CHAPTER

1

GLOBAL FINANCIAL STABILITY REPORT

Online Annex 1.1 Basis Trade Profitability[1]

Although profitability has supported expansion of the basis trade, risks of unwinding are elevated and could interact with repo market stress in a destabilizing feedback loop.

Cash and futures basis trades are arbitrage investment strategies that involve buying a Treasury bond using repo financing and simultaneously selling Treasury futures. Typically, hedge funds use this trade to capture the levered price differential between the two instruments. Proxies for the size of this trade, which include hedge funds' net short Treasury futures positions reported by the Commodities Futures Trading Commission (CFTC) and sponsored repo volumes reported by the Office of Financial Research, suggest approximately [$1 trillion], after rapid growth in recent years. The scale, leverage, and reliance on short-term repo funding have raised concerns that a disorderly unwinding could amplify Treasury yield volatility and expose bond market fragilities (see October 2024 Global Financial Stability Report; Kashyap and others 2025; FSB 2026). This Annex constructs a proxy for the Treasury cash-futures basis profitability and evaluates downside risks to the basis trade.

Basis trade profitability methodology

This section describes the construction of the Treasury cash-futures basis profitability measure. The measure is computed from the perspective of a long-cash / short-futures trading strategy and is intended to capture the expected annualized return to a stylized Treasury basis trade. The approach follows the economic logic Glicoes et al., (2024) framework, considering optimal delivery timing, while relying on Bloomberg generic data for empirical implementation.

We define the net basis yield as:

$$BP_{10Y} = \left(\frac{CFxF_t + AI_T + C_{[t,T]} - P_t}{P_t}\right)\frac{360}{T-t} - \frac{Repo_t}{1 - haircut}$$

Where F_t is the 10Y futures price, CF is the conversion factor of the cheapest to deliver (CTD) bond, P_t is the dirty price of the CTD, AI_T is accrued interest on the CTD evaluated at horizon T, and $C_{[t,T]}$ denotes any coupon payments received between t and T. $Repo_t$ is the CTD-specific repo rate, and *haircut* is the associated repo haircut. Repo financing costs are proxied using Bloomberg's "actual" repo rate, which is a general collateral borrowing rate to finance the CTD bond until its maturity. We use this rate to proxy the expected average funding rate over the holding period.

This formula gives the expected annualized profit/loss of a strategy that holds the CTD bond financed by repo while shorting the corresponding futures contract. On day t, the trader buys the CTD bond at price P_t, finances the position via repo $\frac{Repo_t}{1-haircut}$ and sells the futures contract at price F_t, thereby locking in the futures-implied invoice price at convergence. The position is unwound at or before delivery, yielding the futures-implied invoice amount $CFxF_t$, plus any accrued interest AI_T and coupon payments $C_{[t,T]}$.[2]

For the purposes of this calculation, and in the absence of security-specific data, haircuts are assumed to be zero, while recognizing that haircuts may also be negative. We also exclude interim coupon payments. While coupon flows are economically relevant for cash-and-carry strategies, including them introduces discrete shifts

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[1] This annex was prepared by Kleopatra Nikolaou and Jason Wu.

[2] A key accounting principle is that prices are paid today, while accrual, coupons, and financing are cash flows over time. The dirty price is therefore a spot settlement price and does not include accrual beyond date t; future accrual enters only through accrued interest and coupon cash flows.

in the profitability series that obscure the underlying dynamics of price convergence and financing conditions. Excluding coupons yields a smoother and more comparable measure of relative-value conditions over time.

The first step in the empirical implementation is to identify the active futures contract on each day. Because basis trades are capacity-constrained and require deep liquidity, we restrict attention to the most liquid contract. Among the first and second generic contracts (TY1 and TY2), the active contract on date t is defined as the one with higher open interest, subject to a buffer to limit noise-driven switching.[3]

Given the active futures contract, we collect the relevant futures price and conversion factor and identify the associated CTD bond. For the CTD, we obtain the dirty price, coupon characteristics, and repo rate. Accrued interest depends on the assumed holding horizon.

To determine the economically relevant holding period, we compute profitability under two alternative horizons: holding until the first notice date (FND) and holding until the last delivery date (LDD). This yields two basis-profitability measures at each date. We then select the horizon that maximizes the net basis yield and define the final series as the profitability associated with that optimal horizon. Intuitively, the framework assumes that a basis trader endogenously chooses the delivery boundary that maximizes expected annualized returns.

Using this methodology we construct two components of basis trade returns: (i) the “gross basis,” capturing mainly the difference between the cash and futures prices, and (ii) interest rates paid on overnight repos to finance the trade. Basis trade returns—the difference between the gross basis and repo rates after accounting for the growth in basis trade size—were strong prior to the 2019 repo rate spike, subdued from 2020–23, and rose to nearly 2 percent on numerous occasions in late 2024 and 2025 (Figure 1.1.1, panel 1, blue bars), helping explain renewed growth of the trade.

Value at Risk (VAR) methodology

We then evaluate downside risks to the basis trade using a 95th percentile value-at-risk (VaR) model applied to weekly basis trade returns, estimated with a GARCH(1,1) model. VaR is a common risk management tool that gauges the maximum loss, one week-ahead, with 5 percent probability (Figure 1.1.1, panel 1, red line).

The results suggest that unwinding risk increases when the VaR becomes larger and more volatile, and when returns “breach,” or exceed, the VaR. By these metrics, vulnerabilities have risen since 2022. The VaR peaked in late 2023 and has remained more volatile than in previous years. VaR breaches—statistically expected to occur 5 percent of the time—amounted to 10 percent in 2022 and 15 percent in 2023, before moderating more recently (Figure 1.1.1, panel 2). In a scenario in which repo rates spike by 25 basis points per week, the VaR would decline to about -8 percent after eight weeks (Figure 1.1.1, panel 1, shaded region).

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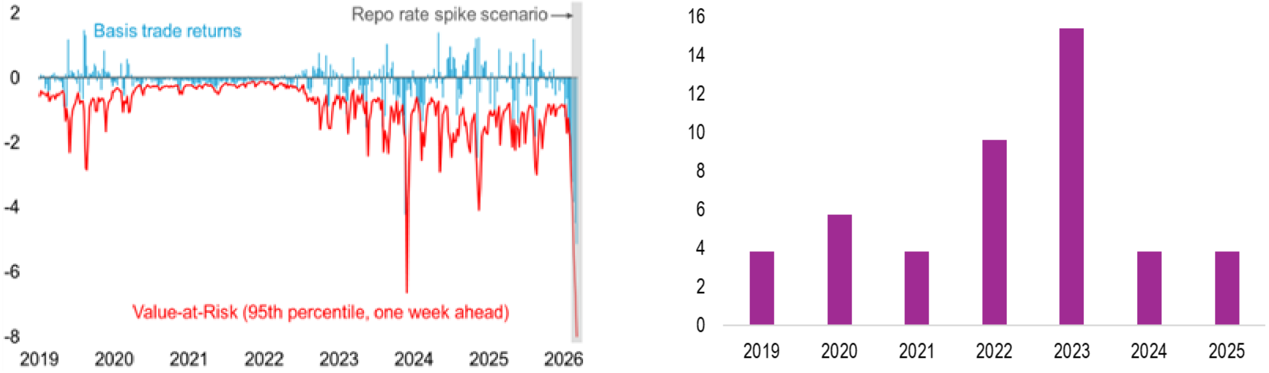
[3] At each date, we define the active 10-year Treasury futures contract as the more liquid of the first and second generic contracts, measured by open interest. Specifically, we select the second generic contract once its open interest exceeds that of the first generic by a fixed buffer, defined as $OI_2 > (1+\delta)OI_1$, where $\delta = 0.5$. Otherwise, the first generic contract remains active. This liquidity-based rule avoids mechanical calendar rolls and ensures that the active contract tracks the contract in which basis-trade activity is concentrated.

Figure 1.1.1. Basis Trade Unwinding Risks Are Elevated Based on a Value-at-Risk Analysis



A value-at-risk for the basis trade has become larger and more volatile.

1. Modeled Weekly Basis Trade Returns and 95th Percentile Value at Risk
(Percent annualized)

Basis trade returns have breached value at risk more frequently.

2. Frequency of Basis Trade Returns Breaching 95th Percentile Value at Risk
(Percent; expectation: 5 percent per year)

Sources: Bloomberg Finance L.P.; Commodities and Futures Trading Commission (CFTC); Office of Financial Research; and IMF staff calculations.
Note: Panel 1 shows model basis trade returns and 95th percentile value-at-risk (VaR). Returns are calculated as the difference between the gross basis (the price differential between cash bonds and futures contracts, adjusted for futures conversion factors and optionality but not coupons) and repo rates matching the basis trade. See Online Annex 1.10 for details. Returns are scaled by an index of aggregate basis trade growth since 2019, based on CFTC data on levered funds' net short positions in Treasury futures. A GARCH (1,1) model with t-distributed errors is used to compute the VaR in-sample. Panel 2 shows incidence of returns breaching the VaR, by year.

Reference

Glicoes, Jonathan, Benjamin Iorio, Phillip Monin, and Lubomir Petrasek (2024). "Quantifying Treasury Cash-Futures Basis Trades," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, March, 08, 2024, https://doi.org/10.17016/2380-7172.3458.

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Online Annex 1.2 Pull and Push Factors for EM Portfolio Flows[1]

The literature on global financial cycles underscores a strong relationship between financial conditions and capital flows (e.g., Miranda-Agrippino and Rey, 2022). Easier global financial conditions—e.g., ease of funding, buoyant asset prices and are associated with surges in capital inflows into emerging markets, whereas episodes of tightening are typically associated with retrenchment and capital outflows. Following Hannan (2017), we examine a set of global “push” factors—primarily global financial conditions—and domestic “pull” factors that are likely to influence emerging market (EM) portfolio flows.

We use the IMF’s Global Financial Conditions Index (FCI) as our primary push (global) factor. The IMF’s Global FCI is explicitly designed as a price-of-risk measure, aggregating information from interest rates, credit spreads, asset prices, and market volatility across major economies. The index captures co-movement across systemically important economies, thereby averaging out idiosyncratic country-specific shocks and isolating a common global component. Easy financial conditions are denoted by an FCI value that is lower than average whereas tight financial conditions are FCIs that are higher than average.

To capture domestic pull factors, we include asset class valuation differences and macro-fundamental variables.[2] For equity flows, we use the equity return differential between the local equity market and the US S&P 500. For bond flows, we use the 10-year government bond yield differential between the local sovereign yield and the US Treasury yield of the same maturity. To proxy for fiscal conditions and sovereign debt supply, we include the change in government debt as a percentage of GDP.[3] Given the importance of trade and external balances for major emerging markets, we also include the change in the current account balance as a percentage of GDP to capture shifts in the balance of payments and a country’s ability to invest abroad. In economies with stronger external positions, larger current account surpluses are expected to be associated with an improved net external financial position, which may materialize predominantly through resident capital outflows. All data are quarterly.

The regression analysis is conducted using a panel framework covering 16 major emerging market economies. We also analyzed regional subsample to assess heterogeneity across regions. The country coverage is as follows: EM Asia: China, India, Indonesia, Malaysia, the Philippines, and Thailand; Latin America (Latam): Brazil, Mexico, Colombia, Chile, and Peru; EMEA: South Africa, Turkey, Poland, Romania, and Hungary. The baseline econometric specifications are described below:

$$(1)\quad EquityFlows_{i,t} = \alpha + \boldsymbol{\beta_1} FCI_t + \boldsymbol{\beta_2} Equity\_Ret\_vs\_SPX_{\,i,t} + \boldsymbol{\beta_3} \Delta Govt\ Debt/GDP_{\,i,t} + \boldsymbol{\beta_4} \Delta Current\ Account/GDP_{\,i,t} + Controls + \epsilon_{i,t}$$

$$(2)\quad DebtFlows_{i,t} = \alpha + \boldsymbol{\beta_1} FCI_t + \boldsymbol{\beta_2} Yield\_Diff\_vs\_UST_{\,i,t} + \boldsymbol{\beta_3} \Delta Govt\ Debt/GDP_{\,i,t} + \boldsymbol{\beta_4} \Delta Current\ Account/GDP_{\,i,t} + Controls + \epsilon_{i,t}$$

Following Hannan (2017), we include a set of structural control variables, namely the financial development index, capital account openness, and trade openness. We controlled for lagged domestic macroeconomic conditions—including inflation, and GDP growth—to capture fundamental drivers and the possibility for persistence in capital flows. We consider the impact of FCI on resident outflows and nonresident inflows

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[1] This annex was prepared by Sally Chen and Jing Zhao.

[2] The correlation between these push(pull) factors is low, which mitigates concerns about multicollinearity in the baseline regressions.

[3] Official government debt-to-GDP data are usually published with a lag; however, government bond issuance is typically announced well in advance as part of the budget process. Investors therefore anticipate debt issuance within the period and adjust portfolio allocations accordingly, which can be reflected in contemporaneous nonresident debt inflows when cross-border transactions are involved. As a robustness check, we also use lagged changes in debt-to-GDP—particularly for equity flows—and obtain qualitatively similar results, albeit with weaker statistical significance.

separately to identify drivers that are specific to these investors' considerations. Country fixed effects are included to control for time-invariant unobserved country-specific characteristics. Standard errors are computed using Driscoll–Kraay estimators to account for potential serial correlation and cross-sectional dependence. The sample spans 2004Q1 to 2025Q3 at a quarterly frequency.[4] Regression results are shown in Table 1.2.1., and data sources are reported in Table 1.2.2.

Table 1.2.1. Baseline Regression Results

Effects of global push and domestic pull factors on EM equity flows.

1. Equity portfolio flows by regions

(Percent of GDP)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	16 EMs		EM Asia ex. CN		Latam		EMEA	
VARIABLES	NR Inflows	Res Outflows	NR Inflows	Res Outflows	NR Inflows	Res Outflows	NR Inflows	Res Outflows
Global FCI	-0.0730	-0.0519	-0.249***	-0.0741*	-0.00617	-0.0355	-0.0576	-0.00737
	(0.0488)	(0.0551)	(0.0682)	(0.0434)	(0.0686)	(0.0957)	(0.0836)	(0.116)
Equity Return vs. SPX	0.0150***	0.0197***	0.0406***	0.00770	0.00518	0.0382***	0.0201*	0.0116
	(0.00417)	(0.00613)	(0.0101)	(0.00517)	(0.00349)	(0.0136)	(0.0113)	(0.00739)
ΔGovt Debt	-0.0458**	-0.000865	0.0326	0.0645	0.0333	-0.0395	-0.0855**	-0.00630
	(0.0217)	(0.0327)	(0.0504)	(0.0494)	(0.0339)	(0.0747)	(0.0349)	(0.0334)
ΔCurrent Account	0.0244*	0.0542**	0.0454*	0.0316**	0.0159	0.186**	0.0218	-0.0307
	(0.0136)	(0.0259)	(0.0243)	(0.0145)	(0.0186)	(0.0753)	(0.0295)	(0.0299)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1,256	1,220	340	353	425	423	406	370
Number of groups	16	16	5	5	5	5	5	5

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Effects of global push and domestic pull factors on EM debt flows.

2. Debt portfolio flows by regions

(Percent of GDP)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	16 EMs		EM Asia ex. CN		Latam		EMEA	
VARIABLES	NR Inflows	Res Outflows	NR Inflows	Res Outflows	NR Inflows	Res Outflows	NR Inflows	Res Outflows
Global FCI	-0.499***	-0.150***	-0.608***	-0.202*	-0.151	-0.120	-0.941**	-0.133***
	(0.166)	(0.0381)	(0.110)	(0.110)	(0.135)	(0.0943)	(0.372)	(0.0384)
10y Yield Diff vs. UST	-0.0288	-0.0186	0.366***	-0.110	0.0654	-0.0363	-0.231**	0.0352
	(0.0458)	(0.0318)	(0.0827)	(0.0840)	(0.114)	(0.0566)	(0.0991)	(0.0289)
ΔGovt Debt	0.287***	0.00569	0.260***	0.0359	0.197*	0.0124	0.326**	-0.0108
	(0.0935)	(0.0264)	(0.0910)	(0.0814)	(0.100)	(0.0593)	(0.153)	(0.0322)
ΔCurrent Account	-0.0906***	0.0118	-0.0242	0.000485	-0.139***	-0.00706	-0.116*	0.0230
	(0.0308)	(0.0241)	(0.0329)	(0.0470)	(0.0500)	(0.0426)	(0.0607)	(0.0151)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1,129	1,024	340	276	375	321	348	348
Number of groups	16	15	5	4	5	5	5	5

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Bloomberg, CEIC, Haver, World Bank, IMF, IMF Staff Calculation.
Note: The BoP database does not provide resident debt outflows for India. Estimated coefficients for control variables are omitted for ease of presentation but are available upon request. "NR" denotes nonresidents; "Res" denotes residents.

In Figure 1.2.1., we illustrate each variable's estimated contribution to recent capital flows by multiplying the estimated regression coefficients by the realized values of the corresponding variables over 2024Q4–2025Q3, separately for nonresident inflows and resident outflows. Overall, looser global financial conditions are associated with both stronger nonresident inflows and larger resident outflows, with the effect being

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[4] The data sample after 2021Q3 for Türkiye has been excluded due to high inflation, which significantly distorts price dynamics and undermines comparability with other EMs.

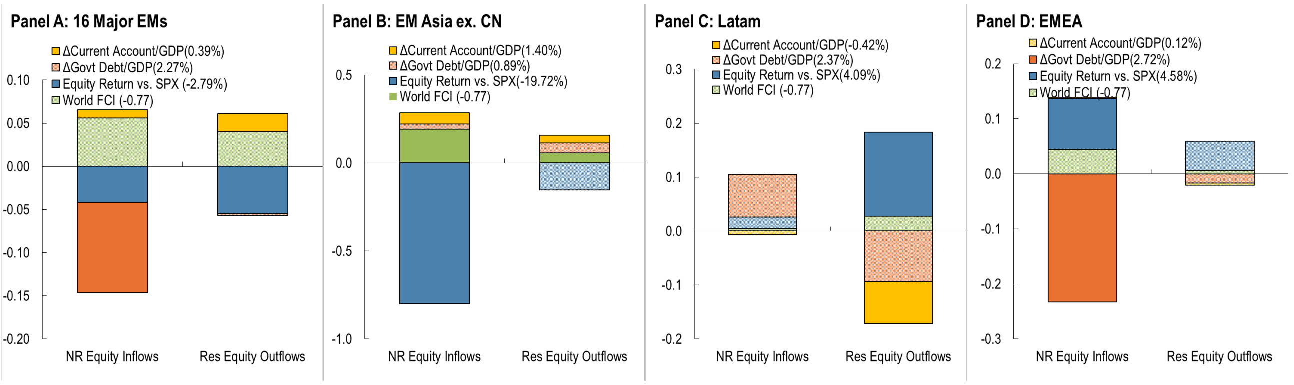
quantitatively larger for nonresident inflows. Equity underperformance has been a key driver of equity outflows from EM Asia, while increased government debt issuance explains a substantial share of nonresident inflows into Latam and EMEA. It should be noted that the figure reports the estimated contributions of four selected factors only; consequently, the stacked values do not match observed aggregate flows exactly. Finally, stronger resident outflows—particularly in EM Asia—can be partly attributed to larger current account surpluses. Other structural factors, such as financial development and capital account openness, also appear to play an increasingly important role, but a detailed discussion of these channels is left for future research.

Figure 1.2.1. Contribution of Key Push and Pull Factors

Relative equity return differentials have been a key driver of equity flows across regions.

1. Contribution to recent equity flows

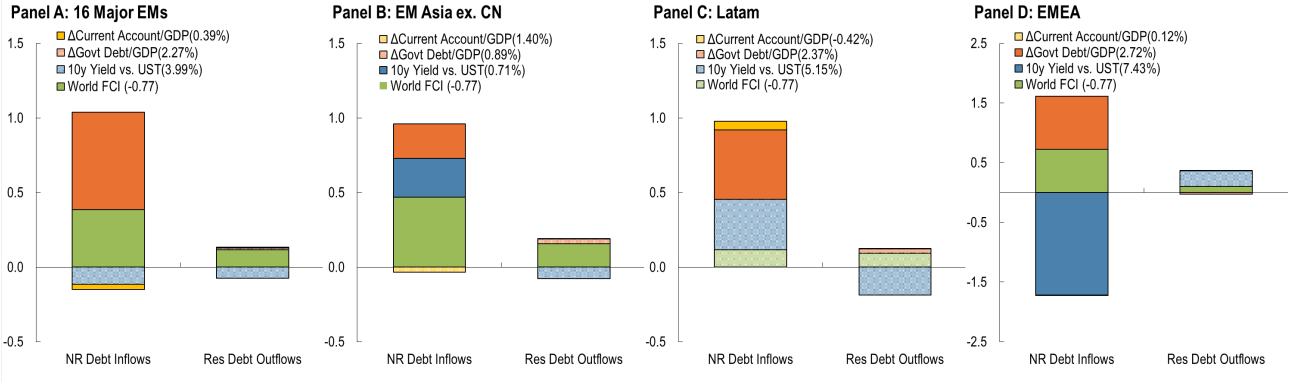
(Percent of GDP)



Loose global financial conditions and increased government debt issuance have contributed significantly to recent EM debt inflows.

2. Contribution to recent debt flows

(Percent of GDP)



Source: Bloomberg, CEIC, Haver, World Bank, IMF, IMF Staff Calculation.
Note: The contribution of each variable is computed as the estimated regression coefficient multiplied by the variable's value over 2024Q4–2025Q3. The values of these variables are shown in parentheses in the legend. The panel regressions relate net equity (debt) inflows, nonresident equity (debt) inflows, and resident equity (debt) flows to the world FCI, equity-return (or 10-year yield) differentials, the change in government debt, and the change in the current account balance. The specification controls for structural factors—including financial development, capital-account openness, and trade openness—as well as lagged inflation, GDP growth, and lagged flows. Solid bars indicate statistical significance at least at the 10 percent level; patterned bars denote coefficients that are not statistically significant. Dark solid colors denote statistical significance; shaded color denote a lack of significance. The sample covers 2004Q1–2025Q3.

Table 1.2.2. Data Sources

Variables	Unit	Sources
Portfolio flows	Percent of GDP	Financial Flow Analytics Database compiled from the IMF’s Balance of Payments Statistics, Haver Analytics
Local equity return	Percent	Bloomberg
10-year govt yield	Percent	Bloomberg
Government debt	Percent of GDP	Arslanalp and Tsuda (2014), updated EM Sovereign Debt Database
Current account balance	Percent of GDP	CEIC, National Sources
Financial development	Level	IMF Dataset
Capital account openness	Level	Chinn and Ito (2006), updated version of the database
Trade openness	Level	World Bank’s World Development Indicators database

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Online Annex 1.3 Leveraged ETFs[1]

Leveraged exchange-traded funds (ETFs) are designed to deliver a fixed multiple of the daily return of an underlying index. To achieve this objective, leveraged ETFs do not hold the underlying assets directly but instead rely primarily on derivatives such as total return swaps, futures, and, to a lesser extent, options. Through these instruments, the fund obtains leveraged exposure while posting collateral, typically cash or highly liquid securities. The derivative counterparties, usually large dealer banks, take the opposite side of this exposure and hedge their resulting positions in the underlying market. If the ETF derivatives position is a long position on the underlying asset, then the derivatives counterparty holds a short position; in turn the hedge is therefore again a long position on the underlying. ETFs are mostly used by retail investors.

Leveraged ETFs can contribute to procyclicality and shock amplification through three key mechanisms:

- **Procyclical fund flows reflecting (retail) investors chasing returns**.
  Investor demand for leveraged ETFs affects fund size through the standard ETF creation and redemption mechanism, whereby authorized participants create or redeem shares in response to deviations between market prices and NAV. When demand is strong, typically when retail investors want to "jump on the train," ETF share prices rise above NAV, and new shares are created. The total exposure of the fund rises and the exposure (through derivatives) is increased, leading to hedging flows from the derivative counterparties in the same direction of price moves in the underlying. Through this mechanism, leveraged ETFs can contributes to "bubbles."
- **Intraday hedging by derivative counterparties tends to be directional with the underlying asset price moves**. Even when the fund's exposure is fixed for the day, the derivative counterparties may need to dynamically hedge their exposure to the underlying asset. The extent to which such derivative counterparty hedging flows are needed depends on the specific instruments used (the instrument's delta and gamma, possibly other "Greeks"). Such hedging flows are empirically hard to distinguish from hedging flows emanating from non-ETF sources.
- **End-of-day rebalancing as a consequence of the fund's reset, typically directional with the underlying asset's price move during the day.** The fund's end-of-day assets, reflecting the leveraged return of that day, form the basis for the starting position of the fund on the next day. Since the fund's assets have changed—even in the absence of share creation—the exposure needs to be adjusted for the next day. These exposure adjustments create hedging flows on the side of the derivative counterparties. Intuitively, if a 2x leveraged fund starts with net asset value A_t at time t, the end of day assets are $A_{t+1} = A_t(1+Lr_t)$ where L is the leverage ratio and r_t is the underlying asset's return. The asset exposure at time t was $E_t = L \cdot A_t$, and in the absence of in/outflows, the desired exposure at time $t+1$ would be $E_{t+1} = L \cdot A_{t+1} = L\, A_t(1+Lr_t)$. The exposure adjustment is now approximately $\Delta E_{t+1} = E_{t+1} - E_t = L^2 A_t r_t$. For technical reasons (see Barbon and others, 2022) the relevant adjustment is (only slightly differently) sized to:

$$\Delta E_{t+1} = L(L-1)A_t r_t \qquad \textbf{(Equation 1)}$$

Henceforth, we will define stock j's total leverage adjusted exposure as:

$$Exposure_{t,j} \equiv \frac{\sum_i L_i(L_i-1)A_{i,j,t}}{Market\ Cap_{j,t}} \qquad \textbf{(Equation 2)}$$

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[1] This annex was prepared by Benjamin Mosk.

Where the leveraged adjusted exposure is summed over all leveraged ETFs i tied to stock j. For a given stock return $r_{i,t}$ the implied rebalancing flow amounts to $Exposure_{t,j} \cdot r_t$ (as a share of stock j's market cap).

The empirical literature on the impact of leveraged ETF on market stability metrics is mixed. Ivaniv and others (2018) find small but economically insignificant effect of leveraged ETFs' on late-day returns. Barbon and others (2022) find that leverage ETFs can induce significant end-of-day momentum stock returns; at the same time, their price impact is short-lived, and with predictable rebalancing flows, leveraged ETFs can actually attract liquidity. Shum and others (2016) find end-of-day volatility to be positively and statistically significantly correlated with the ratio of potential rebalancing trades to total trading volume. Similarly, Cheng and Madhavan (2009) argue that the daily re-leveraging of leveraged ETFs can exacerbate volatility towards the close.

The additional empirical work presented in this annex focuses on single stock leveraged ETFs, and seeks to assess more closely whether leveraged ETF exposures can be associated with elevated intraday volatility. The approach is based on **Equation 1**, taking into account the following observations:

- **Endogeneity of stock returns and leveraged ETF exposures**: to mitigate this, a broader market return R_t^m is used, effectively playing the role of "shock." In addition, the analysis should account for each stock's beta (sensitivity to broader market moves).
- **Self-selection**: in theory, demand (and therefore creation) for leveraged ETFs on a specific underlying asset may be correlated with the asset's features, including its return distribution and volatility. It should be noted though that stocks with high day-to-day volatility should in theory be less interesting for leveraged ETF exposure, everything else equal, due to volatility drag. In addition, intraday volatility is not necessarily equivalent with daily return volatility. Nonetheless, to partially mitigate the potential self-selection bias, the analysis is limited to stocks with existing leveraged ETFs. Within this universe, variation in pressure reflects differences in exposure intensity rather than selection into leveraged ETFs itself.
- **Measuring the magnitude of leveraged ETF exposures**: to assess the impact, the leveraged ETF exposures A_t need to be normalized. Different options are available: market capitalization and 20-day average daily trading volume are considered.
- **Proxying intraday volatility**: given data limitations, volatility will be proxied using daily high (H) and low (L) prices of the underlying stocks: $\sigma^2_{\text{Parkinson}} = \frac{1}{4\ln 2}\ln\left(\frac{H}{L}\right)^2$

Taking into account points A-D, the following panel specifications are considered, whereby i labels individual ETFs, j labels individual stocks, ADV_t^j is stock's j average daily traded volume on the 20 days prior to time t, $MCAP_t^j$ is stock's j market capitalization at time t.

Dependent Variable	Norm.	Specification	#
Intraday volatility $\sigma^2_{\text{Parkinson,j}}$	$MCAP_t^j$	$\sigma^2_{t,j} = \alpha + \gamma \frac{\sum_{i \in \text{ETFs}} L_i(L_i - 1)A_t^{i,j}}{MCAP_t^j} \lvert R_t^m \rvert + \varphi \beta^2_{t,j}(R_t^m)^2 + \delta_j + \varepsilon_{t,j}$	I
	ADV_t^j	$\sigma^2_{t,j} = \alpha + \gamma \frac{\sum_{i \in \text{ETFs}} L_i(L_i - 1)A_t^{i,j}}{ADV_t^j} \lvert R_t^m \rvert + \varphi \beta^2_{t,j}(R_t^m)^2 + \delta_j + \varepsilon_{t,j}$	II

Here $\beta_{t,j}$ is stock j 's rolling beta (12-month window), and δ_j are stock fixed effects. The focus of the analyses is on the coefficient γ, which is indicative of the relationship between the leveraged ETF $PRESSURE_t^j$ (see **Equation 2**) and the dependent variable.

Result

Intraday volatility loads positively and significantly through φ on market variance through the individual stock's beta, as expected. On the full sample, higher ETF pressure is associated with lower intraday volatility, although the specification whereby ETF pressure is normalized by trading volume does not show a statistically significant relationship. In the negative tail of the distribution, however, intraday volatility shows a positive relationship with leveraged ETF pressure.

		Full Sample		**Downside Stress Sample**	
Variable	**Coefficient**	**Normalization:** Market Cap	**Normalization:** Trading Volume	**Normalization:** Market Cap	**Normalization:** Trading Volume
Exposure × |market return|	γ	**_-1.04****_** **_(0.175)_**	**_-19.4_** **_(755)_**	**_0.69**_** **_(0.308)_**	**_682**_** **_(334)_**
Beta^2 × market variance	φ	0.688**** (0.0422)	0.655**** (0.0368)	0.284**** (0.0444)	0.305**** (0.0414)
Constant	α	0.000237**** (2.85e-06)	0.000233**** (3.27e-06)	0.00043**** (1.42e-05)	0.000431**** (1.44e-05)
Observations		16840	16840	1556	1556
Stocks		14	14	14	14
Time periods		1329	1329	123	123
Within R^2		0.117	0.115	0.038	0.036

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Online Annex 1.4 Modeling Distress in Direct Lending[1]

This Annex summarizes the methodology detailed in Ferreira, Martell, and Yakovlev (2026). To assess the performance of direct lending under counterfactual shocks, we simulate a stylized private equity-sponsored leveraged buyout (LBO) originated in Q4 2021—a vintage particularly exposed to the subsequent monetary tightening cycle. LBO targets are drawn from a strict subset of U.S. publicly traded small-cap firms within the S&P SmallCap 600 index. Each selected firm provides historical quarterly Adjusted EBITDA time series, while the company's actual liability structure is replaced with a modeled post-LBO leveraged capital structure.

Because direct-lending borrowers typically exhibit distinct sectoral and financial characteristics, we refine the universe as follows:

- **Industry filtering.** We exclude firms whose business models are not representative of typical sponsor-backed direct-lending transactions. In particular, we remove highly cyclical sectors and industries that do not align with the cash-flow-based lending model.
- **Profitability screening.** We retain only firms that demonstrated sustained profitability during the two years preceding the simulated debt issuance date.

The modeled post-LBO capital structure assumes Enterprise Value (EV) = 12×EBITDA. A unitranche loan finances 50 percent of EV, corresponding to a 50 percent loan-to-value (LTV) ratio. The elevated EV/EBITDA multiple and LTV ratio are reflecting the loose financing conditions prevailing at end-2021. Total leverage equals 6.0× EBITDA with a SOFR+5 percent coupon, reflecting Q4 2021 market terms.

The core of the analysis is a quarterly cash-flow simulation. EBITDA serves as the primary cash inflow, while interest expense constitutes the main cash outflow. Each borrower has access to liquidity reserves – such as cash balances and a revolving facility—cumulatively capped at origination as a share of initial EBITDA. Across simulated scenarios, this cap is uniformly distributed between 0.25x and 0.75x of initial EBITDA.

If quarterly EBITDA covers interest expense, debt service is met in full. If EBITDA falls short of interest expense, the gap is absorbed through liquidity reserves. If the reserves are fully exhausted and a residual shortfall persists, the borrower is considered in distress for the purposes of this analysis. In practice, this situation would require a negotiation between the private credit lender and private equity sponsor to adjust the borrower's liability structure in line with the actual EBITDA stream (e.g., providing temporary Payment-in-Kind relief or other forms of restructuring).

Alongside the historical realized SOFR path, we consider an adverse counterfactual in which the benchmark rate is set at twice the realized historical SOFR path. Quarterly interest expense is computed as the product of the applicable rate path and the outstanding debt balance.

For EBITDA paths of simulated borrowers, we analyze two firm cohorts. The 2021–2025 cohort includes firms continuously listed over the recent tightening cycle, with realized EBITDA paths reflecting current-cycle dynamics. The 2006–2010 cohort captures firms operating through the Global Financial Crisis; their EBITDA trajectories serve as a proxy for severe macro-financial stress.

We consider three scenarios. The "baseline" combines the historical SOFR path and EBITDA trajectories over 2021–2025. The "stressed rates" scenario pairs an adverse counterfactual SOFR path with 2021–2025 EBITDA, assessing how borrower distress would increase if tighter policy were required to secure disinflation.

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[1] This annex was prepared by Dmitry Yakovlev.

The “stressed earnings” scenario combines the historical SOFR path with 2006–2010 EBITDA, assessing how distress would rise if the recent hiking cycle were accompanied by a meaningful contraction in output.

To generate results for the “stressed rates” scenario, we run 10,000 simulations. In each simulation, the liquidity reserves cap is drawn uniformly between 0.25x and 0.75x of EBITDA at origination, and 100 firms are randomly sampled from the 2021–2025 cohort. For each draw, we construct time series of the share of distressed borrowers under both the baseline and stressed rates scenarios and compute their ratio (stressed rates relative to baseline). Figure 1.16, panel 4, depicts the median and interquartile range of this ratio across simulations.

To produce results for the “stressed earnings” scenario, we similarly run 10,000 simulations with randomly drawn liquidity caps, but sample 100 firms from the 2006–2010 cohort. For each simulation, we compute the median share of distressed borrowers over the time series. Figure 1.16, panel 4, reports the ratio of this median to the corresponding median in the baseline scenario.

Reference

Ferreira, Martell, and Yakovlev (2026) “Modeling Distress in Direct Lending” forthcoming 2026.

Online Annex 1.5 Modeling Liquidity in Perpetual Non-Traded BDCs

Motivation for the Analysis

This exercise evaluates the time to a liquidity shortfall for perpetual non-traded (PNT) BDCs under various scenarios. PNT BDCs provide periodic liquidity to investors while holding predominantly illiquid credit assets. We estimate the duration over which these vehicles could continue to meet 5 percent quarterly redemption requests under varying degrees of market dislocation and constrained funding access.

Within the framework, liquidity is eroded by three principal outflows: (i) investor redemptions; (ii) maturities of unsecured debt, which are rolled over in milder scenarios but not under more severe stress; and (iii) borrower drawdowns on previously extended revolving credit facilities—a “dash-for-cash” dynamic. Available liquidity consists of beginning-of-period cash balances and undrawn capacity under secured credit facilities on the liability side, which may be increased in milder scenarios, conditional on available eligible collateral, but not in severe stress. The model operates at quarterly frequency and computes the number of quarters until a given BDC can no longer meet projected redemption requests.

The analysis is conducted for each of the largest PNT BDCs. Simulations are initialized using end-2025 balance sheets and evolve recursively, allowing liquidity, debt, and net asset value (NAV) to adjust endogenously over time. The key output is the final quarter in which a BDC maintains sufficient liquidity to cover the subsequent quarter’s projected cash outflows.

Assumptions

Assumptions of the model include the following:

- No assets are sold or matured during the shock. I.e., it’s assumed that all borrowers are rolling over their debt (e.g., amend-and-extend transactions)
- Partial drawdown of undrawn revolvers by borrowers who were previously granted such revolvers.
- Maturing unsecured debt can’t be refinanced under severe stress because debt markets for unsecured debt are shut down.
- No borrowing-base reductions are modeled for liability-side credit facilities.
- Quarterly redemptions fixed at 5 percent of NAV. No new inflows of shareholder capital from investors
- Regulatory distribution requirement (≥90 percent of net investment income) limits income retention.
- Asset valuation shocks applied via stressed indices for leveraged loans and direct lending.
- Utilization of credit facilities is constrained to maintain compliance with the BDC Asset Coverage Requirement (ACR); breaching the ACR terminates the simulation.

Relaxing the assumptions, e.g., partial proceeds from maturing assets, limited asset sales, or access to additional secured and unsecured funding—would materially extend the horizon to the first observed liquidity gap. Results should therefore be interpreted as simulations for various degree of market stress than a baseline projection.

Model

The dynamic is modeled based on the following equations:

Equation	Interpretation
$TA_t = C_t + TL * PT_t + NL * PN_t$	Total assets (TA_t) comprise cash balances (C_t) and traded and non-traded loans (TL, NL), marked to their respective accounting prices (PT_t, PN_t)
$TL_t = UD_t + OSD_t + ML_t$	Total liabilities (TL_t) consist of unsecured debt (UD_t), outstanding amount of secured debt (OSD_t), and miscellaneous liabilities (ML_t)
$NAV_t = TA_t - TL_t$	Net asset value (NAV_t) equals total assets minus liabilities
$R_t = 5\% * NAV_{t-1}$	Quarterly redemptions (R_t) are fixed at 5 percent of the prior-quarter NAV
$AL_0 = C_0 + ASD_0 - DFC_0$	Initial available liquidity (AL_0) consists of initial cash balances (C_0) and initial available undrawn amount of secured debt (ASD_0), net of initial borrower revolver drawdowns under the "dash-for-cash" shock (DFC_0)
$UL_t = R_t + MUD_t$	Liquidity utilized in quarter *t* (UL_t), spent on redemptions (R_t) and unsecured debt that matures in quarter *t* (MUD_t). In the unsecured rollover scenario, $MUD_t = 0$
$AL_t = AL_{t-1} - UL_t + RI_t$	Available liquidity declines with projected outflows, while marginally replenished by retained income RI_t (mostly insignificant)

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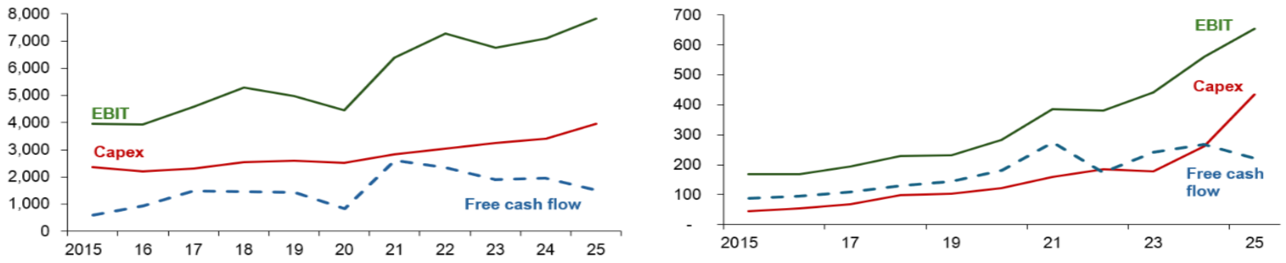
Online Annex 1.6 Artificial Intelligence Stack and Balance Sheet Vulnerabilities[1]

This annex provides the intuition behind the staff's assessment of balance sheets by the key segments of the AI stack. While AI platforms rely on a broad base of traditional industries—including builders and energy providers—as well as highly specialized cloud and data center providers, chip developers and hyperscalers are systemically vital. Chip developers and hyperscalers collectively account for more than 70 percent of the stack's revenue and outstanding debt (as shown in Figure 1.17). In addition, the extraordinary scale of hyperscalers' future capital expenditures (estimated at around $3 trillion through 2029) and funding gaps which could potentially emerge, warrant an assessment of their current balance-sheet vulnerabilities. Recent trends further motivating the assessment are provided in Figure 1.6.1.

Figure 1.6.1. Capex of Hyperscalers and the Potential Future Funding Gaps



Capital expenditure has grown faster than earnings, eroding free cash flows…

1. Global Corporate Capital Expenditure (Excluding Hyperscalers)

(Billions of dollars)

…but for hyperscalers, capital expenditure has been supported by earnings growth, sustaining free cash flows.

2. Hyperscalers' Capital Expenditure

(Billions of dollars)

The capex of hyperscalers in the sample are expected to keep rising for the next few years…

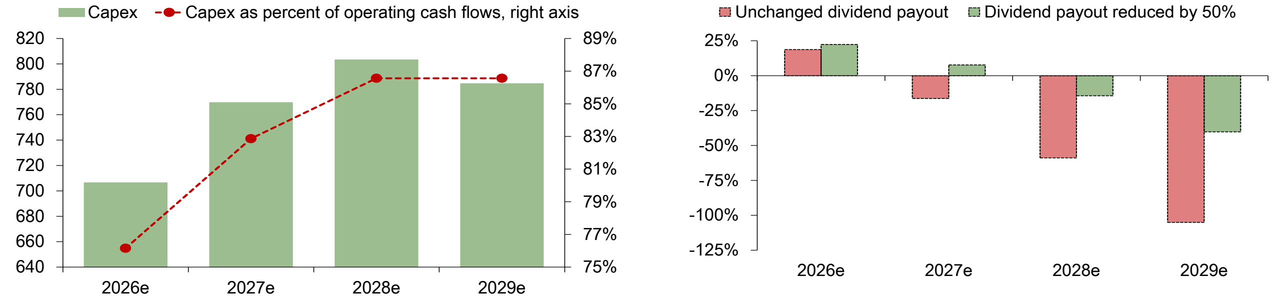
3. Total Capex of the 10 Hyperscalers

(Sum of median estimates in billion US dollar)

.. potentially creating funding gaps, if productive capacity were to be maintained.

4. Cash Balance Estimates for Hyperscalers

(Percent of total assets)



Source: Bloomberg; and IMF staff calculations

Note: Panel 1 shows an aggregation of MSCI All Country World Index constituent companies. In panel 2, hyperscalers include CoreWeave in addition to the firms listed in footnote 25 of the main text. For panel 3, the operating cash flows are estimated under the assumption of constant returns. Panel 4 shows the estimates for total cash balances of the hyperscalers post capital expenditure and varying levels of dividend payouts and prior to raising any additional capital. In both panels, e=estimates.

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[1] This annex was prepared by Yingyuan Chen, Deepali Gautam, and Aki Yokoyama.

A sample of 73 public and private firms is used to assess these vulnerabilities. The sample includes firms from the United States, United Kingdom, Canada, the Netherlands, the Chinese mainland, Taiwan POC, Korea, Hong Kong SAR, and Australia, and is fairly balanced in term of number of firms under each segment. There are 22 firms in the builders and energizers segments; the chip developers and hardware segments include 19 firms; and the data managers and software segments include 20 firms. Hyperscalers are represented by seven U.S. firms: Alphabet, Amazon, Apple, IBM, Meta, Microsoft, and Oracle, and three Chinese firms: Alibaba, Baidu, and Tencent.

There are meaningful differences in the vulnerabilities around the current AI investments and the dot-com period of the early 1990s. During the latter, amid accommodative monetary conditions, massive investments were also made in infrastructures like fiber networks, data centers, server farms, and undersea cables. At the time, concerns about technological obsolescence were relatively limited. However, revenues ultimately fell short of expectations, as many internet-based business models like e-commerce platforms and online advertising had not yet reached commercial maturity. This led to a pronounced gap between realized cash flows and ex ante revenue projections. In the current environment, similar risks of misalignment between revenue expectations and underlying fundamentals could emerge through several channels. These include circular financing structures that may artificially amplify reported revenues and valuations; monetization challenges stemming from evolving and unstable pricing models under intense competitive pressure; and supply-side constraints, notably those related to power generation capacity and heightened cybersecurity risks

Balance sheet vulnerabilities are assessed using five key indicators: leverage (debt-to-equity ratio), liquidity (current assets-to-current liabilities ratio), profitability (operating profit margin), capex intensity (capex-to-revenue ratio), and valuation (price-to-equity ratio). Using the latest available annual financial data, thresholds for each metric are derived based on the average of the within-segment and across-segment top and bottom quartiles. These are identified within the narrower scope of AI value chain; however, as business models could vary across layers judgement is needed while ascertaining these thresholds. Therefore, the profitability metric is set at 10 percent (lower bound) and 20 percent (upper bound) to ensure comparability with broader industry groups (Table 1.6.1.).

Table 1.6.1. Thresholds for Vulnerability Assessment Indicators

Indicator	**Leverage**	**Liquidity**	**Profitability**	**Capex intensity**	**Valuations**
Metric	*Debt-to-equity (percent)*	*Current assets to Current liability ratio*	*Operating profit margin (percent)*	*Capex to Revenue (percent)*	*Price-to-equity ratio*
Top quartile	<47	<1.2	>20	<3.6	<22x
Bottom quartile	>140	>1.9	<10	>35.9	>31x

Source: Bloomberg; and IMF staff calculations

Note: In the color scheme, red refers to the bottom quartile and implies higher vulnerabilities in the form of higher leverage, capital intensity and valuations, and lower liquidity and profitability. Green refers to the top quartile lower relative vulnerabilities in the form of lower leverage, capital intensity and valuations, and higher liquidity and profitability.

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Online Annex 1.7 Banking Sector Analysis

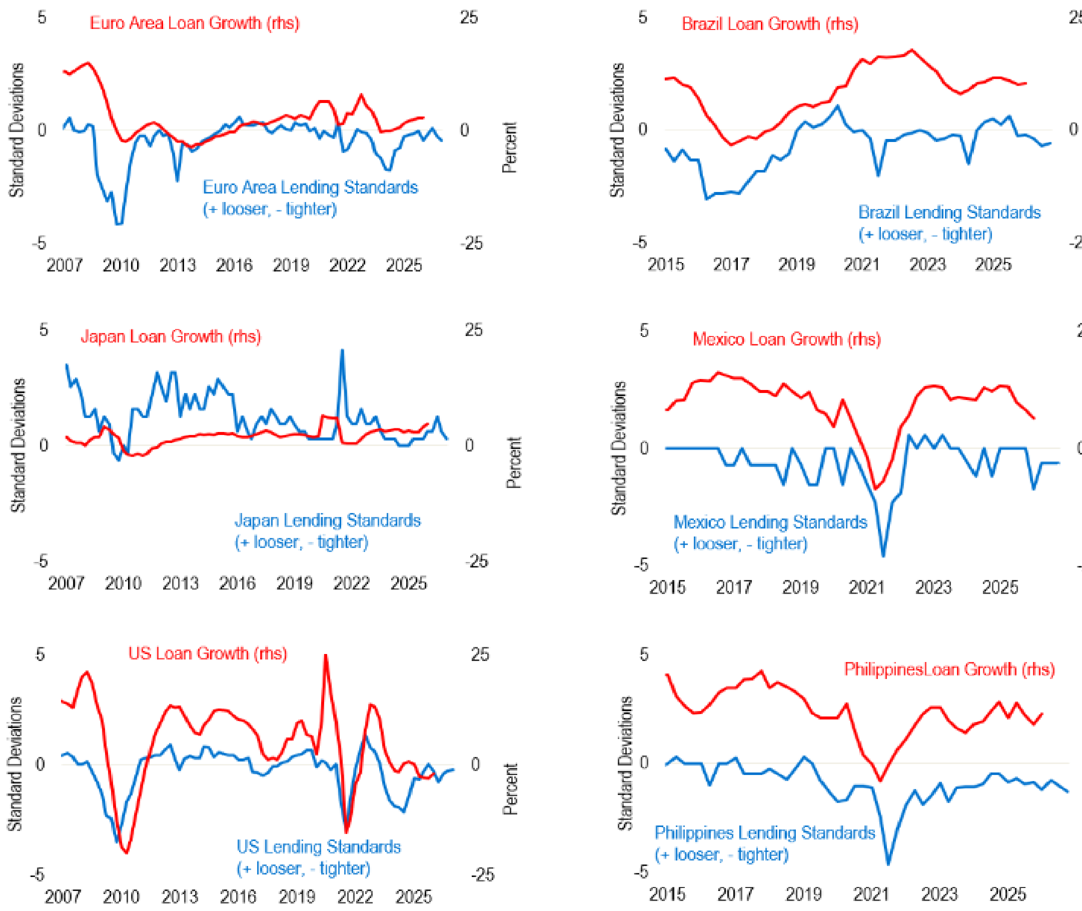
1.7.1 Lending Conditions and Loan Growth[1]

Lending conditions remain broadly stable, reflecting that perceived credit risk has not increased materially. However, in some countries, lending conditions are gradually tightening as risk tolerance declines, even as loan demand continues to rise.

Figure 1.7.1. Lending Standards and Loan Growth

Lending conditions are broadly stable, indicating that perceived credit risk has not meaningfully increased in most jurisdictions.

(Standard deviations and net percent of respondents)



Sources: Bloomberg LP, Haver Analytics, National central banks; Standards & Poor's Capital IQ and Visible Alpha, and IMF staff calculations.

Notes: Shows lending standard series for individual jurisdictions are normalized by their respective standard deviations. Positive values indicate looser standards; negative values indicate tighter standards.

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[1] Section 1.7.1 and 1.7.2 were prepared by Yiran Li and Silvia Ramirez.

1.7.2 Key Risk Indicators

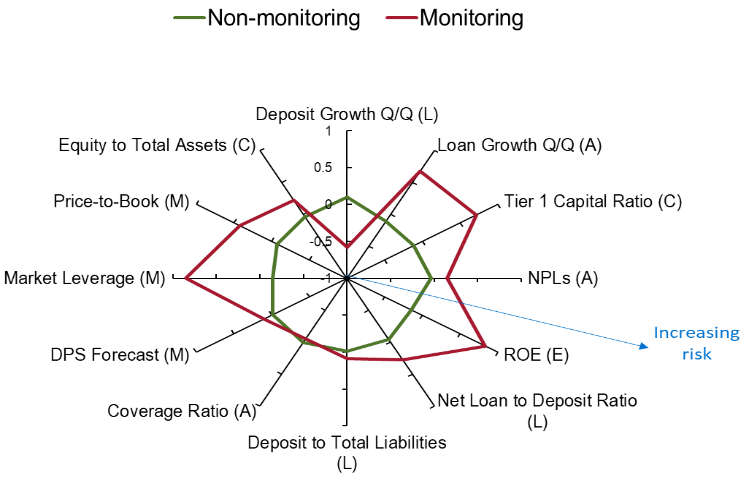
Although the number of banks on the monitoring list has broadly declined since 2022, analysts' forecasts point to some near-term deterioration in earnings and lower returns on equity. At the same time, rising market pressures—evident in lower price-to-book ratios and higher market leverage—alongside tightening liquidity conditions, including higher net loan to deposit ratios and quarterly loan growth, are likely to further pressure the weaker tail of banks (Figure 1.7.2., panel 1).

Figure 1.7.2. Key Risk Indicators

Monitoring or vulnerable banks are characterized by lower profitability, higher market leverage, lower Tier capital ratios, and higher loan growth compared to non-monitoring banks.

1. Comparison of Monitoring List and Non–Monitoring List Banks in 1Q26

(Standardized values)



Source: Bloomberg LP, Visible Alpha SP Global Market Intelligence, and IMF staff estimates.
Note: Panel 1 values are standardized by z-scores based on aggregate consensus forecast data as of first quarter of 2026; larger values along a given axis signify more risks along that characteristic. A = asset quality; C = capital; M = market; L = liquidity; E = earnings.

1.7.3 Credit Growth and Banks' Capital Requirements[2]

Context: Global Changes in Capital Requirements

This section provides additional details on the analytical methodology and results presented in the section "Bank Capital Requirements: Lending and Resilience Trade-offs."

The primary purpose of capital requirements[3] is to ensure that banks maintain buffers sufficient to absorb unexpected losses, such as increases in loan defaults. In the aftermath of the Global Financial Crisis (GFC), supervisors in multiple jurisdictions tightened and updated minimum capital rules and introduced new liquidity and resolvability requirements. These reforms addressed the insufficient capitalization and low liquidity buffers that left many banks vulnerable during the GFC. At the same time, international standard-setting bodies such as the International Accounting Standards Board (IASB) and the Financial Accounting Standards Board (FASB) introduced forward-looking provisioning for financial assets, shifting from incurred-loss to expected-loss models. There is broad consensus that these changes strengthened the financial system, increased bank resilience, supported lending, and helped banks weather subsequent crises, including the COVID-19 shock.

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[2] This section was prepared by Deepali Gautam and Mindaugas Leika.

[3] For the purpose of this annex, the term capital requirements include minimum capital requirements and capital buffers such as the conservation and countercyclical capital buffers.

Research on the impact of lower capital buffers on credit growth remains limited, as most regulatory and supervisory actions over the past 30 years—particularly after the GFC—have focused on increasing capital requirements. Studies conducted following the release of the countercyclical capital buffer (CCyB) in 2020 suggest that banks with lower capital buffers were mostly to benefit from temporary easing (by avoiding deleveraging, making provisions for non-performing assets, slightly increasing credit growth or maintaining exposures), though most were reluctant to materially expand lending. Over the longer term, banks with higher capital buffers (and lower leverage) tend to benefit from lower funding costs, enabling them to offer lower interest rates and stimulate credit demand.[4] Nearly two decades after the GFC, policy discussions in many jurisdictions increasingly focus on regulatory modernization, including the simplification and streamlining of capital and liquidity requirements (Table 1.7.1.).

Table 1.7.1. Selected Announcements about Changes in Capital Requirements

Authority	Changes in Prudential Requirements	Date
ECB (SSM)	CCB / P2G / CCyB	March 2020
Euro Area NCA	CCyB → 0%	Mar–Apr 2020
Bank of England	CCyB 1% → 0%	March 2020
Federal Reserve	SCB	September 2025
US Agencies	eSLR buffer	November 2025
Bank of England	SW Tier 1 14% → 13%	December 2025

These modernization efforts are emerging amid elevated market volatility, rising geopolitical risks, growing bank exposure to the unregulated nonbank financial sector, and a strengthening bank–sovereign nexus driven by widening fiscal deficits and higher public debt. Together, these risks underscore the need for a highly resilient banking system.[5]

Data Description

Table 1.7.2. Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
CE Tier1 Ratio (%)	4427	13	5	4	168
Total Capital Ratio (%)	8348	15	6	5	183
CET1 Capital Buffer (%)	2094	5	3	0.3	28
Total Capital Buffer (%)	2176	5	5	0	160
Asset growth (y-o-y) (%)	9492	11	15	-31	99
Loan growth (y-o-y), gross (%)	9246	12	16	-49	98
Cash to Total Assets (%)	9928	6	5	0.1	65
Loans to total Assets (%)	9678	62	15	2	94
RWA Density (%)	7793	65	18	4	128
Dividend Payout Ratio (%)	8006	40	28	0	297
Share Buyback Ratio (%)	4700	18	16	0	221
Salary to Net Income (%)	8795	141	5	-89	149
Release of capital	162	0.7	0.94	0.01	7.8

We use data from 400 banks across 52 countries, covering all major economies (including the EU, USA, China, Canada, Australia, India, Brazil, South Africa) over a 30-year period (1996–2025). To evaluate the impact of banks' characteristics on credit growth, we examined multiple variables (Table 1.7.2). Annual data is used to mitigate quarterly volatility, and extreme observations related to banks' mergers are excluded. The number of observations varies across variables, especially for capital measures, as some—such as CET1 ratio—were introduced only in 2013. We construct capital buffer ratios by subtracting actual values capital ratios (CET1, total

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[4] Mathur, A., Naylor, M. et al. (2023)

[5] Aikman, D., Vickers, J. (2026)

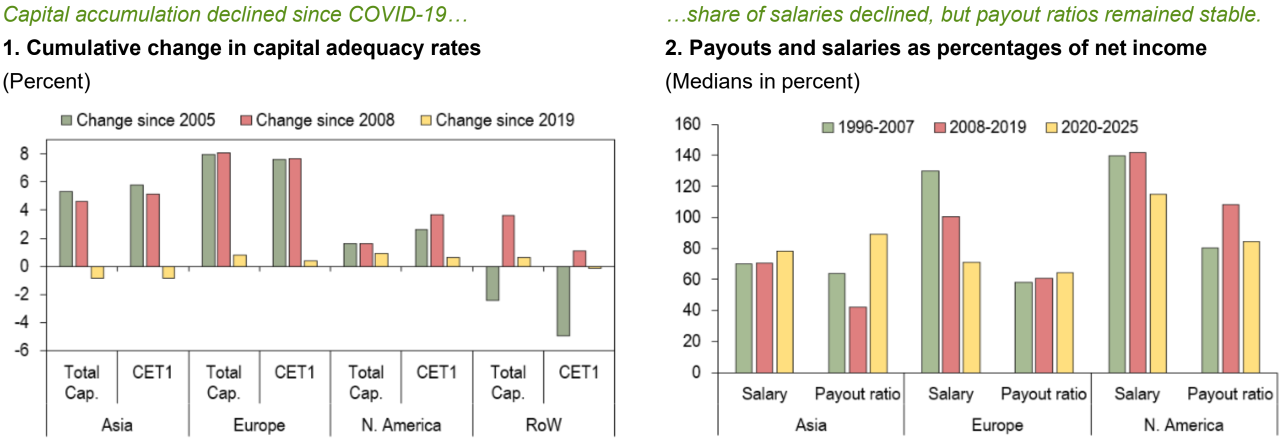
capital) from minimum requirements, as reported by S&P Capital IQ. One limitation of this approach is that capital requirements, such as pillar 2 in some jurisdictions, and other distribution restrictions that are not publicly disclosed, are not captured.

Findings from Descriptive Analysis

Most of the capital used to increase buffers was accumulated through retained earnings. The data reveals significant time and regional differences: capital accumulation was strong immediately after the GFC but slowed markedly after the COVID-19 crisis (Figure 1.7.3., panel 1). In many emerging markets, capital accumulation was even negative, as banks increased leverage and expanded their loan portfolios. Shareholder payouts declined in the immediate aftermath (2008–2011) of the GFC, reflecting the introduction of new capital, liquidity, and resolvability rules. It was rare for payouts to exceed annual income; in most cases, they remained within the range of 40–80 percent of annual net income (Figure 1.7.3., panel 2). Recently, the US has seen several exceptions, as share buybacks have become more prominent. A short period of optimization and regulatory tailoring in the US during 2017–2019 also contributed to an increase in payouts. While capital buffers designed to absorb losses and support lending were reduced in the EU and some other countries in the aftermath of the Covid crisis, they also triggered binding requirements or recommendations on payout restrictions.[6]

Compared with the broader stock, banks' payouts relative to net income exceeded market averages (Figure 1.7.4., panel 1). This was possible because banks were optimizing their asset structures to address tighter capital and liquidity requirements. A decrease in risk-weighted assets (RWAs) has been the most important trend (Figure 1.7.4., panel 2). Empirical studies based on regulatory data confirm this.[7] The reduction in RWAs reflected higher holdings of cash and cash like instruments (deposits at the central banks), as well as increased holdings of sovereign bonds, which coincided with a period of fiscal expansion during and after the COVID crisis.

Figure 1.7.3.



Capital accumulation declined since COVID-19…

1. Cumulative change in capital adequacy rates

(Percent)

…share of salaries declined, but payout ratios remained stable.

2. Payouts and salaries as percentages of net income

(Medians in percent)

Source: S&P Capital IQ, and IMF staff calculations.

After initial fall during the GFC, average loan growth rates across the regions went back to pre-crisis levels despite higher regulatory and capital requirements (Figure 1.7.2., panel 3). At the same time, there is small positive correlation between RWAs density and loan growth (Figure 1.7.2., panel 4). While it may seem as an accounting identity (loans typically have higher RWAs as opposed to cash and securities), it also represents additional cost in terms of allocation of capital. For example, if a bank uses Risk Adjusted Return on Capital (RAROC) methodology, any additional portfolio shift from low-risk weight density assets to higher ones (such as loans to private sector) would require higher return (higher interest rates) to compensate for higher expected losses and higher denominator (RWAs). This would also consume additional capital (capital requirement

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[6] See ESRB (2020), and Katsigianni, E., Klupa., K. et al. (2021) for in-depth review of restrictions on shareholder payouts.

[7] See Raja, A. (2022)

multiplied by change in RWAs). Hence, at the time of loan origination, banks with low RWAs density would need to have higher capital buffers above the minimum requirement as opposed to banks with high RWAs density to be able to reallocate portfolios from low risk to higher risk lending (such as from sovereign or NBFIs to private non-financial companies).

Findings from Econometric Analysis

1.7.3.1. Empirical Design

To assess the impact of shareholder payouts and capital buffers in post capital release period on credit growth, we adopt a difference-in-difference (DiD) approach. We run two main specifications:

$$1.\ \delta loans_{it} = \beta_0 + \beta_1(Post_{it}) + \beta_2(POratio_{it}) + \beta_3(Post_{it} * POratio_{it}) + \lambda_4 X_{it} + \epsilon_{it}$$

$$2.\ \delta loans_{it} = \beta_0 + \beta_1(Post_{it}) + \beta_2\left(CET1_{it}^{buffers}\right) + \beta_3\left(Post_{it} * CET1_{it}^{buffers}\right) + \lambda_4 X_{it} + \epsilon_{it}$$

Dependent variable (loan growth, $\delta loans_{it}$) is included in levels. The treatment variable $(Post_{it})$ identifies the years of and following a reduction in CET1 requirement. In the first equation, total payout ratio $(total\ payout\ as\ a\ percentage\ of\ net\ income, PO\_ratio_{it})$ is demeaned over its cross-sectional average and interacted with $Post_{it}$, while the following equation contains interaction terms wherein CET1 buffer $\left(CET1_{it}^{buffers}\right)$ is interacted with $Post_{it}$. Capital buffer is the difference between actual CET1 ratio and CET1 capital requirements as reported in S&P Capital IQ, the set of control variables (X_{it}) includes RWA density, return on equity, and log of total assets. Due to data availability, the time horizon (2018–2025) for econometric analysis is much smaller than our full dataset. Table 1.7.3 below provides summary of estimation results.

Table 1.7.3.

Dependent variable:	***Loan growth, percent***	
Model:	(1)	(2)
Post	-1.191	-1.250
Total shareholder payout ratio	0.002	
Post * Total shareholder payout ratio	***-0.003***	
CET1 buffers		-0.501***
Post * CET1 buffers		***-0.008***
Log of assets	-0.580***	-0.814***
Return on Equity	0.241***	0.280***
Fixed Effects		
Country	Yes	Yes
Year	Yes	Yes
Fit Statistics		
Observations	1648	1838
R2	0.198	0.213

Results

The DiD results reveal that the marginal impact of shareholder payouts ratio post release of capital on credit growth is inconclusive. Although, the coefficient of the interaction term of capital release, and capital buffers is statistically insignificant on a global sample of banks, it bears a negative sign that aligns with other studies (Bedajo., M., Galan, J. (2024)).

Inferences about shareholder payouts are challenging due to data limitations. Our data sample is relatively short (most capital release observations start in 2020) and is biased toward the EU, where most reductions occurred and where shareholder payouts were directly restricted. It is therefore difficult to isolate the effects of shareholder payouts from those of the buffer releases. At the same time, after the COVID restrictions were lifted, banks tended to increase payouts to compensate for previous limits. As highlighted in the GFSR, analysis of banks' earnings transcripts suggests that capital distributions to shareholders are likely to remain elevated.

Conclusions

There is mixed evidence that lowering capital and liquidity requirements would lead to a significant increase in long-term credit growth. Lowering capital requirements would allow banks to increase leverage and use cheaper debt funding instead of equity, which would boost ROE in the short term but increase the procyclicality of credit over time. Analysis of our sample reveals that key drivers of changes in capital ratios over the past 20 years have been internally generated capital (retained earnings), declining RWA density (especially in the EU), and shareholder payouts. Even after the introduction of tighter post-GFC capital requirements, the decline in credit was temporary and relatively limited, which is consistent with studies such as Behn, Forletta et al. (2024). Capital buffers and annual credit growth show little correlation, even after controlling for lags. At the same time, in line with findings in the literature, banks with lower capital buffers may increase credit growth due to lower minimum capital constraints, while banks with high existing buffers would not necessarily expand credit supply.

Figure 1.7.4. Shareholder Payouts, RWA Density and Loan Growth

Banks maintained systematically higher payout ratios compared to the rest of the sectors

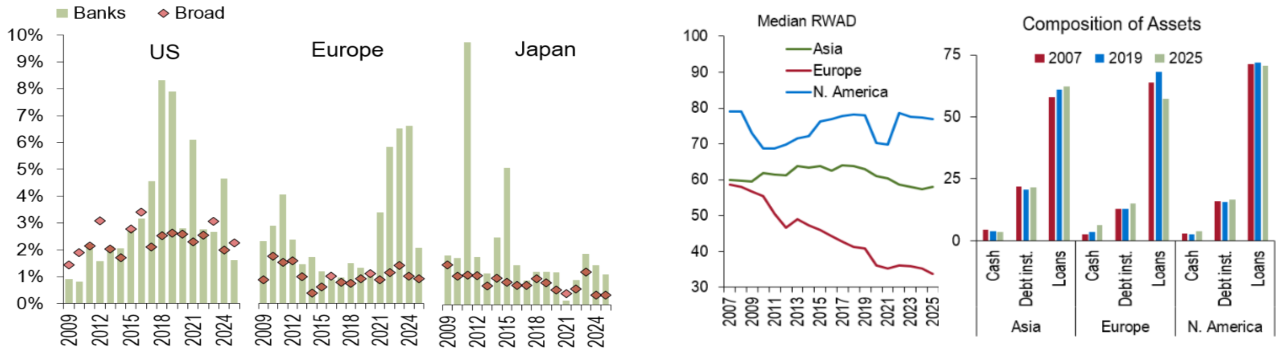
1. Shareholder Payout Ratios

(Percent)

Use of internal (IRB) models as well as accumulation of cash and debt instruments was an important factor in reduction of RWAs density, especially in the EU

2. RWA density and Asset Composition

(Percent)



Loan growth rates stabilized after the GFC are only marginally below the levels seen before the tougher capital and liquidity rules introduced.

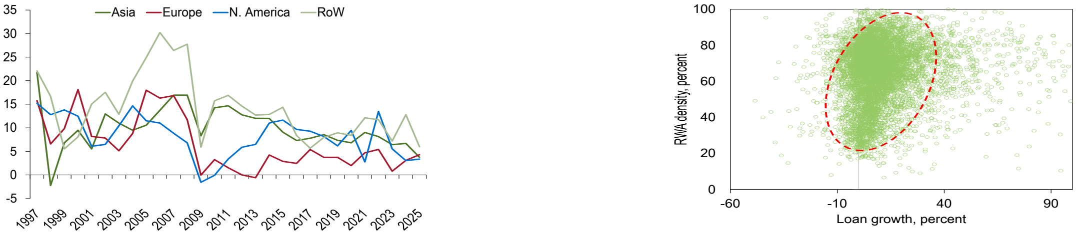
3. Loan growth rates (median, y-o-y)

(Percent)

Banks with higher RWA density have slightly higher loan growth rate while this is an accounting issue, opportunity costs are lower.

4. RWA Density and Loan Growth

(Percent)

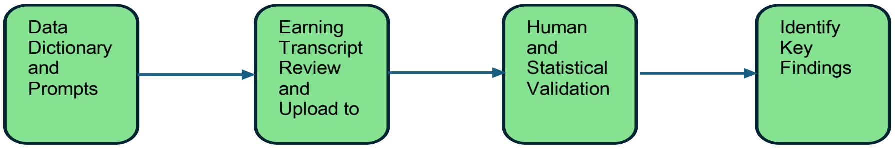


Source: S&P Capital IQ, Bloomberg LLP, and IMF staff calculations.
Notes: RoW = rest of the world, N. America = North America, RWAD = Rish Weighted Asset Density.

1.7.4. Searching for Capital Distribution Strategies using Large Language Models[8]

Earning transcripts from publicly traded banks around the globe, including global systemically important banks (G-SIBs) offer valuable insights into capital redeployment strategies.[9] Released quarterly or semi-annually, these transcripts highlight banks' current redeployment strategies while providing forward-looking commentary on dividend payments, share repurchases, reinvestment, and merger and acquisition activity. To examine capital-redeployment strategies, we conducted a four-step textual analysis of more than 1,000 earning transcripts from 78 banks in 26 countries using large language models (LLMs) (Figure 1.7.5.). The findings suggest that more than two-thirds of bank management teams in the sample expect to maintain or increase capital return to shareholders, supported by strong profitability and solid capital positions heading into 2026. The analysis also indicates a shift among banks in North American toward greater merger & acquisition (inorganic growth) activity compared to prior years. A few banks in Europe and North America disclosed likely plans to further reduce their internal CET1 ratio target levels going forward (Figure 1.7.6.).[10]

Figure 1.7.5. Text-Based Search for Capital Strategies



Sources: IMF staff.

The first step of the analysis involved reviewing G-SIBs earnings transcripts to build a data dictionary and developing a set of targeted prompts to guide the data extraction. The data dictionary specified all text-derived variables alongside precise definitions, scope, sources, and interpretation rules, enabling the LLM to extract information consistently from the transcripts. This structure was essential because terminology in the banking sector varies across institutions and geographies—for example, "excess capital" may appear as capital buffer, surplus capital, distributable capital, CET1 capacity, management buffer, or capital headroom. The dictionary anchored these variations, specified required units, and provided source examples to ensure uniform interpretation.

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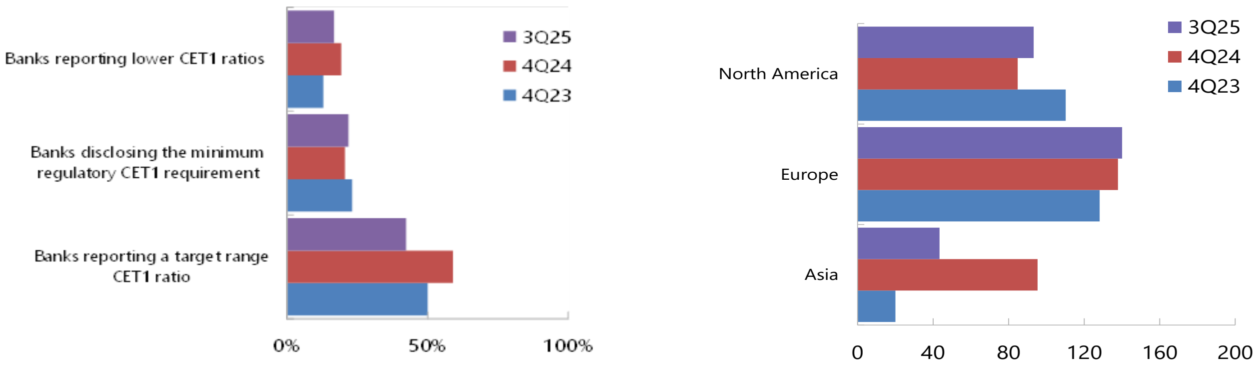
[8] This section was prepared by Yiran Li, Saurav Mazumdar, Silvia L. Ramirez, and Gabriela Conde Vitureira.

[9] Earnings transcripts are verbatim written records of banks' quarterly or semi-annual earnings calls, typically published by major data providers after the release of financial results. They capture all prepared remarks from management as well as the live Q&A with analysts.

[10] The sample comprises 78 publicly traded banks with total assets exceeding $100 billion across 26 countries. Owing to limitations in earnings transcript availability, data content, or coverage, 31 banks—including two G-SIBs in Japan and two in China—were excluded from the original sample of 109 banks.

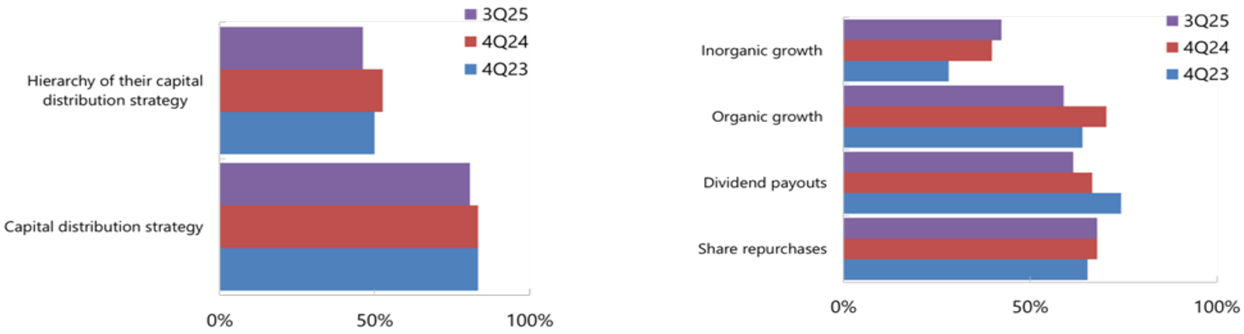
Figure 1.7.6. Key Selected Responses to Capital Redeployment Prompts

Most of banks provide disclosures on capital redeployment strategies, capital distribution hierarchies, and forward-looking guidance across Europe and North America.



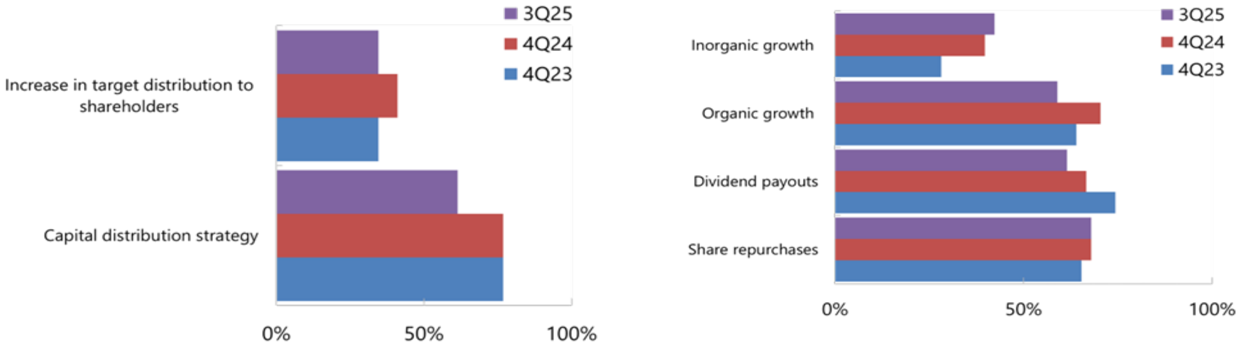
1. Disclosure of CET1 Ratio Trends
(Percent of total respondents)

2. Average CET1 Above Disclosed Target by Geography
(Basis points)



3. Disclosure of Capital Distribution Hierarchy and Strategy
(Percent of total respondents)

4. Disclosure of Capital Distribution Tools
(Percent of total respondents)



5. Disclosure of Forward Guidance

(Percent of total respondents)

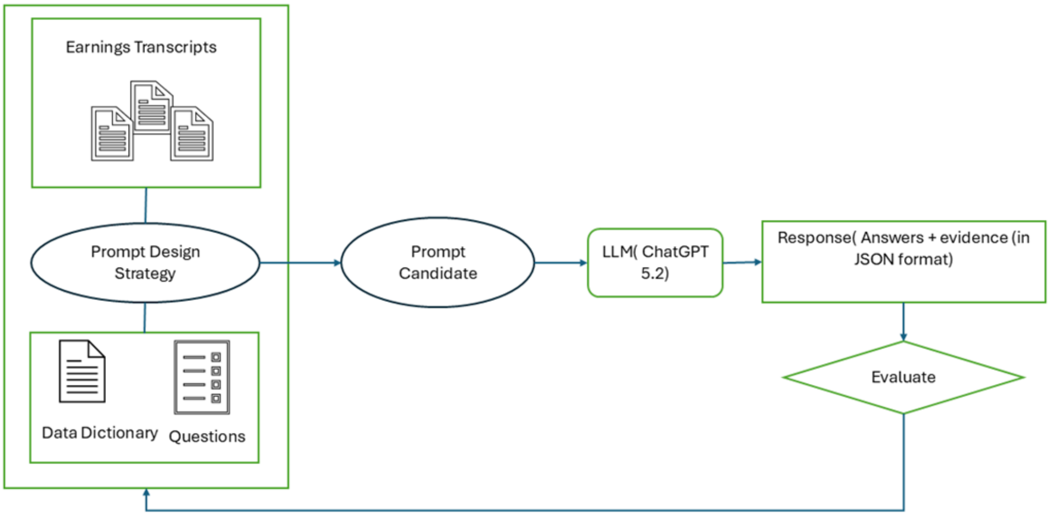
6. Disclosure of Forward Guidance on Capital Distribution Tools

(Percent of total respondents)

Source: IMF staff estimates.
Note: Sample size included 78 banks, including 22 G-SIBs in Asia, Europe, North America, and the United Kingdom and excluded Agricultural Bank of China, Bank of China, Bank of Communications, Mitsubishi UFJ Financial Group, and Sumitomo Mitsui Financial Group due to data unavailability. Panel 1, panel 3 to 6 show results as percent of total respondents in each quarter. Panel 2 shows the average CET1 capital above disclosed CET1 target ratio (lower bound).

The prompts were designed to support specific analytical objectives. To ensure auditability, the prompts included instructions for retrieval of direct quotes and transcript sections as evidence. This phase of prompt design involved multiple iterations. For each iteration, we generated a candidate prompt using several prompt engineering strategies.[11] Initial versions of the prompts were drafted with assistance from an LLM and then refined through human review (Figure 1.7.7.). Once a final prompt was selected, the prompt was run against the entire dataset of quarterly earnings call transcripts.

Figure 1.7.7. Prompt Formulation Process



Sources: IMF staff.

These prompts were then used to systematically interrogate the transcripts for insights related to capital redeployment activities. Both the data dictionary and the prompts served as inputs to the LLM to examine and answer specific research questions. We initially proposed fifty questions covering capital trends, strategy, targets, and forward guidance, which we then refined to 16 across three dimensions, current capital trends, current capital strategy, and forward strategy guidance (Figure 1.7.8. and Figure 1.7.9.).

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[11] Prompt engineering strategies are different techniques used to design prompts that guide a large language model to produce more accurate, reliable, or specialized outputs, and included zero-shot, one-shot and few-shot prompting, reflection, decomposition, and chain-of-thought approaches. Zero-shot prompting gives the model a task with no examples, one-shot prompting provides one example of the desired output, few-shot prompting provides several examples, reflection prompting asks the model to review or critique its own answer, decomposition prompting breaks a complex task into smaller sub-tasks, and chain-of-thought prompting asks the model to show its reasoning steps.

Figure 1.7.8. Data Dictionary

Data Field	Data Type	Description	Source Example
Buyback_Guidance	String	Forward guidance on buyback volume or pace	On the buybacks, you should not take it as a new run rate, definitely... stay very focused on the fact that we are guiding to over $8 billion between '24 and '26.|| Speaker: Diego De Giorgi (Group CFO & Group Executive Director) || Section: Q&A (Standard Chartered).
Buyback_Status	Categorical	Status of the buyback program (Active, Paused, Accelerated).	The EUR 2 billion share buyback we announced in November is still ongoing || Speaker: Steven J. A. van Rijswijk (CEO) || Section: Prepared remarks (ING)
Buyback_Volume_Qtr	Currency	Total value of shares repurchased in the quarter.	We also repurchased approximately 408,000 shares this quarter, or $67 million.|| Speaker: Katherine Gibson (CFO & Controller) || Section: Prepared remarks. Royal Bank of Canada.
CET1_buffer	Basis Points	The target buffer held above regulatory minimums.	The CET1 ratio is at 13.3% in Q4. This is around 310 basis points above the MDA buffer. || Speaker: Leopoldo Alvear (Chief Financial Officer) || Section: Prepared remarks (Societe Generale)
CET1_Current	Decimal (%)	The reported Common Equity Tier 1 ratio.	We grew our tangible book value per share by 4% and ended 2024 with a CET1 ratio of 13.6%, approximately 150 bps above our regulatory capital requirement. || Speaker: Jane Nind Fraser (CEO & Director) || Section: Prepared remarks (Citigroup)
CET1_manage_down	Categorical	Manage excess capital buffers down	As we get clarity on reg rules... you'll see us continue to manage down to that 13.1%. || Speaker: Mark A.L. Mason (Chief Financial Officer) || Section: Q&A (Citigroup)
CET1_Target_Range	String (Range)	The management's stated target range for CET1 capital.	We're not changing our target of over 12% we are now closing at 12.8% || Speaker: Ana Botin (Executive Chair) || Section: Prepared remarks (Santander).
Distribution_Goal	Currency	Total capital committed to be returned over a specific period.	I am particularly pleased to announce that our Board authorized a $20 billion share repurchase program. || Speaker: Jane Nind Fraser (CEO & Director) || Section: Prepared remarks (Citigroup).
Dividend_amount	Currency	Total common dividends paid in the quarter.	EUR 4.79 per share (FY24 dividend per share) (BNP Paribas)
Dividend_Guidance	String	Forward guidance on dividend of pace	For the 2025 financial year, we plan to accrue for an increase in our dividend of around 10%.|| Speaker: Sergio P. Ermotti, Group CEO || Section: Prepared remarks (UBS)
Dividend_status	Categorical	Status of the divindend program (Active, Paused, Accelerated).	This includes GBP 1.2 billion of dividends, enabling a 5% increase in our dividends per share to 8.4p. || Speaker: Coimbatore Sundararajan Venkatakrishnan (Group CEO & Executive Director) || Section: Prepared remarks (Barclays)
Hierar_strategy	Categorical	Hierarchy of capital redeployment	We will continue to prudently grow the dividend, continue to invest in each of our three businesses and across our infrastructure and continue to opportunistically repurchase the stock.|| Speaker: Edward N. Pick (CEO & Chairman) || Section: Prepared remarks (Morgan Stanley)
Inorganic_Spend	Currency	Capital allocated to acquisitions or M&A	If it makes sense, we are always on the lookout for a strategicâ€¦ inorganic opportunity to create value in our U.S. wealth franchise, our U.S. commercial banking franchise over time || Speaker: David I. McKay (President, CEO & Director) || Section: Q&A (Royal Bank of Canada).
Inorganic_Spend_Guidance	String	Forward guidance on capital allocated to acquisitions or M&A	We continue to look at bolt-on acquisitions much more than transformational acquisitions.|| Speaker: Jerome Grivet (Deputy CEO) || Section: Q&A (Credit Agricole).
Inorganic_Spend_strategy	Categorical	Prioritize organic growth or internal reinvestment over share buybacks?	While organic growth is at the heart of the plan, opportunities for inorganic growth in the market are also significant. || Speaker: Coimbatore Sundararajan Venkatakrishnan (Group CEO & Executive Director) || Section: Prepared remarks (Barclays)
Model_Impact	Basis Points	Capital impact from internal model updates or regulatory floors	The marginal increase in credit risk was driven by model changes, largely offset by reductions from capital efficiency measures. || Speaker: James von Moltke (CFO) || Section: Prepared remarks (Deutsche Bank).
Organic_RWA_Deploy	Currency	Capital deployed into business growth (loans, trading assets)	So first, we prioritize profitable organic growth, investments across our businesses.|| Speaker: Ana Botin (Executive Chair) || Section: Q&A (Banco Santander)
Reg_Basel_Regime_Status	String	Status of major rules (e.g., Basel III Endgame)	This 12.9% at the year-end has become 12.4% on January 1, given the day 1 implementation of Basel IV in Europe.|| Speaker: Lars Machenil (CFO) || Section: Prepared remarks (BNP Paribas)
Reg_changes	Categorical	Expected changes in minimum regulatory capital requirements	This 12.9% at the year-end has become 12.4% on January 1, given the day 1 implementation of Basel IV in Europe.|| Speaker: Lars Machenil (CFO) || Section: Prepared remarks (BNP Paribas)
RoTE_Target	Decimal (%)	Target Return on Tangible Equity (often linked to capital deployment)	We continue to target a circa 50% cost to income ratio for Barclays U.K. in 2026... We continue to target a circa 50% cost to income ratio... Our 2026 targets are unchanged, including our North Star of a RoTE above 12%. || Speaker: Angela Anna Cross (Group Finance Director & Executive Director) || Section: Prepared remarks (Barclays).
RWA_Total	Currency	Total Risk-Weighted Assets reported	RWAs increased GBP 18 billion from Q3 to GBP 358 billion. || Speaker: Angela Anna Cross (Group Finance Director & Executive Director) || Section: Prepared remarks (Barclays)
Strategy	Categorical	Capital redeployment strategy	We will consider shareholder returns in light of growth investment opportunities and market conditions, ensuring an appropriate total payout.|| Speaker: Masahiro Kihara (President, Group CEO) || Section: Prepared remarks (Mizuho)
Total_Payout_Ratio	Decimal (%)	Percentage of earnings returned via dividends and buybacks	We returned $5.5 billion of capital back to shareholders, with $2 billion in common dividends paid and the repurchase of $3.5 billion in shares this quarter.|| Speaker: Alastair M. Borthwick (Chief Financial Officer) || Section: Prepared remarks (Bank of America).

Sources: IMF staff.

Figure 1.7.9. Questions included in Prompts

Current Capital Trends	**Output Type**	**Data Dictionary**
What is the CET1 (common equity Tier 1 capital) ratio in the quarter?	Number	CET1_current
What is the target or the target range or operating range for the CET1 ratio?	%	CET1_target_range
What is the minimum regulatory CET1 plus buffers or minimum regulatory CET1?	number	CET1_req_buffer
Did the bank manage down or decrease CET1 in the quarter?	y/N	CET1_manage_down
Current Capital Strategy		
Does the bank have a capital distribution or allocation or optimization strategy?	Y/N	Strategy
What is the hierarchy of the capital distribution or allocation or optimization strategy?		Hierar_strategy
Does the capital distribution or allocation or optimization strategy include organic growth or organic risk-weighted asset growth?	Y/N	Organic_RWA_Deploy
Does the capital distribution or allocation or optimization strategy include dividends, dividend payments or dividend payouts?	Y/N	Dividend_strategy
Does the capital distribution or allocation or optimization strategy include share repurchase or share buybacks?	Y/N	Buyback_strategy
Does the capital distribution or allocation or optimization strategy include nonorganic growth or acquisitions or merger & acquisitions?	Y/N	Inorganic_Spend_strategy
Forward Capital Strategy Guidance		
What is the forward guidance or outlook or looking ahead for the capital allocation or capital distribution strategy?		Capital_strategy_fwd
What is the forward guidance or outlook or looking ahead for organic growth?		Cap_organic_fwd
Going forward, will the bank consider non organic growth or acquisitions or merger & acquisitions?	y/N	Inorganic_Spend_Guidance_fwd
Going forward, will the bank increase dividend or dividend payouts or dividend payments?	amount or %	Dividend_Guidance_fwd
Going forward, will the bank increase share repurchase or share buybacks?	amount or %	Buyback_Guidance_fwd
Going forward will the bank increase or upgrade its target return to shareholder or capital distribution?	amount or %	Distribution_Goal_fwd

Sources: IMF staff.

The second step focused on identifying and evaluating the frequency and availability of earnings transcripts across banks, including G-SIBs. During the prompt-design and initial implementation stages, the project evaluated transcripts and sourced 1,068 English-language earning transcripts for 109 banks from the first quarter of 2023 to the fourth quarter of 2025, subject to availability as of February 22, 2026. The start date was selected to capture potential changes in capital strategy following the banking stress experienced in the United States in March 2023. Across this sample, these banks had estimated total assets of $79 trillion, weighted average CET1 of 13.5, ROE of 11.8 in the third quarter of 2025. Profitability trends have supported elevated total payout ratios since 2023 (Figure 1.7.10.).

The third step of the project involved implementing the workflow and validating the extracted data. The project used a Question-and-Answer agent-based framework to extract key data points (Figure 1.7.11.). Agent 1 monitored a designated file directory and, whenever a new earnings transcript was uploaded, retrieved the file, and extracted the text. This text was then passed to Agent 2, which was responsible for answering the full set of questions and providing supporting evidence for each response. At this stage, limitations related to transcript availability and data coverage on capital distribution strategies reduced the sample from 109 to 78 banks. Validation occurred as a secondary step by reviewing each answer alongside the evidence provided. For numerical outputs, responses were cross-checked against external data sources or the original earnings transcript. In some cases, the same question was posed in two different ways to assess the consistency of the model's responses.

The fourth step reviewed the findings across banks and geographies. Several findings stand out regarding existing capital strategies and forward-looking guidance on capital strategies, as summarized below.

- Banks disclosed CET1 ratios and trends in their earning transcripts as part of prepared remarks or Q&A session. In 3Q25, 92 percent of the banks in the sample disclosed this information.
- About half of the banks in the sample disclosed internal CET1 targets. In the third quarter of 2025, disclosures were concentrated among banks in Europe and North America. On average, CET1 capital buffers above internal targets ranged from 43 to 140 basis points (Figure 1.7.6., panel 2). Meanwhile, two-thirds of G-SIBs disclosed internal CET1 target ratios in the third quarter of 2025; comparisons with current CET1 levels suggested capital buffers above internal targets ranged from 50 to 150 basis points for nearly all G-SIBs.
- Banks, including G-SIBs, provide a high-level overview of their capital distribution strategies and disclose a hierarchy among these strategies. In Asia, dividend payments and organic growth are the primary approaches, while in Europe and North America dividends rank first, followed by share repurchases, organic growth, and inorganic growth (Figure 1.7.6., panel 3 and 4).

- In North America, banks including G-SIBs shifted their capital distribution hierarchy in 2025, prioritizing organic growth and dividend payouts ahead of share repurchases and inorganic growth, while a greater number also disclosed inorganic growth plans compared with previous quarters.
- Forward guidance on capital distributions suggests that banks including G-SIBs expect to maintain or increase capital returns to shareholders, supported by continued profitability and solid capital positions heading into 2026 (Figure 1.7.6., panel 5 and 6).
- A small number of banks in Europe and North America also disclosed information in the third and fourth quarters of 2025, indicating a potential further reduction in their internal CET1 target ratio ranges.
- Overall, banks in Europe, North America, and the United Kingdom—including G-SIBs—provided more extensive disclosures on capital distribution strategies than other banks and G-SIBs in Asia.

Figure 1.7.10. G-SIBs Characteristics

The G-SIBs in the sample reported total assets of $79 trillion …

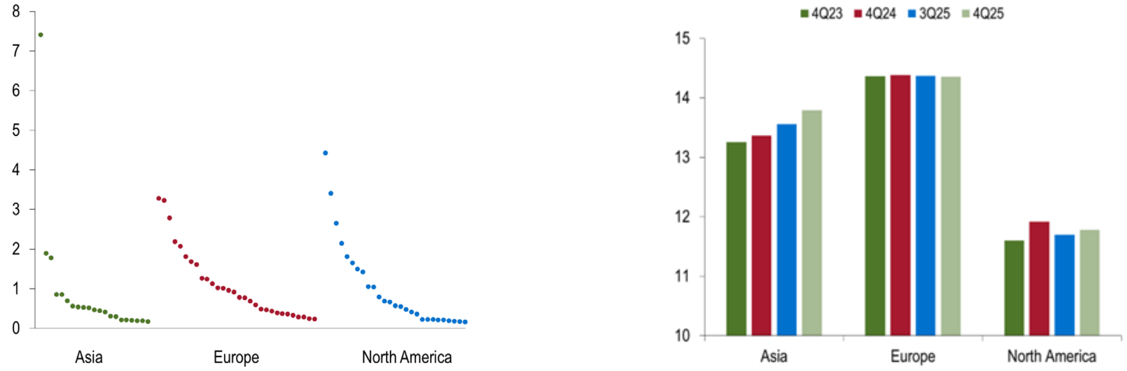
1. Total Assets

(U.S. trillions of dollars)

…and weighted average CET1 ratios of 13.53 percent in 3Q25.

2. CET1 Ratio

(Percent)



Banks' increased profitability …

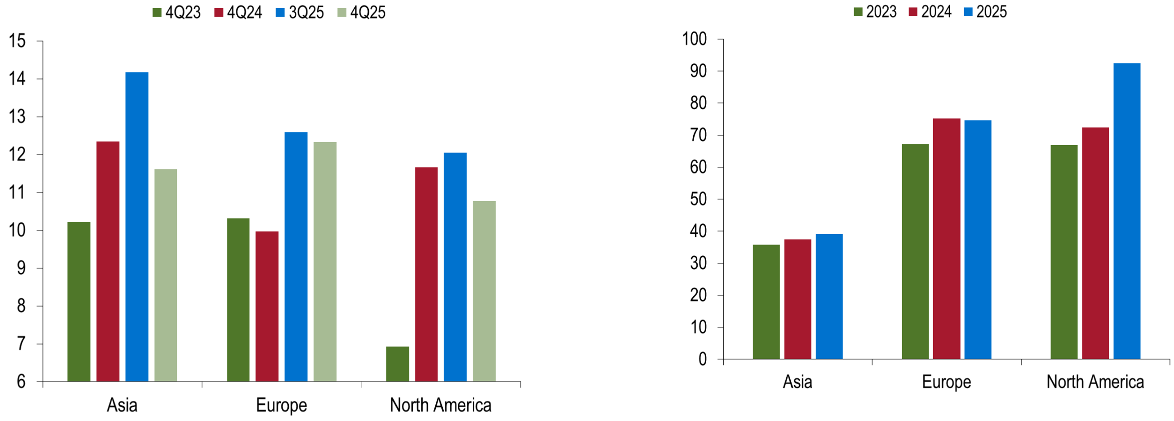
3. Return on Equity

(Percent)

…has supported elevated capital shareholder returns.

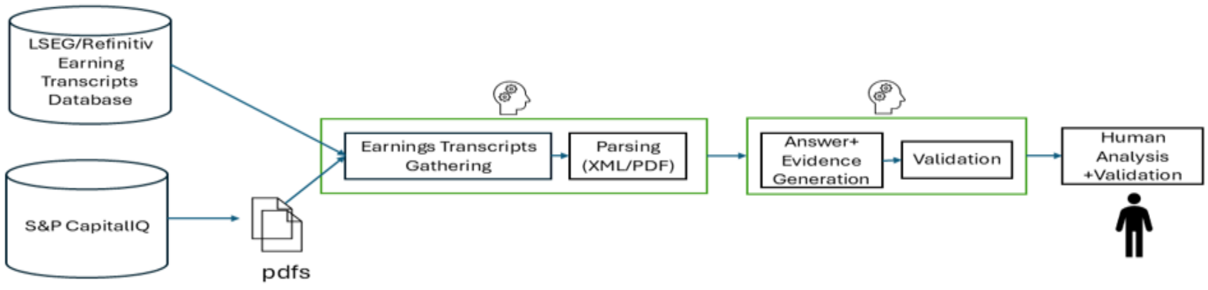
4. Total Payout Ratio

(Percent)



Source: Visible Alpha SP Global Market Intelligence, SP Capital IQ Pro, and IMF staff estimates.
Note: Panel 2 and panel 3 statistics are calculated as median based on actual 4Q25 bank report as of February 10, 206. Panel 4 is weighted average by total assets.

Figure 1.7.11. Agent Workflow



Sources: IMF staff.

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Online Annex 1.8 Frontier Market Resilience Index[1]

The Frontier Market Resilience Index (FMRI) is constructed to provide a systematic and transparent assessment of macroeconomic and institutional resilience across frontier and lower-income emerging market economies. The index is intended to complement existing surveillance tools by focusing on a country's capacity to absorb shocks (including external, fiscal, and financial) without generating destabilizing macroeconomic or balance-of-payments pressures. A key design principle of the FMRI is that resilience is evaluated relative to a country's own historical experience, rather than through cross-country comparisons of levels at a given point in time. This approach allows the index to capture improvements or deteriorations in underlying fundamentals even when countries differ structurally in income levels, economic size, or institutional development. The FMRI is a contemporeneous by construction and is intended as a near-real time summary measire of underlying resilience as opposed to a predictive model of stress episodes.

The Frontier Market Resilience Index covers 43 frontier and low-income economies. Sub-Saharan Africa accounts for the largest share of the sample (17 countries, about 40 percent), reflecting both the prominence of frontier economies in the region and comparatively broad data coverage. Latin America and the Caribbean comprises 11 countries (about 24 percent), while Europe and Central Asia is represented by 6 countries (about 13 percent). Southeast Asia is represented by 5 countries and the Middle East and North Africa accounts for the remaining 4 countries (about 9 percent). As a result, regional representation is uneven and varies across indicators and over time.. The country list and regional classifications follow IMF WEO conventions.

Resilience is estimated as a multi-dimensional concept encompassing external buffers, fiscal space, debt sustainability, price stability, and institutional capacity. To reflect these dimensions, the index aggregates a set of macroeconomic and governance indicators into economically coherent buckets. Each bucket represents a distinct channel through which shocks may be absorbed or amplified.

The aggregation framework is intentionally parsimonious and avoids ex ante weighting schemes. All indicators within a bucket, and all buckets within the index, are equally weighted. This choice reflects both transparency considerations and the absence of strong empirical priors on optimal weights for frontier economies.

Indicators are selected based on four criteria: relevance for shock absorption, consistency with IMF surveillance frameworks, availability across frontier markets, and interpretability. Grouping indicators into buckets reduces sensitivity to idiosyncratic data issues and allows for a clearer economic narrative when interpreting movements in the index. The FMRI primarily relies on macroeconomic and balance-sheet indicators rather than market-based asset pricing variables. Although improvements in fundamentals may coincide with tighter sovereign spreads, the index does not mechanically incorporate sovereign bond spreads or other financial market prices, limiting risks of circularity in interpretation.

The FMRI is constructed at a quarterly frequency to provide the highest feasible update frequency given data availability across macroeconomic and structural indicators. While some variables, such as inflation or financial market spreads, are available at higher frequency, others (including national accounts, fiscal aggregates, and governance indicators) are updated less frequently. Quarterly aggregation therefore represents a practical compromise between higher-frequency market indicators and slower-moving structural variables, ensuring comparability across countries while maintaining timely updates for surveillance purposes. Structural indicators such as governance measures are therefore included at quarterly frequency using their most recently

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[1] This annex was prepared by Esti Kemp.

available values, reflecting the view that institutional quality evolves gradually but remains an important determinant of resilience.

Figure 1.8.1. Indicators and Buckets used for the Frontier Market Resilience Index

Bucket	Economic Rationale	Indicator	Construction
External Liquidity	capturing short-term external financing capacity and reserve adequacy	Import Cover (IMF)	(3 x International reserves / Quarterly imports)
		Short-term debt to reserves (WB/IMF)	Short-term external debt / international reserves
		Current account balance to GDP (IMF)	Four-quarter sum of current account / GDP
External Solvency	reflecting medium-term sustainability of the external position	NIIP net of FDI to GDP (IMF)	(NIIP − FDI liabilities) / GDP
Fiscal Stance	measuring near-term fiscal space and policy flexibility	Fiscal balance (IMF)	General government primary net lending or net borrowing (% of GDP)
Public Debt Vulnerability	capturing debt levels, composition, and dynamics	General government debt (IMF)	Gross general government debt (% of GDP)
		Debt FX share (IMF)	FX-denominated government debt / total government debt
		Debt sustainability gap (IMF)	Primary balance minus debt-stabilizing balance: $PB_t - PB_t^*$. where $PB_t^* = \frac{(r_t - g_t)}{(1+ g_t)}$ All inputs annual; values repeated quarterly
Price Stability	reflecting inflationary pressures	CPI inflation (IMF)	Quarter-average of monthly year-over-year CPI inflation rate
Institutions & Governance	capturing policy credibility and institutional quality	Political risk (Bloomberg)	Composite political risk indicator
		Government effectiveness	World Bank Governance Indicator
		Rule of law	World Bank Governance Indicator
		Control of corruption	World Bank Governance Indicator

Source: IMF WEO, World Bank and IMF staff calculations.
Note: Within each Bucket, indicators are equally weighted.

Each indicator is transformed into a standardized z-score at the country-indicator level, ensuring that index movements reflect changes relative to a country's own historical distribution rather than cross-sectional differences across countries. For each country c and indicator i, the z-score is defined as:

$$z_{c,i,t} = \frac{x_{c,i,t} - \mu_{c,i}}{\sigma_{c,i}}$$

where the mean and standard deviation are computed over a fixed baseline window from 2010Q1 to 2019Q4. This period is chosen to anchor normalization in a relatively stable pre-pandemic environment while excluding recent crisis-related volatility.

Country-indicator series are included in the z-score calculation only if sufficient historical observations are available to estimate a reliable baseline distribution. Specifically, a minimum of eight quarterly observations is required within the baseline period (2010Q1–2019Q4). For indicators that are structurally sparse, a lower threshold of three observations is applied. If this condition is not met, z-scores are omitted for the affected country-indicator pair. Where sufficient cross-country data exist, pooled baseline moments may be used as a fallback; otherwise, the series is excluded. Indicator signs are adjusted, where necessary, so that higher z-scores consistently indicate stronger resilience (for example inflation, public debt and foreign-currency debt exposure enter with inverted signs).

Z-scores are aggregated sequentially. First, for each country and quarter, bucket scores are computed as the simple average of available indicator z-scores within each bucket. Second, global and regional bucket series are constructed as unweighted averages across countries with available data in each period. Country coverage is reported alongside each aggregate to ensure transparency.

The headline resilience index is defined as the sum of bucket scores. This unbalanced-panel approach allows the index to extend to the most recent available data without mechanically dropping countries or indicators due to reporting lags, an important consideration for near real-time surveillance.

Increases in the index represent improvements in resilience relative to a country’s own historical norms, given that normalization is country-specific. Given the reliance on within-country standardization and an unbalanced panel, the FMRI is best interpreted as tracking changes in resilience over time within countries and across the sample, rather than providing a strict ranking of structural resilience levels across countries. Aggregate movements reflect whether improvements or deteriorations are broad-based across countries or driven by a narrower subset.

The FMRI is intended as a complementary monitoring tool that synthesizes multiple resilience dimensions into a single framework. It can help identify emerging vulnerabilities, track whether improvements in flow variables, such as fiscal balances or inflation, are translating into stronger balance sheets, and contextualize movements in sovereign spreads. The index may also highlight cases where market pricing diverges from underlying fundamentals, prompting deeper country-specific analysis. The FMRI is not intended to replace existing debt sustainability or external sector assessments, but rather to provide a standardized summary measure to inform risk discussions.

The FMRI changes over time reflect major global shocks and subsequent policy responses. The sharp decline in 2020 is mainly driven by the deterioration in external balances, fiscal positions, and debt dynamics during the COVID-19 shock, alongside heightened macroeconomic instability and rising inflation. Between end-2022 and end-2024, the aggregate FMRI improved back toward average levels observed during 2010–2019, primarily as the result of improvements in external liquidity and the stabilization of inflation. However, public debt vulnerabilities remained elevated, reflecting the slow-moving nature of debt stocks and higher interest burdens, while external solvency indicators remained weaker than pre-pandemic norms.

From a surveillance perspective, the FMRI can serve as a structured diagnostic tool to identify emerging vulnerabilities, assess the breadth of resilience gains across countries, and distinguish between improvements driven by cyclical external conditions and those supported by stronger fiscal or institutional fundamentals. While not designed as a predictive stress-testing model, the index provides a near-real-time signal of evolving resilience dynamics across frontier markets.

CHAPTER

1

GLOBAL FINANCIAL STABILITY REPORT

Online Annex 1.9 Depreciation and Credit Spreads[1]

This annex describes a structural framework to show how economic depreciation and capital obsolescence—particularly relevant in the case of large, capital-intensive technology firms, such as hyperscalers—map into credit risk and credit spreads. The key premise is that rapid technological advancement could shorten the economic life of capital (e.g., GPU and advanced chips), lowering the true return on productive assets even if accounting profits remain strong. Some argue that GPUs' effective useful lives could be as short as one year or less, pointing to faster model and chip upgrade cycles, including Nvidia's shift toward a roughly annual product cadence that can make prior-generation chips economically outdated for frontier training, even if they remain operational.

The framework used here adopts a replacement-cost perspective, focusing on economic capital required to maintain the productive asset base. This follows the capital-replacement and investment literature (e.g., Jorgenson, 1963; Tobin, 1969; Hayashi, 1982), and the residual-income and accounting-based valuation literature (e.g., Feltham and Ohlson, 1995; Penman, 2010). The structural credit component builds on the option-theoretic model of Merton (1974), and the empirical implementation of Bharath and Shumway (2008).

Importantly, the framework does not attempt to forecast default probabilities (PD) or predict future paths of PDs. Instead, the objective is to link changes in economic depreciation and buffer policy to scenario-consistent movements in fair-value credit spreads, measured relative to the baseline risk-neutral PD, and to corresponding valuation-multiple adjustments implied by the replacement-cost economics.

This approach outlined here departs from standard treatments of depreciation, by embedding it directly into a replacement-cost valuation framework. Economic depreciation is not treated as an accounting convention, but as a determinant of the firm's sustainable productive capacity and long-run returns.

The framework explicitly accounts for: the economic useful life of capital (τ), the implied depreciation schedule (d_t), the reinvestment need to maintain productive capital (K^{prod}), and the role of cash buffers (B_t) in financing capital expenditures.[2] Let K^{dep} denote depreciable capital and S denote the residual value of the depreciable asset block after τ periods. The economic accounting identity is[3]

$$K^{dep} = \sum_{t=1}^{\tau} d_t + S \tag{1}$$

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[1] This annex was prepared by Deepali Gautam, Johannes Kramer, and Aki Yokoyama.

[2] Depreciable capital is proxied by property and equipment, and operating lease asset. Non-depreciable capital is proxied by the difference between total assets and the sum of depreciable assets and cash buffers. Cash buffers are defined as cash and cash equivalents plus short-term securities. The economic useful life of capital τ is approximated by the ratio of productive capital, K^{prod}, to annual depreciation. Financial statement data are taken from SEC Form 10-K filings, and when unavailable, from other disclosure sources. The analysis is an approximation based on publicly available company information and does not necessarily reflect the actual situation. . The analysis assumes a widely used straight-line depreciation methodology. See the International Accounting Standards Board Standard 16, Property, Plant, and Equipment, and the US Generally Accepted Accounting Principles Accounting Standards Codification, ASC 360-10-35-4. Straight-line method is standard practice among major hyperscalers, as per US Securities and Exchange Commission (SEC) filings.

[3] Depreciation allowances create tax shields that can lower income tax payments, consistent with Modigliani–Miller (1963) in the presence of corporate taxes. Because the framework applied here focuses on replacement-cost and economic depreciation as the primary drivers of reinvestment needs and risk, it abstracts from tax considerations for tractability. Tax shields affect after-tax cash flows and may vary with the tax position over the cycle. Separately, a meaningful share of AI-related financing is reportedly structured through off-balance-sheet vehicles, including special purpose vehicles and variable-interest entities. To the extent sponsors retain effective control, or provide explicit or implicit support, such structures may not materially reduce underlying economic exposure, even if reported leverage metrics are affected (BIS 2026).

In this stylized framework, productive capital stock K^{prod} is defined as the sum of depreciable capital K^{dep} and non-depreciable capital K^{ndep}. From these elements, the model derives an economic internal rate of return (IRR) on productive assets, denoted r^{econ}, which captures the economically meaningful return after accounting for obsolescence and maintenance investment. Let C_t denote the operating cash flow in period t before economic depreciation, and ϕ denote the terminal-value component.

$$K^{prod} = \sum_{t=1}^{\tau} \frac{C_t - d_t}{(1+r^{econ})^t} + \frac{\Phi}{(1+r^{econ})^\tau} \tag{2}$$

If accounting useful lives exceed economic lives, then d_t is understated, inflation reported ROE. Equation (2) corrects this by requiring consistency between K^{dep} and d_t via equation (1).

In terms of the notation, we adopt the notation of Merton (1974) and proceed with a continuous-time structural model. Let $\widehat{V_A}$ denote the market value of firm assets and assume that under the risk-neutral measure asset values follow a geometric diffusion with physical drift μ_A^P and asset volatility σ_A:

$$dV_{A,t} = \mu_A^P V_A dt + \sigma_A V_A dW_t$$

A central modeling step is the interpretation of the economic, internal rate of return (IRR) as the physical drift of firm assets:

$$\mu_A^P = r^{econ}$$

This links firm-level capital dynamics directly to the stochastic evolution of asset values in a structural credit framework.

At the baseline—defined by current depreciation assumptions, capital intensity, and buffer policies—the model delivers a baseline economic return r_0^{econ}. Given a corresponding risk-neutral asset drift $\hat{\mu}_A^Q$ and asset volatility $\hat{\sigma}_A$, the framework infers a market price of asset risk is inferred as

$$\hat{\theta} = \frac{r_0^{econ} - \hat{\mu}_A^Q}{\hat{\sigma}_A}$$

The parameter $\hat{\theta}$ summarizes how markets price a unit of asset risk relative to the economic return implied by replacement-cost valuation under current conditions. Importantly, it provides a stable bridge between economic fundamentals and risk-neutral dynamics, allowing the analysis to focus on changes in depreciation and capital lives without re-estimating market pricing behavior.

The core analytical exercise considers counterfactual depreciation scenarios. For a given scenario s—such as a shorter economic life of capital τ_s, higher replacement investment needs, or altered buffer policies—the replacement-cost IRR calculation yields a new economic return r_s^{econ}.

The scenario physical drift is set to:

$$\mu_{A,s}^P \;=\; r_s^{econ}$$

and, holding the market price of risk $\hat{\theta}$ fixed, the scenario risk-neutral drift becomes:

$$\mu_{A,s}^Q = r_s^{econ} - \hat{\theta}\hat{\sigma}_A$$

Let D denote the face value of debt, and T the horizon, and $\widehat{\sigma_A}$ the asset volatility.[4] The risk-neutral distance to default at maturity T is:

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[4] V_A is approximate as $E + D$, where E is the market value of equity, following Bharath and Shumway (2008). Asset volatility is approximated as $\sigma_A \approx \frac{E}{E+D}\sigma_E$, where σ_E is long term realized volatility of GS US TMT AI Basket Index since 2015.

$$DD^{Q,s}(T) = \frac{\ln(\hat{V}_A / D) + (\mu_A^{Q,s} - \frac{1}{2}\hat{\sigma}_A^2)T}{\hat{\sigma}_A \sqrt{T}}$$

The associated risk-neutral default probability is:

$$PD^{Q,s}(T) = N(-DD^{Q,s}(T))$$

Given a loss-given-default parameter LGD, the model-based credit spread at maturity T is:

$$s_s(T) = -\frac{1}{T}\ln\left(1 - \mathrm{LGD} \cdot PD^{Q,s}(T)\right)$$

The framework highlights a clear mechanism: shorter economic lives of capital lower economic returns, which reduce risk-neutral asset drifts, shorten distances to default, and mechanically increase default probabilities and credit spreads. This occurs even absent an immediate deterioration in revenues or accounting earnings.

For hyperscalers, whose business models rely on large capital stocks vulnerable to rapid obsolescence, the analysis provides a structural explanation for why credit risk can be sensitive to technological change and capital intensity rather than traditional leverage metrics alone.

The framework is intentionally conservative. Obsolescence may be accompanied by higher-performing chips and productivity gains, and even obsolete chips can likely be repurposed for lower profile business which may not require high-performance chips. If investment translates into stronger revenue and earnings growth, firms may be able to raise equity, while ample cash flows could help limit their reliance on debt financing.

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