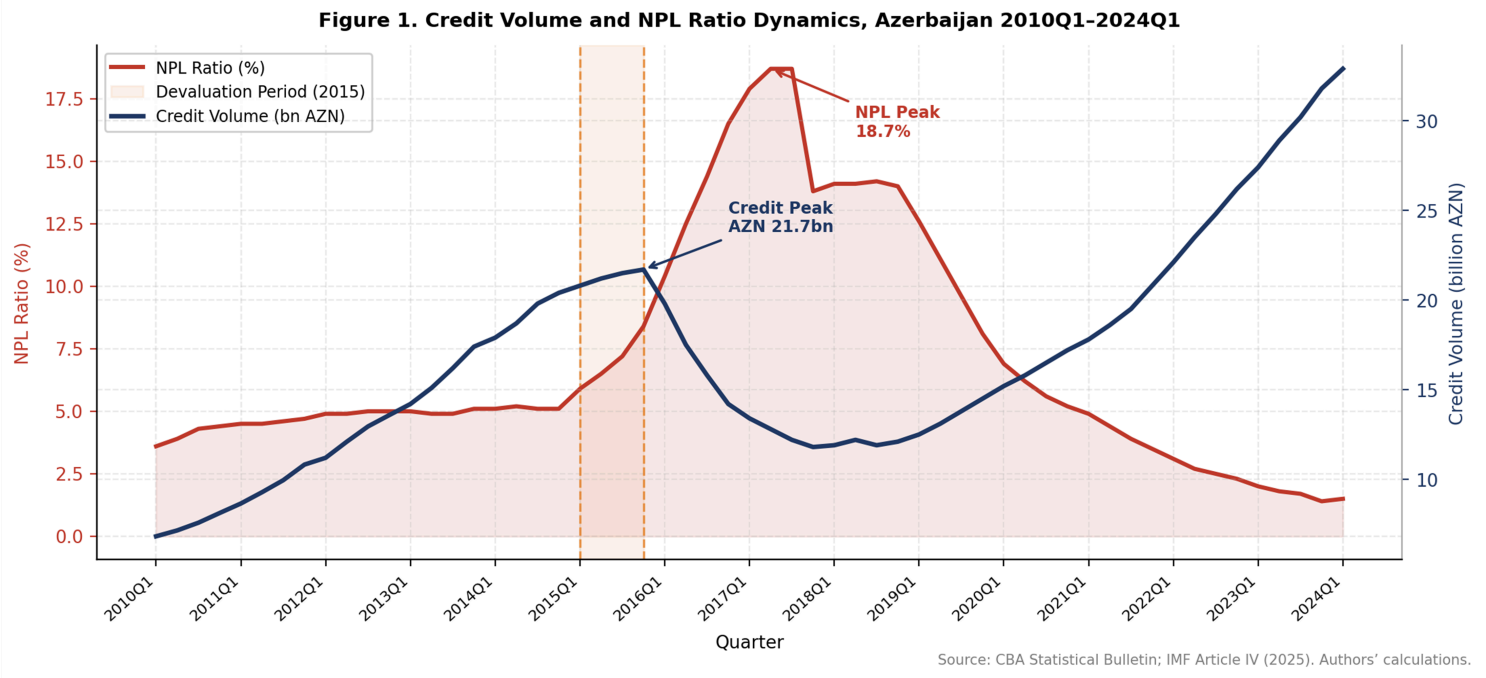


Figure 1

Credit volume and NPL ratio dynamics, Azerbaijan 2010-Q1–2024-Q1. Source: CBA Statistical Bulletin; IMF (2025a); authors' calculations

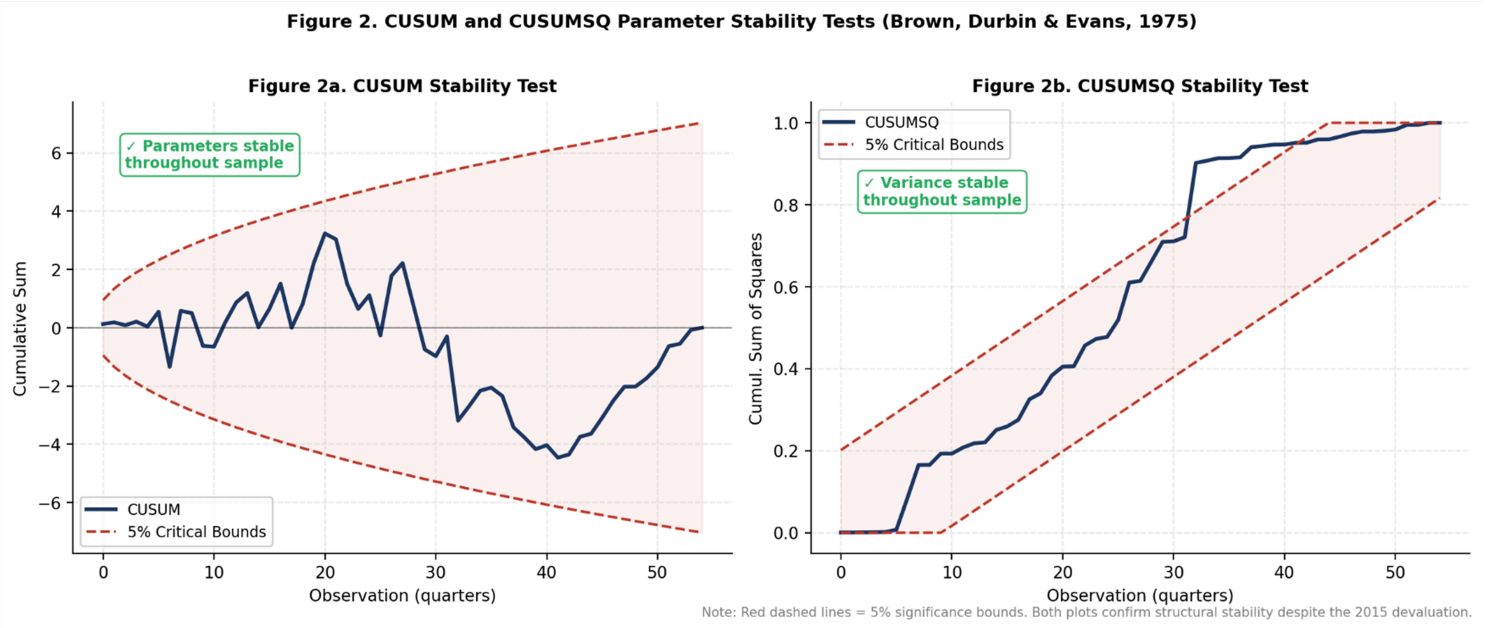


Figure 2

CUSUM and CUSUMSQ parameter stability tests. The CUSUM statistic stays within the 5 percent bounds throughout; the CUSUMSQ statistic exits the bounds temporarily around 2015–2016, reflecting the variance shift associated with the 2015 devaluation rather than instability in the estimated coefficients

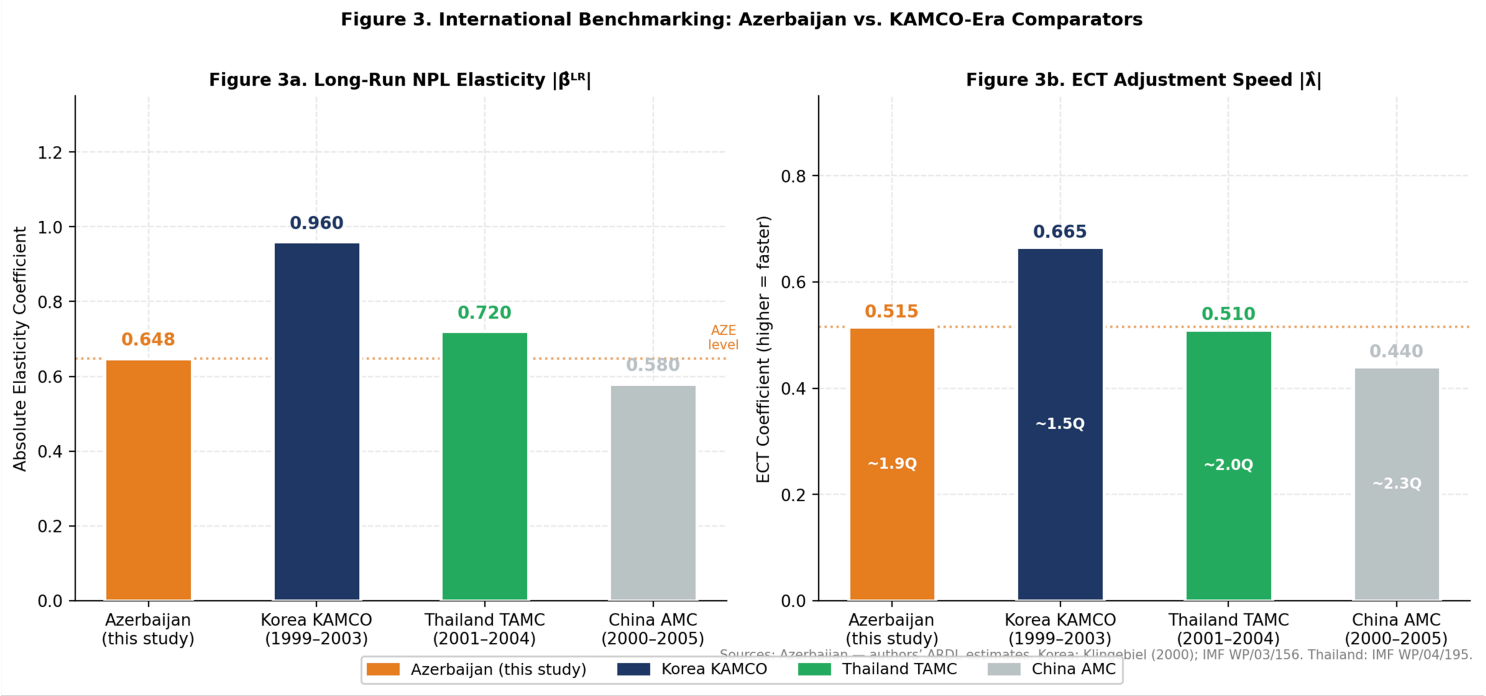


Figure 3

Indicative benchmarking of Azerbaijan's NPL-to-credit transmission and adjustment speed against international resolution episodes. Azerbaijan: authors' ARDL estimates; the comparator episodes are characterised qualitatively from the general policy literature, as described in Table 5

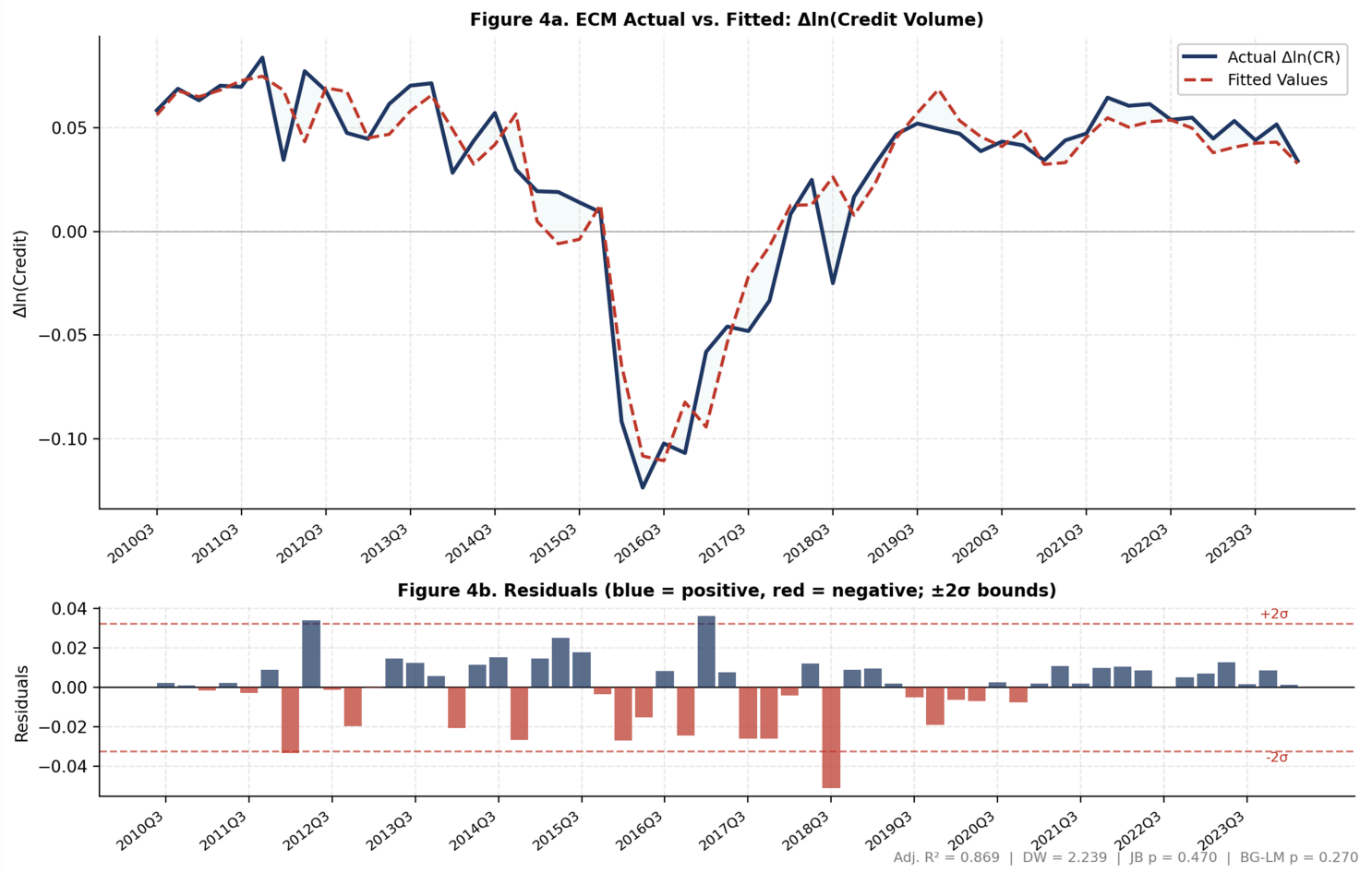


Figure 4

ECM actual versus fitted values and residual diagnostics. Adjusted $R^2 = 0.869$; DW = 2.239; Jarque–Bera p = 0.470. Authors' calculations

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- ESM1Dataset.xlsx
- ESM2ARDLReplication1.r
- ESM2ReplicationScript1.pdf