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Sectoral Debt-Service Exposure and Corporate Investment Under Global Monetary Tightening: Cross-Country Local Projections and Emerging-Market Financing Benchmarks

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Abstract

Standard floating-rate transmission models predict that monetary tightening depresses corporate capital formation more steeply in economies entering a hiking cycle with elevated non-financial corporate debt-service ratios and reprices shorter-maturity corporate obligations faster than household mortgages. Combining harmonized quarterly institutional sector accounts and Bank for International Settlements sectoral debt-service panels through mid-2026 with an external emerging-market financing benchmark across all 20 regions of Kazakhstan, we evaluate these predictions over the 2022–2025 tightening cycle. Local projections with country and quarter fixed effects and restricted wild cluster bootstrap inference uncover no statistically distinguishable conditional contraction gradient in real non-financial corporate fixed capital formation across 2021Q4 corporate debt-service exposures: at the four-quarter horizon (N = 206 across 16 economies), the interaction per 100-basis-point quarterly policy-rate increase and one-percentage-point initial exposure is -0.0158 log percentage points (country-clustered SE = 0.1127; wild cluster bootstrap p = 0.8732; inverted bootstrap 95% confidence interval [-0.2796, 0.1940]), remaining -0.0189 (bootstrap p = 0.8412) under full-rank Japan-only seasonal indicators, with 80% minimum detectable effects of 2.59 log percentage points per cross-country standard deviation. Evaluated at mean initial exposure, household debt-service ratios rise by 0.7947 percentage points at eight quarters (bootstrap p = 0.0147; 95% bootstrap interval [0.2275, 1.2862]), whereas corporate debt-service (-0.7314, p = 0.6725) and corporate-minus-household gap (-1.5261, p = 0.4103) slopes remain statistically unresolved. In Kazakhstan's external boundary benchmark under 14.25%–18.00% policy rates, enterprise and organization own funds supply 53.17%–55.70% of fixed-capital investment against 4.01%–5.56% from bank loans, exceeding bank credit in all 60 region-period observations.

Keywords: monetary policy transmission; debt-service ratio; corporate fixed capital formation; local projections; internal financing; emerging-market credit

1. Introduction

A central proposition in modern macro-finance holds that balance-sheet debt burdens amplify the real investment transmission of monetary policy through two reinforcing margins: marginal external finance premia on newly issued liabilities and mechanical cash-flow resets on legacy floating-rate or short-

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maturity debt stocks (Fazzari et al., 1988; Kashyap et al., 1994; Holmström & Tirole, 1997; Gertler & Karadi, 2015). Because corporate bank loans, revolving credit lines, and commercial paper carry shorter repricing maturities than long-term fixed-rate residential mortgages in several advanced economies, rapid policy-rate tightening is widely expected to lift non-financial corporate debt-service ratios faster than household debt-service ratios (Ippolito et al., 2018; Juselius & Drehmann, 2020; Poeschl, 2023; Greenwald et al., 2025) and to compress real corporate capital formation most severely in economies entering tightening with elevated corporate debt-service commitments (Ottonello & Winberry, 2020; Durante et al., 2022; Cloyne et al., 2023).

The global monetary tightening cycle initiated in 2022 offers a macroeconomic laboratory for testing whether aggregate sectoral debt-service ratios govern corporate investment dynamics in the manner predicted by cash-flow reset theory (Moessner et al., 2023; Alessandri et al., 2025). Between the fourth quarter of 2021 and late 2023, central banks across advanced and emerging economies raised policy interest rates by 350 to more than 500 basis points while inflation repriced nominal corporate revenues and gross operating surpluses simultaneously (Drechsler et al., 2017; Hodula & Melecký, 2020; Cloyne et al., 2025). Two institutional features complicate direct extrapolations from pre-2008 debt cycles or single-country syndicated-loan regressions (Chodorow-Reich, 2014; Crouzet, 2018; Cloyne et al., 2020). First, corporate debt-service ratios divide interest and scheduled principal outlays by nominal gross operating income (Bank for International Settlements, 2015); when inflationary price pass-through expands nominal corporate surpluses alongside nominal interest expenses, denominator growth offsets numerator resets in ways unavailable to wage-earning households facing sticky nominal labor contracts. Second, when external bank credit is costly or constrained by earnings-based borrowing limits (Lian & Ma, 2021), non-financial enterprises can fund physical capital formation out of retained earnings, depreciation allowances, and public capital transfers.

Existing macro-empirical studies of debt-service burdens rely primarily on economy-wide gross fixed capital formation, pooling non-financial corporate investment with residential housing construction and general government infrastructure, or examine pre-pandemic episodes dominated by household deleveraging (Juselius & Drehmann, 2020; Cloyne et al., 2020). Conversely, recent microeconometric studies identify firm-level investment sensitivity to high-frequency monetary surprises using balance-sheet leverage or bond maturity schedules within a single jurisdiction, most often the United States or the euro area (Ottonello & Winberry, 2020; Durante et al., 2022; Cloyne et al., 2023; Poeschl, 2023). Whether cross-country dispersion in pre-tightening non-financial corporate debt-service ratios predicts differential contractions in institutional-sector corporate capital formation across the 2022–2025 tightening episode therefore remains unresolved. This commentary addresses that gap across two complementary institutional settings: a harmonized cross-country institutional sector panel of advanced market economies through mid-2026 and an external emerging-market boundary benchmark from Kazakhstan, where policy base rates remained between 14.25% and 18.00% throughout 2024–2026 alongside statutory retail debt-service ceilings (National Bank of the Republic of Kazakhstan, 2026; Agency of the Republic of Kazakhstan for Regulation and Development of the Financial Market, 2025).

We advance this inquiry through three empirical findings. First, we construct an accounting-consistent quarterly panel across 68 economies up to an evidence cutoff of 13 November 2026, separating institutional-sector non-financial corporate gross fixed capital formation (2,736 country-quarter observations across 26 economies through 2026Q2) from economy-wide aggregate fixed capital formation (5,816 observations across 56 economies) and linking them to sectoral debt-service ratios for non-financial corporations and households (1,853 observations each across 17 reporting economies through 2026Q1) (Bank for International Settlements, 2026a; Bank for International Settlements, 2026b; Eurostat, 2026; Organisation for Economic Co-operation and Development, 2026; Board of Governors of the Federal Reserve System, 2026). Estimating local projections (Jordà, 2005; Jordà, 2023) over horizons $h = 0, \dots, 8$ quar-

ters with country and observation-quarter fixed effects, predetermined macroeconomic lags, and 9,999-replication restricted wild cluster bootstrap inference (Cameron et al., 2008; Roodman et al., 2019; MacKinnon et al., 2023), we find no statistically resolved conditional contraction gradient in real corporate fixed investment across initial 2021Q4 corporate debt-service exposures. At the benchmark four-quarter horizon ($N = 206$, $G = 16$ economies), the interaction per 100-basis-point quarterly policy-rate increase and one-percentage-point higher initial corporate debt-service ratio is −0.0158 log percentage points (country-clustered SE = 0.1127, wild cluster bootstrap $p = 0.8732$, inverted bootstrap 95% confidence interval $[-0.2796, 0.1940]$), remaining −0.0189 (bootstrap $p = 0.8412$) when country-specific seasonal indicators are restricted to full-rank indicators for Japan alone. Across all nine horizons ($h = 0, \ldots, 8$), confidence intervals span zero for real corporate investment, for the corporate investment-to-surplus ratio, and for economy-wide aggregate investment.

Second, to test whether muted investment heterogeneity reflects muted cash-flow resets, we estimate sectoral debt-service local projections directly across the 17 reporting economies. Neither the corporate debt-service ratio, the household debt-service ratio, nor the within-country corporate-minus-household debt-service gap exhibits a statistically significant exposure interaction slope with respect to initial 2021Q4 corporate debt-service ratios. Evaluated at sample-mean initial exposure, a 100-basis-point quarterly policy-rate increase is conditionally associated with a cumulative rise of +0.7947 percentage points in the household debt-service ratio at $h = 8$ quarters (country-clustered SE = 0.2466, wild cluster bootstrap $p = 0.0147$, inverted bootstrap 95% confidence interval $[0.2275, 1.2862]$), whereas the eight-quarter corporate debt-service slope (−0.7314 percentage points, bootstrap $p = 0.6725$) and the directly estimated corporate-minus-household differential (−1.5261 percentage points, bootstrap $p = 0.4103$) remain statistically unresolved. Alongside pre-2022 corporate maturity extension and inflationary operating-surplus growth, an institutional compilation convention helps account for this cross-country stability: official international debt-service statistics impose time- and country-invariant remaining maturities of 13 years for non-financial corporations and 18 years for households (Bank for International Settlements, 2015), suppressing cross-country heterogeneity in contractual debt duration by construction.

Third, to examine realized capital-expenditure funding when bank borrowing costs remain persistently elevated, we establish an external emerging-market boundary benchmark using bilingual Kazakh- and Russian-language regional fixed-capital financing compendia across all 20 contemporary administrative regions of Kazakhstan (and 16 consolidated historical parent regions) over full-year 2024, full-year 2025, and January–September 2026 (Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 2025; Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 2026). Under double-digit central bank base rates of 14.25%–18.00%, own funds of enterprises and organizations (separated from individual residential developers' funds within Kazakhstan's broader state-and-private organizational perimeter) finance 53.17%–55.70% of national fixed-capital investment compared with 4.01%–5.56% from bank loans, exceeding bank credit in all 60 region-period observations while between-parent regional specialization accounts for 90.80% to 71.79% of cross-regional population variance.

The remainder of the paper proceeds as follows. Section 2 develops the cash-flow reset model and states three falsifiable hypotheses. Section 3 documents institutional sector harmonization, deflation rules, and subnational Kazakhstani financing accounts. Section 4 specifies the local-projection estimators and small-cluster inference protocol. Section 5 reports cross-country corporate investment local projections and statistical power bounds. Section 6 examines sectoral debt-service reset dynamics, the emerging-market regional financing benchmark in Kazakhstan, and sensitivity and temporal falsification diagnostics. Section 7 consolidates methodological and measurement boundaries, and Section 8 outlines policy implications for monetary transmission and macroprudential surveillance.

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2. Theoretical Framework and Falsifiable Hypotheses

2.1. Cash-Flow Reset Mechanics, Operating-Surplus Repricing, and Internal Funds

Consider the non-financial corporate institutional sector of economy c in quarter t, holding nominal debt stock $D_{c,t-1}$ and generating nominal gross operating surplus $Y^N_{c,t} = P_{c,t}y_{c,t}$, where $P_{c,t}$ denotes the domestic output price level and $y_{c,t}$ denotes real corporate operating surplus. Following the standardized amortization formula underlying international debt-service accounts (Bank for International Settlements, 2015; Juselius & Drehmann, 2020), the sectoral corporate debt-service ratio $S^N_{c,t}$ equals total interest plus scheduled principal repayments divided by nominal gross operating surplus:

$$S^N_{c,t} = \frac{i^N_{c,t}}{1 - (1 + i^N_{c,t})^{-M_N}} \cdot \frac{D_{c,t-1}}{P_{c,t}y_{c,t}}, \tag{1}$$

where $i^N_{c,t}$ is the effective average interest rate paid on outstanding corporate debt and M_N denotes effective remaining amortization maturity. Let $\omega_c \in [0,1]$ denote the fraction of legacy corporate debt whose effective coupon resets within a short horizon following a policy-rate change $\Delta r_{c,t}$, so that $\partial i^N_{c,t+h}/\partial r_{c,t} = \omega_c \psi_h$ with pass-through profile $\psi_h \geq 0$ (Ippolito et al., 2018; Greenwald et al., 2025). Log-linearizing Equation (1) around a pre-tightening anchor quarter t_0 shows that the cumulative change in corporate debt-service burden depends on the balance between effective interest-rate pass-through on the numerator and nominal operating-surplus growth on the denominator:

$$\Delta_h S^N_{c,t} \approx S^N_{c,t_0}\left[\kappa_N \omega_c \psi_h \Delta r_{c,t} + \Delta_h \log D_{c,t-1} - \Delta_h \log P_{c,t} - \Delta_h \log y_{c,t}\right], \tag{2}$$

where $\kappa_N > 0$ is the semi-elasticity of the annuity factor in Equation (1) with respect to $i^N_{c,t}$.

In cash-flow-constrained investment models (Fazzari et al., 1988; Holmström & Tirole, 1997; Lian & Ma, 2021), real corporate fixed capital formation $I^N_{c,t}$ responds both to the marginal cost of newly issued debt and to unencumbered internal cash flow $(1 - S^N_{c,t})Y^N_{c,t}$ plus liquid financial buffers L_{c,t_0}. If $\omega_c \psi_h > 0$, nominal surplus pass-through $\Delta_h \log P_{c,t}$ is muted, and external debt finances a substantial share $(1 - \phi_c)$ of capital expenditures (where $\phi_c \in [0,1]$ denotes the internal own-funds financing share), Equation (2) implies multiplicative cash-flow reset amplification: a given policy-rate increase $\Delta r_{c,t}$ absorbs a larger share of corporate cash flow in economies with higher pre-tightening debt-service commitments $E_c \equiv S^N_{c,t_0}$, depressing subsequent real corporate capital formation (Ottonello & Winberry, 2020; Cloyne et al., 2023). Conversely, if corporations termed out fixed-rate bond liabilities during the low-rate era ($\omega_c \to 0$) (Crouzet, 2018), expanded nominal gross operating surpluses alongside post-2021 inflation ($\Delta_h \log P_{c,t} > 0$), or funded physical capital formation predominantly out of retained internal funds ($\phi_c \to 1$), the conditional cross-country interaction between $\Delta r_{c,t}$ and initial exposure E_c attenuates toward zero.

2.2. Testable Empirical Hypotheses

Treating balance-sheet amplification as an empirical question, we test three falsifiable hypotheses:

- **Hypothesis 1 (Conditional Corporate Investment Exposure Gradient).** *Conditional on country fixed effects, observation-quarter fixed effects, and predetermined macroeconomic lags, economies entering the 2022–2025 tightening cycle with higher 2021Q4 non-financial corporate debt-service ratios (or higher corporate credit-to-GDP intensity) exhibit steeper negative cumulative responses in real non-financial corporate fixed capital formation and corporate investment-to-surplus ratios over horizons $h = 1, \ldots, 8$ quarters following policy-rate increases.*
- **Hypothesis 2 (Sectoral Corporate-versus-Household Reset Asymmetry).** *If corporate debt portfolios reprice faster than household mortgage stocks, policy-rate increases generate a larger positive*

dynamic response in the non-financial corporate debt-service ratio than in the household debt-service ratio ($\Delta_h S^N_{c,t} - \Delta_h S^H_{c,t} > 0$), amplified in jurisdictions with higher pre-tightening debt-service exposure.

- **Hypothesis 3 (Internal Financing Dominance in a High-Rate Emerging-Market Benchmark).** *In an external emerging-market benchmark characterized by sustained double-digit policy base rates and retail borrower debt-service regulation, realized subnational fixed-capital formation relies predominantly on internal enterprise and organization own funds relative to domestic and foreign bank credit across administrative regions.*

3. Data Sources and Institutional Sector Harmonization

3.1. Cross-Country Sectoral Debt-Service and Capital Formation Panel

All statistical series, metadata releases, and regulatory texts satisfy an evidence cutoff of 13 November 2026; only completed historical quarterly reference periods through 2026Q2 (and subnational cumulative releases published on or before 13 November 2026) enter the empirical dataset, without forecast extrapolation. Across all retrieved international databases, the master quarterly calendar spans 7,480 country-quarter cells across 68 economies from 1999Q1 through 2026Q2, with missing historical cells left unimputed.

Sectoral debt-service ratios come from the 14 September 2026 release of the Bank for International Settlements debt-service database, supplying quarterly ratios through 2026Q1 for non-financial corporations (1,853 observations across 17 economies), households and non-profit institutions serving households (1,853 observations across the same 17 economies), and the consolidated private non-financial sector (3,476 observations across 32 economies) (Bank for International Settlements, 2026a). Central bank policy interest rates (5,887 observations across 59 economies through 2026Q2, released 12 November 2026), consumer price indices (released 29 October 2026), and break-adjusted market-value credit to non-financial corporations from all lenders (4,521 observations across 43 economies through 2026Q1) are drawn from Bank for International Settlements monetary and credit statistics (Bank for International Settlements, 2026b). Quarterly policy interest rates equal the arithmetic mean of the three month-end policy rates within each completed calendar quarter, with quarter-end rates retained for sensitivity analysis. For euro-area Member States, European Central Bank policy rates map to each Member State from its exact currency-union accession quarter, and the aggregate euro-area entity is excluded from all regressions to avoid double counting while retaining cross-country heterogeneity in balance-sheet exposure and corporate investment.

Institutional-sector non-financial corporate capital formation is harmonized from three official national-accounts databases: Eurostat quarterly non-financial sector accounts (updated 29 October 2026) and national-accounts price deflators (updated 11 November 2026) (Eurostat, 2026), Organisation for Economic Co-operation and Development quarterly institutional sector and expenditure accounts (Organisation for Economic Co-operation and Development, 2026), and the 11 September 2026 release of the United States Integrated Macroeconomic Accounts (Board of Governors of the Federal Reserve System, 2026). For European and OECD reporters, corporate investment measures paid gross fixed capital formation of the System of National Accounts non-financial corporate sector, paired with received gross operating surplus and mixed income on the corporate income account. For the United States, we use the integrated macroeconomic accounts non-financial corporate fixed capital formation series—which maintains a consistent institutional perimeter including equity real estate investment trust residential structures while excluding inventory valuation and non-produced asset acquisitions—and compute gross corporate operating surplus as net operating surplus plus consumption of fixed capital, dividing seasonally adjusted annual-rate flows by four.

Because quarterly sector-specific capital-goods deflators are unpublished across institutional sector accounts, real non-financial corporate fixed capital formation ($I^N_{c,t}$) is obtained by dividing nominal corporate gross fixed capital formation by each country's quarterly economy-wide gross fixed capital formation price index (reconstructed where required as the exact ratio of current-price to chain-linked volume aggregate gross fixed capital formation, with the country's own gross domestic product deflator serving as an explicit fallback). Seasonal adjustment selection is enforced at the country level without splicing: seasonally and calendar-adjusted series take precedence, followed by seasonally adjusted series, and finally unadjusted series accompanied by calendar-quarter fixed effects (applicable to Japan's unadjusted corporate sector accounts).

Across the 68 economies, harmonized real corporate fixed capital formation covers 2,736 observations in 26 economies, while real economy-wide aggregate fixed capital formation covers 5,816 observations in 56 economies. Intersecting corporate investment coverage with the 17 economies reporting pre-tightening 2021Q4 non-financial corporate debt-service ratios yields 16 baseline advanced economies: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom, and the United States. The Republic of Korea reports sectoral debt-service ratios and economy-wide investment (entering the 17-economy aggregate investment baseline with $N_0 = 272$), whereas quarterly institutional-sector corporate fixed capital formation is unavailable in public sector-account dissemination. Within the 16-economy corporate baseline, policy-change origin quarters t span 2022Q1–2025Q4 ($N_0 = 243$ complete observations at $h = 0$), while forward outcomes $t + h$ extend through 2026Q2; Norway exits at horizons $h \geq 6$ ($G = 15$, $N_8 = 144$) because its published quarterly corporate series ends in 2023Q2, and Japan's corporate endpoint in 2025Q1 governs late-horizon attrition without extrapolation.

Table 1. Descriptive statistics for horizon-zero estimation panels (2022Q1–2025Q4) and distinct 2021Q4 initial exposures.

Sample and variable	Unit	*N*	Mean	SD	P25	Median	P75	Min	Max
Panel A: Corporate investment baseline ($G = 16$ economies)									
Non-financial corporate debt-service ratio	% income	243	39.88	9.42	32.20	38.70	46.10	25.00	59.80
Household debt-service ratio	% income	243	9.15	3.62	6.10	7.90	12.50	4.20	17.60
Quarterly mean policy interest rate	%/year	243	2.75	1.64	1.88	3.00	4.25	-0.60	5.38
Quarterly policy-rate change ($\Delta r_{c,t}$)	pp	243	0.15	0.54	-0.17	0.00	0.50	-0.83	1.67
Non-financial corporate credit to GDP	% GDP	243	109.45	38.29	76.70	113.00	133.40	57.10	208.90
Real corporate investment quarterly growth	100 log-pt	243	0.75	5.23	-0.94	0.88	2.74	-24.03	24.13
Real aggregate investment quarterly growth	100 log-pt	243	0.47	2.88	-0.56	0.53	1.62	-17.58	17.98
Corporate investment to gross operating surplus	% surplus	243	58.27	11.70	51.58	58.81	66.60	19.40	91.10
Real gross domestic product quarterly growth	100 log-pt	243	0.38	0.76	0.07	0.36	0.78	-5.43	3.06
Consumer price inflation (year-on-year)	%/year	242	4.33	2.82	2.24	3.46	6.58	-0.01	12.26
Initial 2021Q4 corporate DSR (distinct countries)	% income	16	41.30	9.25	33.13	40.25	46.25	28.00	58.70

(continued)

Table 1 (continued)

Sample and variable	Unit	*N*	Mean	SD	P25	Median	P75	Min	Max
Panel B: Aggregate investment baseline ($G = 17$ economies)									
Non-financial corporate debt-service ratio	% income	272	39.63	8.98	32.50	38.50	44.55	25.00	59.80
Household debt-service ratio	% income	272	9.73	4.11	6.38	8.20	12.60	4.20	21.10
Quarterly mean policy interest rate	%/year	272	2.79	1.60	1.92	3.00	4.25	-0.60	5.38
Quarterly policy-rate change ($\Delta r_{c,t}$)	pp	272	0.14	0.51	-0.17	0.00	0.50	-0.83	1.67
Non-financial corporate credit to GDP	% GDP	272	110.53	36.53	79.13	112.95	134.25	57.10	208.90
Real corporate investment quarterly growth	100 log-pt	243	0.75	5.23	-0.94	0.88	2.74	-24.03	24.13
Real aggregate investment quarterly growth	100 log-pt	272	0.42	2.82	-0.67	0.49	1.62	-17.58	17.98
Corporate investment to gross operating surplus	% surplus	243	58.27	11.70	51.58	58.81	66.60	19.40	91.10
Real gross domestic product quarterly growth	100 log-pt	272	0.37	0.75	0.06	0.36	0.78	-5.43	3.06
Consumer price inflation (year-on-year)	%/year	271	4.22	2.70	2.25	3.38	5.94	-0.01	12.26
Initial 2021Q4 corporate DSR (distinct countries)	% income	17	40.92	9.09	33.50	40.00	45.90	28.00	58.70

Notes. Unweighted country-quarter summary statistics over policy-change origin quarters 2022Q1–2025Q4 at horizon $h = 0$, supplemented at the bottom of each panel by cross-sectional distributions of predetermined 2021Q4 corporate debt-service exposure (E_c) across distinct baseline economies (sample standard deviation with $G - 1$ denominator). Panel A covers 16 economies with harmonized institutional-sector corporate capital formation; Panel B adds the Republic of Korea ($G = 17$, where corporate-sector investment and surplus rows retain $N = 243$). Contemporaneous inflation has one fewer observation at 2025Q4 where lagged inflation controls remain complete.

Table 1 summarizes the horizon-zero estimation samples alongside the distinct cross-sectional 2021Q4 initial exposures, and Figure 1 illustrates observed sectoral debt-service paths, mean-exposure local-projection trajectories, and initial 2021Q4 balance-sheet coupling across the 17 reporting economies. Across the 243 country-quarters in Panel A of Table 1, contemporaneous corporate debt-service ratios average 39.88% of sector income (SD = 9.42), while predetermined 2021Q4 initial corporate debt-service exposure across the 16 distinct corporate baseline economies averages 41.30% (SD = 9.25; 40.92% with SD = 9.09 across all 17 economies in Panel B), exceeding household debt-service ratios (9.15% of income in Panel A; 2021Q4 mean 9.31%, SD = 3.66) by more than fourfold because corporate gross operating surplus is a narrower income concept than household disposable income and corporate principal turns over on shorter assumed schedules. Quarterly real corporate fixed capital formation exhibits substantially higher volatility (SD = 5.23 log percentage points) than real economy-wide fixed capital formation (SD = 2.88 log percentage points), explaining why pooling public infrastructure and residential housing investment obscures business capital-expenditure fluctuations.

As shown in Figure 1 (Panel a), as the median central bank policy rate rose from 0.00% in 2021Q4–2022Q2 to 4.50% in 2023Q4–2024Q1 before easing toward 2.00% by 2025Q4–2026Q1, the median cumulative change in corporate debt-service ratios relative to 2021Q4 remained negative throughout 2022Q1–2026Q1 (reaching −2.30 percentage points in 2023Q1 and −2.20 percentage points in 2025Q2,

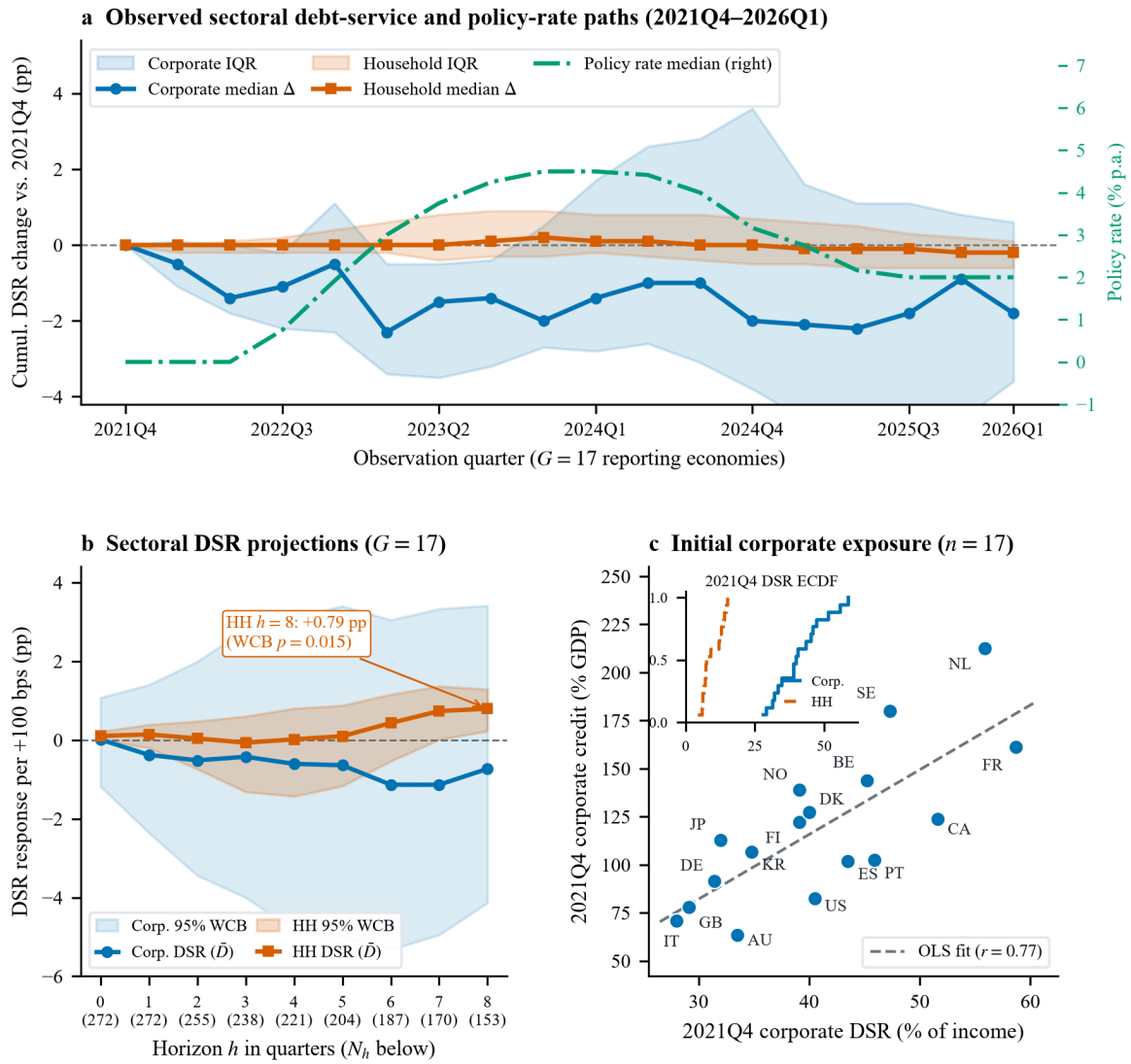


Figure 1. Observed sectoral debt-service paths, mean-exposure local projections, and initial balance-sheet exposure.

Notes. Panel a plots cross-country medians and interquartile bands (25th–75th percentiles) of cumulative changes in non-financial corporate and household debt-service ratios relative to 2021Q4 (left axis, percentage points) alongside the cross-country median central bank policy interest rate level (right axis, % per year) across $G = 17$ reporting economies from 2021Q4 through 2026Q1. Panel b plots sectoral debt-service local-projection responses $\hat{\phi}_h^m$ from Equation (4) per 100-basis-point quarterly policy-rate change evaluated at sample-mean 2021Q4 corporate exposure over horizons $h = 0, \ldots, 8$ quarters ($N_0 = 272$ to $N_8 = 153$), with shaded 95% restricted wild cluster bootstrap confidence sets. Panel c plots 2021Q4 corporate credit-to-GDP ratios against 2021Q4 corporate debt-service ratios across $G = 17$ economies (ordinary least squares linear fit, Pearson $r = 0.77$, $p = 0.0003$), with an inset empirical cumulative distribution function comparing 2021Q4 corporate (Corp.) and household (HH) debt-service distributions.

with an interquartile range spanning from −5.30 percentage points in 2025Q2 to +3.60 percentage points in 2024Q4), whereas the median cumulative household debt-service change stayed tightly bounded between −0.20 and +0.20 percentage points with an upper quartile reaching +0.90 percentage points in 2023Q3–2023Q4. Conditional on country and quarter fixed effects and lagged controls, Figure 1 (Panel b) previews the delayed upward household reset (+0.7947 percentage points at $h = 8$, wild cluster bootstrap $p = 0.0147$) alongside flat-to-negative and imprecise corporate responses examined in Section 6.1. Figure 1 (Panel c) documents wide pre-tightening dispersion in 2021Q4 corporate debt-service burdens—from below 30% in Italy (28.0%) and the United Kingdom (29.1%), with Germany just above at

31.4%, to above 50% in Canada (51.6%), the Netherlands (55.9%), and France (58.7%), while Norway (39.1%) and Sweden (47.3%) lie in the upper-middle range—positively correlated with 2021Q4 corporate credit-to-GDP ratios ($r = 0.77$, $p = 0.0003$; $r = 0.77$, $p = 0.0005$ across the 16 corporate investment economies), while the dual-sector inset confirms first-order separation between initial household (4.3%–15.0%) and corporate (28.0%–58.7%) debt-service distributions.

3.2. External Emerging-Market Financing Benchmark in Kazakhstan

Because quarterly institutional-sector debt-service statistics from the Bank for International Settlements cover advanced and major G20 market economies, we complement the cross-country panel with an external emerging-market boundary benchmark from Kazakhstan covering full-year 2024 (released 4 July 2025), full-year 2025 (released 3 July 2026), and cumulative January–September 2026 (released 16 October 2026) (Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 2025; Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 2026). Kazakh- and Russian-language statistical compendia exhibit exact numerical equivalence across all 20 contemporary administrative regions (17 oblasts plus the three republican cities of Astana, Almaty, and Shymkent). Distinct from the advanced-economy System of National Accounts non-financial corporate regressions, Kazakhstan illustrates how realized fixed-capital funding is organized in a resource-exporting, state-enterprise-intensive emerging market operating under sustained double-digit policy interest rates.

Three accounting rules govern this subnational benchmark. First, total fixed-capital investment decomposes into four mutually exclusive primary sources: total own funds, total bank loans, government budget funds, and other borrowed funds. Within total own funds, we separate own funds of enterprises and organizations from individual residential developers' own funds so that household self-built housing does not inflate enterprise internal financing shares; at the same time, we note explicitly that the statistical category of enterprises and organizations encompasses state-owned enterprises, quasi-sovereign holdings, and non-corporate organizations alongside private corporations. Second, foreign-bank credit is a sub-item of total bank loans and nonresident non-bank borrowing is a sub-item of other borrowed funds; we preserve this nested hierarchy without double counting, leaving official confidentiality suppressions on regional foreign-bank sub-cells unimputed (five regions in 2024 and two regions each in 2025 and January–September 2026) while using the published national foreign-bank total for national domestic-bank shares. Third, because Kazakhstan established three new oblasts in mid-2022 (splitting Abai from East Kazakhstan, Zhetysu from Almaty Region, and Ulytau from Karaganda, alongside Shymkent and Turkestan), we evaluate both all 20 contemporary regions and 16 consolidated historical parent regions. Over this period, National Bank of Kazakhstan Monetary Policy Committee decisions maintained the base rate between 14.25% and 15.75% in 2024 (time-weighted mean 14.68%), raised it to 18.00% in October 2025 (2025 mean 16.59%), and held it between 16.25% and 18.00% across January–September 2026 (mean 17.47%) (National Bank of the Republic of Kazakhstan, 2026), while Resolution No. 52 of 25 August 2025 enforced a 0.50 borrower debt-service-to-income ceiling on covered resident natural-person loans (Agency of the Republic of Kazakhstan for Regulation and Development of the Financial Market, 2025).

4. Econometric Specification and Small-Cluster Inference

To trace conditional dynamic heterogeneity across pre-tightening corporate balance-sheet exposures without imposing autoregressive lag restrictions across horizons, we estimate local projections (Jordà, 2005; Jordà, 2023) separately at each quarterly horizon $h \in \{0, 1, \ldots, 8\}$ over policy-rate origin quarters $t \in [2022Q1, 2025Q4]$:

$$100(\log I_{c,t+h} - \log I_{c,t-1}) = \alpha_c^h + \tau_t^h + \beta_h \Delta r_{c,t}(E_c - \bar{E}) + \theta_h \Delta r_{c,t} + \sum_{\ell=1}^{2} \mathbf{\Gamma}'_{h,\ell} \mathbf{Z}_{c,t-\ell} + s^h_{c,q(t)} + u_{c,t+h}. \quad (3)$$

In Equation (3), $I_{c,t+h}$ denotes real non-financial corporate gross fixed capital formation (or, in comparative baseline blocks, economy-wide real gross fixed capital formation), so $100(\log I_{c,t+h} - \log I_{c,t-1})$ is measured in hundred log points (log percentage points); for the corporate investment-to-surplus outcome, the dependent variable is the percentage-point change $(I^{\text{nom}}_{c,t+h}/Y^N_{c,t+h} - I^{\text{nom}}_{c,t-1}/Y^N_{c,t-1}) \times 100$. The exposure variable E_c is the predetermined 2021Q4 non-financial corporate debt-service ratio centered at its horizon-specific estimation-sample mean $\bar{E}$, and $\Delta r_{c,t}$ is the one-quarter change in the quarterly mean policy interest rate in percentage points ($\Delta r_{c,t} = 1.0$ corresponds to a 100-basis-point hike). Country fixed effects α_c^h absorb time-invariant national investment trends and cross-country level differences in E_c, while observation-quarter fixed effects τ_t^h absorb common global macroeconomic, energy-price, and financial shocks. The predetermined control vector $\mathbf{Z}_{c,t-\ell}$ ($\ell = 1, 2$) contains two lags each of quarterly real investment log growth, real gross domestic product log growth, year-on-year consumer price inflation, and quarterly changes in corporate credit-to-GDP ratios; contemporaneous output growth is omitted from the baseline to avoid conditioning on a post-rate-change channel and enters in a dedicated sensitivity check. In the primary corporate baseline (Panels A and B of Table 2), $s^h_{c,q(t)}$ interacts calendar-quarter indicators across country panels containing unadjusted series ($K = 86$ at $h = 0$ after automatic collinearity reduction of redundant seasonal interactions), whereas our full-rank parsimonious specification in Section 6.3 restricts $s^h_{c,q(t)}$ strictly to Q2, Q3, and Q4 indicators for Japan—the sole unadjusted series in the 16-country sample—saving up to 45 degrees of freedom ($K = 44$ at $h = 0$, $K = 42$ at $h = 4$, and $K = 37$ at $h = 8$, with zero omitted collinear terms) and matching the seasonal parameterization of the fully seasonally adjusted aggregate investment panel.

To test Hypothesis 2, we estimate paired sectoral debt-service local projections over the 17 reporting economies:

$$S^m_{c,t+h} - S^m_{c,t-1} = \mu_c^{m,h} + \lambda_t^{m,h} + \delta_h^m \Delta r_{c,t}(E_c - \bar{E}) + \phi_h^m \Delta r_{c,t} + \sum_{\ell=1}^{2} \mathbf{\Pi}^{m\prime}_{h,\ell} \mathbf{W}_{c,t-\ell} + \varepsilon^m_{c,t+h}, \quad (4)$$

for $m \in \{N, H, \text{gap}\}$, where $S^{\text{gap}}_{c,t} \equiv S^N_{c,t} - S^H_{c,t}$ is the corporate-minus-household debt-service ratio differential. Because $\mathbf{W}_{c,t-\ell}$ includes identical predetermined lags—real aggregate investment growth, real output growth, consumer price inflation, corporate credit-to-GDP changes, and two lags each of ΔS^N and ΔS^H—across all three equations on an identical sample, ordinary least squares satisfies exact cross-equation additivity ($\hat{\delta}^{\text{gap}}_h = \hat{\delta}^N_h - \hat{\delta}^H_h$ and $\hat{\phi}^{\text{gap}}_h = \hat{\phi}^N_h - \hat{\phi}^H_h$), where $\hat{\phi}^m_h$ measures the cumulative sectoral debt-service change per 100-basis-point policy-rate change evaluated at mean initial exposure $\bar{E}$. Because $\Delta r_{c,t}$ reflects endogenous central bank policy reactions without an external monetary surprise instrument, β_h, δ^m_h, and ϕ^m_h estimate conditional dynamic heterogeneity and conditional mean-exposure slopes.

With $G = 15$ to 17 country clusters in the baseline panels (and $G = 23$ to 24 in credit-intensity extensions), asymptotic cluster-robust t-tests can over-reject in finite samples (Cameron et al., 2008; MacKinnon et al., 2023). Alongside small-sample corrected country-clustered standard errors referenced to $t(G - 1)$, every regression model reports pointwise two-sided p-values and 95% confidence intervals from a country-level restricted wild cluster bootstrap using 9,999 Rademacher draws, imposing the null hypothesis, re-estimating all parameters including fixed effects, studentizing with small-sample cluster covariance, and inverting the two-sided bootstrap test across a 161-point grid with bisection boundary refinement (Roodman et al., 2019). We additionally report two-way country-and-quarter clustered standard errors, euro-area-by-quarter fixed effects, and conditional 80% minimum detectable effect bounds (MDE_{80}) computed from the exact two-sided noncentral-$t(G - 1)$ distribution at $\alpha = 0.05$.

5. Cross-Country Corporate Investment Local Projections

Table 2 presents baseline estimates of β_h from Equation (3) across horizons $h = 0, \dots, 8$ for real non-financial corporate fixed capital formation, the nominal corporate investment-to-gross-operating-surplus ratio, and economy-wide real aggregate fixed capital formation. Figure 2 displays dynamic exposure-interaction trajectories, the raw cross-country corporate investment growth scatter, and four-quarter specification and country-exclusion diagnostics.

Table 2. Local-projection estimates of pre-tightening corporate debt-service exposure interactions across investment outcomes ($h = 0, \dots, 8$).

Outcome and horizon (h, quarters)	$\hat{\beta}_h$	Cluster SE	Cluster CI	Cluster p	WCB p	WCB CI	N_h	G_h
Panel A: Real non-financial corporate fixed capital formation (100 log points)								
$h = 0$ (impact quarter)	0.0578	0.0408	[-0.0291, 0.1447]	0.1769	0.1798	[-0.0570, 0.1532]	243	16
$h = 1$	0.0560	0.0413	[-0.0321, 0.1441]	0.1956	0.1396	[-0.0565, 0.1224]	241	16
$h = 2$	0.0478	0.0668	[-0.0946, 0.1901]	0.4854	0.4100	[-0.1513, 0.1521]	238	16
$h = 3$	0.0258	0.0883	[-0.1624, 0.2141]	0.7739	0.7401	[-0.1864, 0.1679]	222	16
$h = 4$ (one-year benchmark)	-0.0158	0.1127	[-0.2560, 0.2244]	0.8903	0.8732	[-0.2796, 0.1940]	206	16
$h = 5$	-0.0148	0.1322	[-0.2965, 0.2668]	0.9121	0.8970	[-0.3058, 0.2191]	190	16
$h = 6$	0.0158	0.1217	[-0.2452, 0.2769]	0.8984	0.8794	[-0.2449, 0.2262]	174	15
$h = 7$	0.0528	0.1579	[-0.2858, 0.3914]	0.7429	0.7038	[-0.2638, 0.3206]	159	15
$h = 8$ (two-year horizon)	0.0309	0.1582	[-0.3084, 0.3703]	0.8477	0.8537	[-0.2925, 0.2710]	144	15
Panel B: Corporate investment-to-gross-operating-surplus ratio (percentage points)								
$h = 0$	0.0569	0.0524	[-0.0547, 0.1685]	0.2943	0.3168	[-0.0874, 0.1969]	243	16
$h = 1$	0.0414	0.0959	[-0.1630, 0.2459]	0.6720	0.6703	[-0.2346, 0.2452]	241	16
$h = 2$	0.0228	0.1269	[-0.2476, 0.2932]	0.8599	0.8720	[-0.3395, 0.2754]	238	16
$h = 4$	-0.0108	0.1370	[-0.3028, 0.2812]	0.9382	0.9401	[-0.3899, 0.2956]	206	16
$h = 6$	0.0251	0.1605	[-0.3191, 0.3693]	0.8779	0.8397	[-0.3277, 0.4669]	174	15
$h = 8$	-0.0304	0.2290	[-0.5216, 0.4609]	0.8964	0.9072	[-0.4641, 0.4465]	144	15
Panel C: Economy-wide real aggregate fixed capital formation (100 log points)								
$h = 0$	-0.0307	0.0379	[-0.1110, 0.0495]	0.4288	0.5259	[-0.1443, 0.0455]	272	17

(continued)

Table 2 (continued)

Outcome and horizon (h, quarters)	$\hat{\beta}_h$	Cluster SE	Cluster CI	Cluster p	WCB p	WCB CI	N_h	G_h
$h = 1$	-0.0265	0.0552	[-0.1435, 0.0906]	0.6381	0.7612	[-0.1957, 0.0932]	272	17
$h = 2$	-0.0178	0.0652	[-0.1561, 0.1205]	0.7889	0.8669	[-0.2084, 0.1228]	272	17
$h = 4$	-0.0135	0.0615	[-0.1438, 0.1168]	0.8294	0.8417	[-0.1722, 0.1188]	238	17
$h = 6$	0.0382	0.0475	[-0.0625, 0.1390]	0.4329	0.3815	[-0.0516, 0.1390]	204	17
$h = 8$	0.0292	0.0567	[-0.0909, 0.1494]	0.6127	0.5738	[-0.1077, 0.1291]	170	17

Notes. Estimates of β_h from Equation (3) measuring cumulative outcome change from $t - 1$ to $t + h$ per 100-basis-point quarterly policy-rate increase interacted with a one-percentage-point higher 2021Q4 corporate debt-service ratio (in log percentage points for Panels A and C, and percentage points of gross operating surplus for Panel B). All models include country fixed effects, observation-quarter fixed effects, seasonal indicators where applicable, and two lags of investment growth, output growth, consumer price inflation, and corporate credit-to-GDP changes. Conventional 95% confidence intervals and p-values use small-sample corrected country-clustered covariance (t_{G-1}); WCB p-values and 95% confidence intervals use 9,999 restricted Rademacher wild cluster bootstrap draws with numerical test inversion. Intermediate horizons $h = 3, 5, 7$ in Panels B and C likewise span zero (−0.0209 to +0.0551, all pointwise WCB $p \geq 0.2199$).

The estimates in Panel A of Table 2 provide no support for Hypothesis 1. In the impact and immediate post-hike quarters ($h = 0, 1, 2$), point estimates of the corporate debt-service exposure interaction are slightly positive ($\hat{\beta}_0 = 0.0578$, wild cluster bootstrap $p = 0.1798$; $\hat{\beta}_1 = 0.0560$, bootstrap $p = 0.1396$), moving near zero at the one-year benchmark ($\hat{\beta}_4 = -0.0158$ log percentage points, equivalent to −0.000158 unscaled log points; country-clustered SE = 0.1127, conventional $p = 0.8903$, wild cluster bootstrap $p = 0.8732$, inverted bootstrap 95% confidence interval $[-0.2796, 0.1940]$) and $h = 5$ ($\hat{\beta}_5 = -0.0148$, bootstrap $p = 0.8970$), before returning to small positive values at $h = 6$ through $h = 8$ ($\hat{\beta}_8 = 0.0309$, SE = 0.1582, bootstrap $p = 0.8537$, WCB 95% interval $[-0.2925, 0.2710]$). Scaled by one cross-country standard deviation of distinct 2021Q4 corporate debt-service exposure across the 16 baseline economies (SD = 9.25 percentage points in Table 1), $\hat{\beta}_4 = -0.0158$ implies a four-quarter cumulative corporate investment differential of −0.15 log percentage points per 100-basis-point policy-rate hike, with an inverted wild-bootstrap 95% confidence interval of $[-2.59, +1.79]$ log percentage points (and −0.17 log percentage points with WCB 95% interval $[-2.44, +1.62]$ under the full-rank Japan-only seasonal specification in Section 6.3). Holding observed full-rank clustered standard errors fixed under a two-sided 5% noncentral-t test ($df = G - 1$), the conditional 80% minimum detectable effect (MDE_{80}) is 0.280 log percentage points per unit exposure (2.59 log percentage points per cross-country standard deviation) at $h = 4$ and 0.282 (2.61 per standard deviation) at $h = 8$. Thus, the cross-country panel rules out large conditional contraction gradients exceeding roughly 2.6 log percentage points per standard-deviation exposure per 100-basis-point hike, while remaining compatible with modest negative or positive heterogeneity.

Scaling capital expenditures by contemporaneous corporate internal cash generation in Panel B of Table 2 yields parallel results: the interaction slope of the nominal corporate investment-to-gross-operating-surplus ratio is −0.0108 percentage points at $h = 4$ (SE = 0.1370, bootstrap $p = 0.9401$, WCB 95% interval $[-0.3899, 0.2956]$) and −0.0304 percentage points at $h = 8$ (SE = 0.2290, bootstrap $p = 0.9072$, WCB 95% interval $[-0.4641, 0.4465]$). Figure 2 (Panel a) and Panel C of Table 2 clarify the role of institutional sector disaggregation: on the 17-economy aggregate investment sample, short-horizon point estimates are mildly negative ($\hat{\beta}_0 = -0.0307$, WCB 95% interval $[-0.1443, 0.0455]$; $\hat{\beta}_1 = -0.0265$,

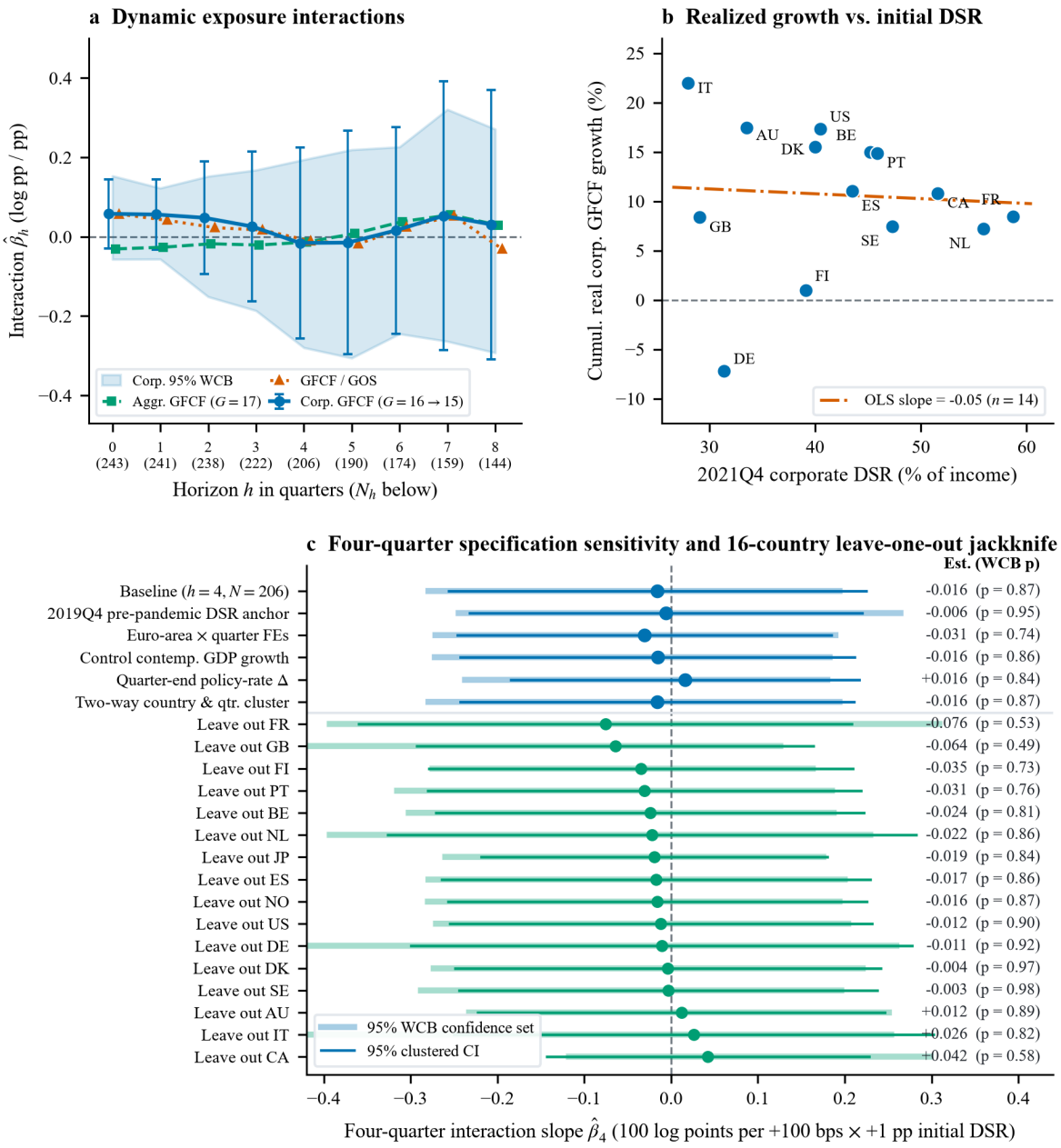


Figure 2. Dynamic local-projection paths for corporate and aggregate investment, raw cross-country growth scatter, and specification diagnostics.

Notes. Panel a plots dynamic exposure-interaction coefficients $\hat{\beta}_h$ from Equation (3) over horizons $h = 0, \ldots, 8$ for real non-financial corporate fixed capital formation ($G = 16 \to 15$, $N_0 = 243$ to $N_8 = 144$), displaying 95% conventional country-clustered error bars and the shaded 95% restricted wild cluster bootstrap confidence set alongside point paths for full-sample aggregate investment ($G = 17$), matched-sample aggregate investment ($G = 16 \to 15$), and the corporate investment-to-surplus ratio. Panel b plots unconditional cumulative real corporate fixed capital formation change from 2021Q4 to 2025Q4 ($100[\log I_{c,2025Q4} - \log I_{c,2021Q4}]$) against 2021Q4 corporate debt-service ratios across the $n = 14$ baseline economies with complete 2025Q4 corporate observations (excluding Japan and Norway due to earlier series endpoints; ordinary least squares slope = −0.05, $r = -0.06$). Panel c displays four-quarter ($h = 4$) estimates, thin conventional 95% intervals, thick 95% WCB intervals, and right-column WCB p-values across full-rank Japan-only seasonal fixed effects, alternative anchors, euro-area-by-quarter fixed effects, contemporaneous output and rate-timing checks, the pre-response test ($t - 5$ to $t - 1$), and all 16 leave-one-country-out subsamples (with the wide-scale 2016–2017 placebo noted at bottom).

WCB 95% interval $[-0.1957, 0.0932]$), reflecting interest-sensitive residential construction embedded inside economy-wide capital formation, whereas on the matched 16-economy corporate sample ($N_4 = 206$) the aggregate investment interaction is +0.0104 at $h = 0$ (bootstrap $p = 0.6117$) and +0.0251 at $h = 4$ (SE = 0.0542, bootstrap $p = 0.5419$). Consistently, the unconditional cross-country scatter across the 14 economies reporting corporate investment through 2025Q4 in Figure 2 (Panel b) exhibits a flat bivariate slope of −0.05 log percentage points per exposure point ($r = -0.06$).

6. Sectoral Reset Mechanisms, Emerging-Market Benchmarks, and Robustness

6.1. Corporate-versus-Household Debt-Service Reset Dynamics

To examine why higher 2021Q4 corporate debt-service ratios were not accompanied by steeper post-hike corporate investment contractions, Table 3 estimates the sectoral debt-service reset projections in Equation (4) across the 17 reporting economies ($N_0 = 272$, $N_4 = 221$, and $N_8 = 153$ through the 2026Q1 debt-service endpoint).

Table 3. Cross-country sectoral debt-service and credit-intensity local projections ($h = 0, 1, 4, 8$).

Specification	$h = 0$	$h = 1$	$h = 4$	$h = 8$
Corporate DSR: $\Delta r_{c,t}\times$ 2021Q4 corporate DSR ($G = 17$)	-0.0152 (0.0134)	-0.0346 (0.0297)	-0.0560 (0.0962)	-0.0768 (0.0680)
[Cluster p/WCB p]	[0.2728/0.2616]	[0.2617/0.3150]	[0.5685/0.6501]	[0.2760/0.2591]
Household DSR: $\Delta r_{c,t}\times$ 2021Q4 corporate DSR ($G = 17$)	-0.0030 (0.0038)	-0.0080 (0.0087)	-0.0221 (0.0178)	-0.0066 (0.0137)
[Cluster p/WCB p]	[0.4509/0.4755]	[0.3734/0.4303]	[0.2320/0.3384]	[0.6365/0.6893]
Corporate-minus-household DSR gap interaction ($G = 17$)	-0.0122 (0.0123)	-0.0266 (0.0256)	-0.0339 (0.0866)	-0.0702 (0.0705)
[Cluster p/WCB p]	[0.3357/0.2989]	[0.3144/0.3282]	[0.7011/0.7456]	[0.3346/0.3166]
Corporate DSR slope at mean initial exposure $\hat{\phi}_h^N$ ($G = 17$)	0.0114 (0.4868)	-0.3793 (0.8366)	-0.6059 (1.7603)	-0.7314 (1.7163)
[Cluster p/WCB p]	[0.9816/0.9792]	[0.6564/0.6500]	[0.7352/0.7487]	[0.6757/0.6725]
Household DSR slope at mean initial exposure $\hat{\phi}_h^H$ ($G = 17$)	0.1031 (0.0480)	0.1417 (0.1226)	0.0170 (0.4288)	0.7947 (0.2466)
[Cluster p/WCB p]	[0.0475/0.0624]	[0.2645/0.2973]	[0.9688/0.9662]	[0.0053/0.0147]
Sector DSR gap slope at mean initial exposure $\hat{\phi}_h^{\text{gap}}$ ($G = 17$)	-0.0918 (0.4967)	-0.5210 (0.8388)	-0.6229 (1.6287)	-1.5261 (1.8089)
[Cluster p/WCB p]	[0.8557/0.8511]	[0.5433/0.5351]	[0.7071/0.7202]	[0.4113/0.4103]
Four-quarter cumulative rate change × corporate DSR ($G = 17$)	-0.0052 (0.0049)	-0.0105 (0.0103)	-0.0201 (0.0273)	-0.0272 (0.0231)
[Cluster p/WCB p]	[0.3041/0.3595]	[0.3260/0.4004]	[0.4711/0.5351]	[0.2557/0.2450]
Real corporate investment: $\Delta r_{c,t}\times$ 2021Q4 credit/GDP ($G = 24/23$)	0.0044 (0.0118)	0.0088 (0.0173)	0.0114 (0.0527)	0.0600 (0.0487)
[Cluster p/WCB p]	[0.7112/0.6213]	[0.6158/0.6394]	[0.8301/0.7971]	[0.2308/0.1934]

Notes. Columns report quarterly horizons $h = 0, 1, 4, 8$ ($N = 272, 272, 221, 153$ across $G = 17$ economies for sectoral debt-service models; $N = 371, 369, 316, 222$ across $G = 24, 24, 24, 23$ economies for the corporate credit-intensity investment model). Parentheses report small-sample country-clustered standard errors; brackets report pointwise [cluster p/WCB p] from 9,999 restricted Rademacher wild cluster bootstrap draws.

Three mechanism patterns emerge in Table 3. First, contrary to Hypothesis 2, the exposure interaction on corporate debt-service ratios ($\hat{\delta}_h^N$) is negative and statistically indistinguishable from zero across horizons (−0.0560 at $h = 4$, bootstrap $p = 0.6501$; −0.0768 at $h = 8$, bootstrap $p = 0.2591$, WCB 95% interval $[-0.2365, 0.0896]$), and the directly estimated corporate-minus-household gap interaction

($\hat{\delta}_h^{\text{gap}}$) is likewise negative and unresolved (−0.0702 at $h = 8$, bootstrap $p = 0.3166$, WCB 95% interval [−0.2509, 0.0926]).

Second, evaluated at sample-mean initial exposure, household debt-service burdens exhibit a statistically resolved upward trajectory at the two-year horizon: a 100-basis-point quarterly policy-rate increase corresponds to +0.1031 percentage points on impact (conventional $p = 0.0475$, wild cluster bootstrap $p = 0.0624$) and +0.7947 percentage points at $h = 8$ quarters (SE = 0.2466, conventional $p = 0.0053$, conventional t_{16} 95% confidence interval [0.2719, 1.3174], pointwise wild cluster bootstrap $p = 0.0147$, inverted WCB 95% confidence interval [0.2275, 1.2862]). Over the same two-year horizon, the mean-exposure corporate debt-service slope is negative and imprecise (−0.7314 percentage points, SE = 1.7163, bootstrap $p = 0.6725$, WCB 95% interval [−4.1359, 3.4121]), so the direct corporate-minus-household slope differential ($\hat{\phi}_8^{\text{gap}} = -1.5261$ percentage points, SE = 1.8089, bootstrap $p = 0.4103$, WCB 95% interval [−5.0830, 2.8670]) does not establish a statistically significant cross-sector difference on its own, though its point sign runs opposite to Hypothesis 2 ($\Delta_h S^N - \Delta_h S^H > 0$). Through Equation (2), widespread corporate maturity extension prior to 2022 (Crouzet, 2018) alongside nominal operating-surplus expansion during post-2021 inflation buffered corporate denominators, while adjustable-rate and renewing household mortgages gradually repriced upward.

Third, using four-quarter cumulative policy-rate changes leaves corporate and sector-gap interactions unresolved across all horizons, and replacing 2021Q4 debt-service ratios with 2021Q4 non-financial corporate credit-to-GDP ratios—expanding real corporate investment coverage from 16 to 24 economies ($N_0 = 371$, $N_4 = 316$, $N_8 = 222$)—similarly yields small, imprecise positive interactions ($\hat{\beta}_4 = 0.0114$, SE = 0.0527, bootstrap $p = 0.7971$; $\hat{\beta}_8 = 0.0600$, SE = 0.0487, bootstrap $p = 0.1934$).

6.2. External Emerging-Market Boundary Benchmark: Regional Financing in Kazakhstan

Equation (2) implies that capital formation becomes insulated from bank-loan repricing when internal enterprise funds finance the bulk of investment ($\phi_c \to 1$). Table 4 and Figure 3 evaluate Hypothesis 3 across Kazakhstan's 20 contemporary regions and 16 consolidated historical parent regions during 2024, 2025, and January–September 2026 (Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 2025; Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 2026), examining realized subnational investment funding under central bank base rates of 14.25%–18.00% and Resolution No. 52's 0.50 retail debt-service-to-income cap (National Bank of the Republic of Kazakhstan, 2026; Agency of the Republic of Kazakhstan for Regulation and Development of the Financial Market, 2025).

Table 4. Subnational fixed-capital financing structure in Kazakhstan (2024–2026Q3).

Financing component and regional metric	2024	2025	2026Q1–Q3	Benchmark
National total fixed-capital investment (trillion KZT)	19.46	23.49	16.08	16.08–23.49
Enterprise own-funds share: national weighted (%)	54.95	53.17	55.70	53.17–55.70
20-region unweighted mean (SD)	51.02 (16.50)	50.73 (14.08)	52.63 (13.27)	60/60 (>bank)
16-parent consolidated mean (SD)	52.01 (16.10)	52.19 (12.95)	54.56 (10.99)	48/48 (>bank)
Individual developers' own-funds share: national weighted (%)	7.94	7.99	10.14	7.94–10.14
Total bank-loans share: national weighted (%)	4.01	4.59	5.56	4.01–5.56
20-region unweighted mean (SD)	3.36 (2.69)	4.62 (2.90)	6.11 (6.07)	Dom. 2.91–5.29%
16-parent consolidated mean (SD)	3.76 (2.76)	4.17 (2.51)	4.80 (3.80)	For. 0.27–1.10%
Government budget-funds share: national weighted (%)	21.63	21.54	14.28	14.28–21.63

(continued)

Table 4 (continued)

Financing component and regional metric	2024	2025	2026Q1–Q3	Benchmark
Other borrowed funds share (incl. nonresident non-bank, %)	11.47	12.71	14.33	Ext. 3.53–4.33%
National Bank of Kazakhstan base rate: time-weighted mean (%)	14.68	16.59	17.47	14.25–18.00%

Notes. Columns report full-year 2024, full-year 2025, cumulative January–September 2026, and cross-period summary benchmarks across Kazakhstan's $N = 20$ contemporary administrative regions and 16 consolidated historical parent regions. Regional standard deviations use the sample $N-1$ denominator (19 for contemporary regions; 15 for consolidated parent regions), whereas the orthogonal between-/within-parent variance decomposition in Figure 3c uses exact $N = 20$ population weights ($n_p/20$, $n_p \in \{1, 2\}$). Dom., For., and Ext. denote national domestic-bank, foreign-bank-branch, and combined external (foreign-bank plus nonresident non-bank) financing shares. Unrounded primary financing shares reconcile to 100% in every period.

At the national level (Table 4), total own funds account for 62.89% of the 19.46 trillion KZT invested in 2024, 61.16% of the 23.49 trillion KZT invested in 2025, and 65.84% of the 16.08 trillion KZT invested over January–September 2026 (reported on its nine-month cumulative basis without annualization). Separating own funds of enterprises and organizations from individual residential developers' funds (7.94%, 7.99%, and 10.14%) shows that enterprise and organization internal funds supply 54.95% of national capital formation in 2024, 53.17% in 2025, and 55.70% in January–September 2026. Combined with government budget funds (21.63%, 21.54%, and 14.28%, reflecting fourth-quarter fiscal capital disbursement seasonality), enterprise own funds and public budgets together finance 76.58% of national fixed investment in 2024, 74.71% in 2025, and 69.98% in January–September 2026. Total bank loans—summing domestic commercial banks (2.91%, 4.29%, and 5.29%) and foreign bank branches (1.10%, 0.31%, and 0.27%)—account for 4.01%, 4.59%, and 5.56%, while other non-bank borrowed funds supply 11.47%–14.33% (with combined foreign bank and nonresident non-bank borrowing equal to 4.33%, 3.94%, and 3.53%).

Across all 20 contemporary regions in 2025, Figure 3 (Panel a) shows wide spatial dispersion around the 53.17% national enterprise own-funds share—spanning from public-budget-intensive Zhetysu, Kyzylorda, North Kazakhstan, and Turkestan at the bottom to hydrocarbon and metallurgical centers such as Atyrau, Karaganda, Pavlodar, and Mangystau at the top—while bank credit remains a minor slice across jurisdictions. In Figure 3 (Panel b), the regional empirical cumulative distribution of enterprise own-funds shares lies entirely to the right of the bank-loan share distribution in all three periods: enterprise and organization own funds strictly exceed total bank loans in all 60 region-period observations, supporting Hypothesis 3. Unweighted 20-region mean enterprise own-funding shares equal 51.02% (sample SD = 16.50 with $N - 1 = 19$ denominator, corresponding to sample variance $s^2 = 272.12$ and exact $N = 20$ population variance $\sigma^2 = \frac{19}{20}s^2 = 258.51$ squared percentage points), 50.73% (SD = 14.08, $s^2 = 198.19$, $\sigma^2 = 188.28$), and 52.63% (SD = 13.27, $s^2 = 176.18$, $\sigma^2 = 167.37$). Weighting each of the 16 consolidated historical parent clusters by its constituent contemporary region share $n_p/20$ ($n_p = 2$ for split parent clusters and $n_p = 1$ for unsplit regions), Figure 3 (Panel c) shows that between-parent variation accounts for 90.80% of cross-regional population variance in 2024 (234.73 of 258.51), 82.28% in 2025 (154.91 of 188.28), and 71.79% in January–September 2026 (120.16 of 167.37).

6.3. Robustness, Full-Rank Seasonality, Placebo, and Country-Exclusion Diagnostics

Table 5 and Figure 2 (Panel c) subject the baseline corporate investment estimate ($\hat{\beta}_4 = -0.0158$) to full-rank Japan-only seasonal fixed effects, pre-pandemic exposure anchoring, currency-union fixed effects, contemporaneous output controls, alternative rate timing, pre-tightening placebo and pre-response falsification checks, two-way clustering, and exhaustive leave-one-country-out jackknife estimation.

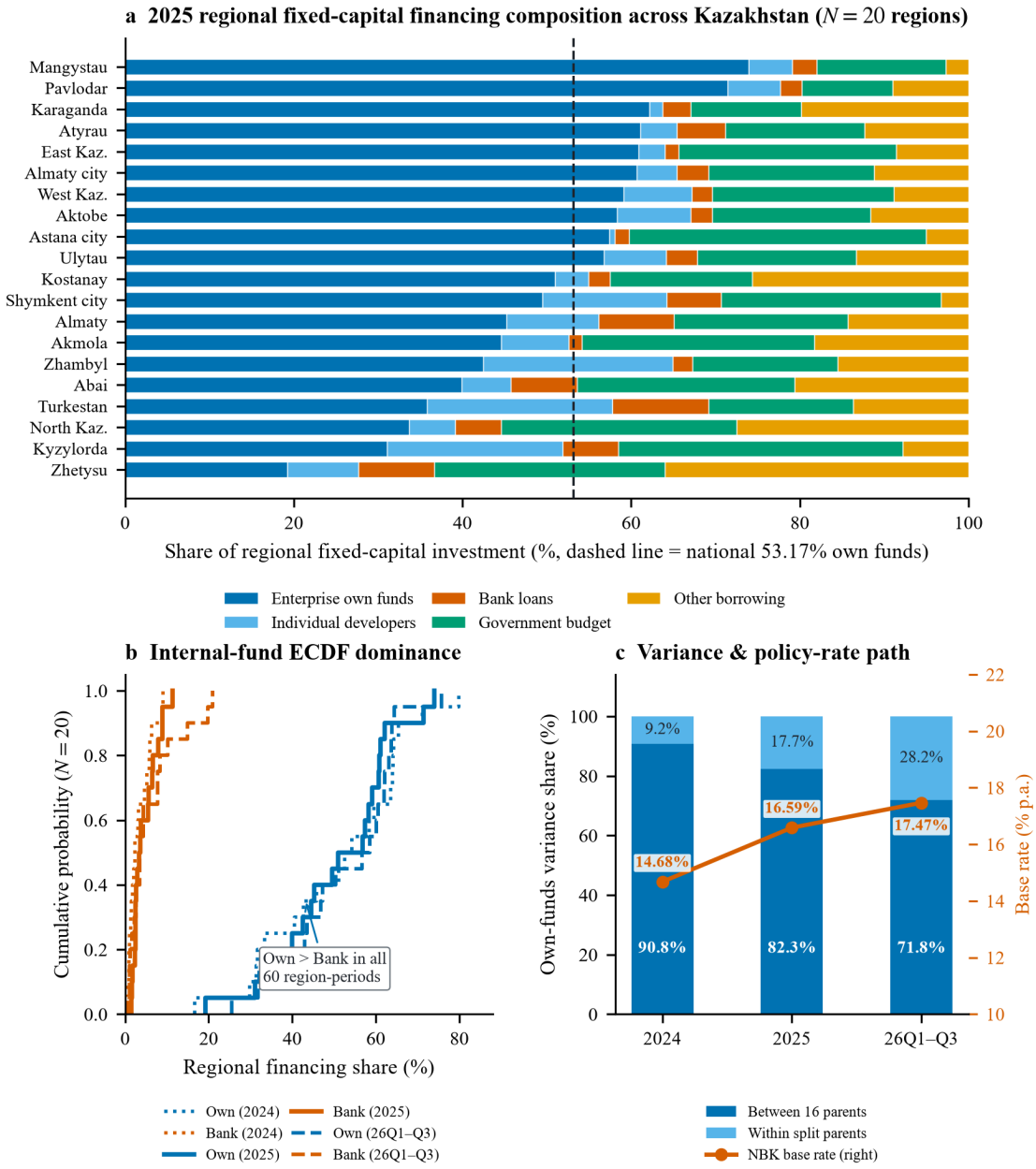


Figure 3. Subnational fixed-capital financing shares, enterprise own-funding dominance, and spatial variance decomposition in Kazakhstan (2024–2026Q3).

Notes. Panel a plots 2025 regional fixed-capital investment financing shares (summing to 100% in each region) across all $N = 20$ contemporary regions of Kazakhstan, ordered by enterprise and organization own-funds share, into enterprise own funds, individual residential developers' own funds, total bank loans, government budget funds, and other borrowed funds; the vertical dashed reference line marks the 2025 national weighted enterprise own-funds share (53.17%). Panel b plots empirical cumulative distribution functions comparing regional enterprise own-funds shares against regional total bank-loan shares across $N = 20$ contemporary regions in 2024, 2025, and January–September 2026 (60 region-period cells total). Panel c decomposes the exact population variance ($N = 20$ denominator) of regional enterprise own-funds shares into between-parent variance across 16 consolidated historical parent regions (weighted by $n_p/20$, $n_p \in \{1, 2\}$) and within-parent split-region variance alongside the time-weighted National Bank of Kazakhstan base rate.

Table 5. Robustness, full-rank seasonality, placebo, pre-response, and country-exclusion diagnostics for real corporate fixed capital formation.

Diagnostic specification	h	$\hat{\beta}$	Cluster SE	Cluster CI	Cluster p	WCB p	N	G
Baseline corporate specification (2021Q4 anchor)	4	-0.0158	0.1127	[-0.2560, 0.2244]	0.8903	0.8732	206	16
Full-rank Japan-only seasonal indicators ($K = 42$)	4	-0.0189	0.0933	[-0.2177, 0.1800]	0.8425	0.8412	206	16
Full-rank Japan-only seasonal indicators ($K = 37$)	8	0.0470	0.0937	[-0.1539, 0.2480]	0.6235	0.5980	144	15
Pre-pandemic exposure anchor (2019Q4 DSR)	4	-0.0058	0.1060	[-0.2318, 0.2201]	0.9568	0.9518	206	16
Euro-area × quarter fixed effects	4	-0.0309	0.1010	[-0.2462, 0.1843]	0.7635	0.7383	206	16
Contemporaneous real GDP growth control	4	-0.0155	0.1065	[-0.2425, 0.2114]	0.8858	0.8620	206	16
Quarter-end policy-rate changes	4	0.0164	0.0940	[-0.1841, 0.2168]	0.8643	0.8411	206	16
Two-way country and quarter clustering	4	-0.0158	0.1050	[-0.2426, 0.2110]	0.8826	0.8732	206	16
Pseudo-tightening placebo (2016–2017, 2015Q4 anchor)	4	0.2914	1.3388	[-2.5621, 3.1449]	0.8306	0.8014	124	16
Four-quarter pre-response diagnostic ($t-5$ to $t-1$)	-1	0.1271	0.1254	[-0.1401, 0.3943]	0.3267	0.3961	245	16
Leave-one-out range at $h = 4$: omit France (min)	4	-0.0757	0.1323	[-0.3595, 0.2081]	0.5764	0.5306	192	15
Leave-one-out range at $h = 4$: omit Canada (max)	4	0.0425	0.0865	[-0.1431, 0.2280]	0.6312	0.5807	192	15
Leave-one-out short-horizon sensitivity: omit Canada	1	0.0839	0.0318	[0.0158, 0.1521]	0.0193	0.0161	225	15
Leave-one-out short-horizon sensitivity: omit Canada	2	0.0949	0.0423	[0.0042, 0.1856]	0.0416	0.0326	222	15

Notes. Each row modifies Equation (3) while retaining country and quarter fixed effects and two predetermined lags. The full-rank Japan-only seasonal rows restrict calendar-quarter indicators (Q2, Q3, Q4; Q1 reference) strictly to Japan's unadjusted series, eliminating all redundant seasonal interactions (zero omitted collinear terms; inverted WCB 95% intervals $[-0.2635, 0.1755]$ at $h = 4$ and $[-0.1836, 0.2169]$ at $h = 8$). The 2016–2017 placebo uses a 2015Q4 exposure anchor so eight-quarter forward outcomes conclude by 2019Q4 (inverted WCB 95% interval $[-3.8670, 10.1792]$). The pre-response diagnostic regresses cumulative real corporate investment growth from $t-5$ to $t-1$ on $\Delta r_{c,t}(E_c - \bar{E})$ with controls dated $t-5$ and $t-6$ (inverted WCB 95% interval $[-0.1279, 0.3995]$). The final two rows report the sole jackknife cells with pointwise WCB $p < 0.05$ across all $16 \times 9 = 144$ country-by-horizon cells.

Restricting seasonal fixed effects strictly to Japan's unadjusted corporate accounts in rows 2–3 of Table 5 restores a full-rank design matrix across every horizon ($K = 44$ with residual degrees of freedom 199 at $h = 0$; $K = 42$ and residual $df = 164$ at $h = 4$; $K = 37$ and residual $df = 107$ at $h = 8$), tightening clustered standard errors by 17% at $h = 4$ and 41% at $h = 8$ while leaving the conditional gradient near zero: $\hat{\beta}_0 = 0.0530$ (WCB $p = 0.2329$), $\hat{\beta}_1 = 0.0684$ (WCB $p = 0.1049$), $\hat{\beta}_2 = 0.0485$ (WCB $p = 0.4235$), $\hat{\beta}_4 = -0.0189$ (SE = 0.0933, WCB $p = 0.8412$, WCB 95% interval $[-0.2635, 0.1755]$), $\hat{\beta}_6 = 0.0176$ (WCB $p = 0.8710$), and $\hat{\beta}_8 = 0.0470$ (SE = 0.0937, WCB $p = 0.5980$, WCB 95% interval $[-0.1836, 0.2169]$). Anchoring exposure in 2019Q4 ($\hat{\beta}_4 = -0.0058$, WCB $p = 0.9518$), absorbing euro-area-by-quarter fixed effects ($\hat{\beta}_4 = -0.0309$, WCB $p = 0.7383$), clustering two-way by country and quarter (SE = 0.1050, $p = 0.8826$), controlling for contemporaneous real output growth ($\hat{\beta}_4 = -0.0155$,

WCB $p = 0.8620$), or using quarter-end policy-rate changes ($\hat{\beta}_4 = 0.0164$, WCB $p = 0.8411$) yields consistent near-zero point estimates.

Temporal falsification checks fail to detect statistically significant pre-tightening divergence, though wide finite-sample intervals temper strong structural claims. Over the 2016–2017 pseudo-tightening window anchored to 2015Q4 debt-service ratios ($N = 124$, residual $df = 46$), the four-quarter interaction is noisy ($\hat{\beta}_4 = 0.2914$, SE = 1.3388, WCB $p = 0.8014$, WCB 95% interval $[-3.8670, 10.1792]$). Regressing cumulative corporate investment growth over $t-5$ to $t-1$ on subsequent policy-rate interactions yields $\hat{\beta}_{-1} = 0.1271$ (SE = 0.1254, conventional 95% interval $[-0.1401, 0.3943]$, WCB $p = 0.3961$, $N = 245$). Dropping each of the 16 baseline economies one at a time at $h = 4$ produces estimates bounded between −0.0757 (omitting France, WCB $p = 0.5306$) and +0.0425 (omitting Canada, WCB $p = 0.5807$), with all 16 pointwise bootstrap p-values exceeding 0.49. Across all 144 country-by-horizon jackknife cells, only omitting Canada at $h = 1$ ($\hat{\beta}_1 = 0.0839$, WCB $p = 0.0161$) and $h = 2$ ($\hat{\beta}_2 = 0.0949$, WCB $p = 0.0326$) reaches pointwise $p < 0.05$, both with positive signs opposite to Hypothesis 1.

7. Methodological Limitations and Interpretation Boundaries

Four methodological and measurement boundaries frame our conclusions. First, quarterly policy-rate changes $\Delta r_{c,t}$ reflect endogenous central bank reactions to domestic inflation and output conditions (Gertler & Karadi, 2015; Alessandri et al., 2025), and inference across horizons and subsamples is conducted pointwise. Although country fixed effects, observation-quarter fixed effects, euro-area-by-quarter interactions, and predetermined lags absorb time-invariant national structure and common global shocks, unobserved country-specific demand resilience coinciding with steeper hikes in higher-debt economies could attenuate negative structural investment elasticities toward zero. Moreover, with 15 to 16 clusters in the corporate baseline, inverted wild-bootstrap confidence intervals span $[-0.2796, 0.1940]$ log percentage points per unit exposure at $h = 4$ ($[-0.2635, 0.1755]$ under full-rank seasonal indicators, with $\text{MDE}_{80} = 2.59$ log percentage points per cross-country standard deviation), and numerical grid inversion cannot rule out arbitrarily narrow disconnected acceptance regions outside the tested grid; the evidence establishes an unresolved conditional gradient within finite-cluster precision bounds, distinct from an exact zero causal elasticity.

Second, the standardized compilation methodology of the Bank for International Settlements fixes remaining amortization maturities at $M_N = 13$ years for non-financial corporations and $M_H = 18$ years for households across all reporting jurisdictions and quarters (Bank for International Settlements, 2015). Published cross-country differences in sectoral debt-service ratios therefore capture debt-to-income ratios and average effective interest rates while leaving unobserved any cross-national dispersion in contractual maturity walls or floating-rate loan shares (Ippolito et al., 2018; Poeschl, 2023).

Third, institutional-sector corporate capital formation is deflated using country-specific economy-wide gross fixed capital formation price indices (or gross domestic product deflator fallbacks) because sector-specific corporate capital-goods deflators are unpublished, and United States integrated macroeconomic accounts include equity real estate investment trust residential structures inside the corporate perimeter (Board of Governors of the Federal Reserve System, 2026). Earlier series endpoints for Norway (2023Q2) and Japan (2025Q1) likewise reduce late-horizon cluster counts from 16 to 15.

Fourth, Kazakhstan serves strictly as an external institutional boundary benchmark outside the 16-economy OECD corporate sample. Its statistical category of enterprises and organizations aggregates private corporations with state-owned enterprises and non-corporate organizations, measures realized investment funding without observing loan applications or rejected credit demand (Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 2026), and pairs with a statutory 0.50 borrower debt-service cap that governs covered natural-person retail borrowing while

leaving corporate bank and bond obligations outside its statutory perimeter (Agency of the Republic of Kazakhstan for Regulation and Development of the Financial Market, 2025).

8. Conclusion and Policy Implications

Evaluating the 2022–2025 global monetary tightening cycle across harmonized quarterly institutional sector accounts and an external emerging-market financing benchmark recalibrates standard priors on aggregate debt-service transmission. First, across 16 advanced economies reporting institutional-sector corporate capital formation (and 24 economies in corporate credit-intensity extensions), higher pre-tightening 2021Q4 corporate debt-service ratios did not generate a statistically distinguishable conditional contraction gradient in real corporate fixed investment ($\hat{\beta}_4 = -0.0158$ log percentage points, WCB $p = 0.8732$; full-rank seasonal $\hat{\beta}_4 = -0.0189$, WCB $p = 0.8412$, ruling out conditional differentials beyond $\text{MDE}_{80} = 2.59$ log percentage points per cross-country standard deviation at 80% power) or in corporate investment-to-surplus ratios. Second, evaluated at mean initial exposure across 17 reporting economies, household debt-service ratios rose by +0.7947 percentage points two years after a 100-basis-point quarterly rate hike (WCB $p = 0.0147$), whereas corporate debt-service (-0.7314, WCB $p = 0.6725$) and direct corporate-minus-household gap (-1.5261, WCB $p = 0.4103$) slopes remained statistically unresolved amid nominal operating-surplus repricing. Third, across all 20 administrative regions of Kazakhstan under 14.25%–18.00% policy rates, enterprise and organization own funds supplied 53.17%–55.70% of realized fixed-capital formation against 4.01%–5.56% from bank loans, exceeding bank credit in all 60 region-period cells.

Three policy implications follow for central banks and financial-stability authorities. First, macro-financial surveillance should complement aggregate corporate debt-service ratios—computed under uniform 13-year maturity conventions—with granular credit-registry indicators tracking contractual maturity walls, undrawn credit-line covenants, and nominal operating-margin pass-through jointly. Second, international statistical compilers should supplement constant-maturity sectoral debt-service ratios with maturity-bucketed interest-coverage distributions disaggregated between floating-rate bank borrowers and fixed-rate bond issuers. Third, in high-interest resource-exporting emerging economies where enterprise and organization own funds plus government capital budgets finance roughly seven-tenths to three-quarters of realized fixed investment (76.58% in 2024, 74.71% in 2025, and 69.98% in January–September 2026) while bank credit supplies roughly one-twentieth, domestic credit-channel tightening bears unevenly across sectors, warranting coordinated fiscal-investment and household macroprudential monitoring alongside headline policy-rate decisions.

Statements

Data availability. Primary macroeconomic, institutional-sector, and regional financing series analyzed in this study originate from public releases of the Bank for International Settlements, Eurostat, the Organisation for Economic Co-operation and Development, the Board of Governors of the Federal Reserve System, the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, the National Bank of the Republic of Kazakhstan, and the Legal Information System of Regulatory Legal Acts of the Republic of Kazakhstan. The archived source snapshots, harmonized cross-country and regional panels, and complete replication code have been permanently deposited in Zenodo at https://doi.org/10.5281/zenodo.24199634.

AI declaration. Assistance from OpenAI Codex was restricted to translating and proofreading Russian- and Kazakh-language statistical and regulatory materials, harmonizing source datasets, and verifying estimation scripts at the implementation level. Every assisted step was independently inspected and validated by all authors, who completed all remaining research and writing tasks and assume full responsibility for the article.

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