Congestion in Global Sovereign Debt Markets[‡]

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Abstract

Do sovereigns compete for funding when issuing debt in primary markets? I construct a new dataset covering the near universe of sovereign debt issuance across 28 countries and show that competition depends on both the volume of foreign issuance and the composition of concurrent issuers. I first document three facts: (i) on the extensive margin, issuers select auction days according to a small set of calendar characteristics which can explain the variation of daily global issuance, (ii) conditional on issuing, domestic issuance amounts are uncorrelated with concurrent foreign supply, whose variation is large at any level of domestic issuance, and (iii) a small set of "Hub" countries are both large and share many dealers with other countries. Using predetermined debt rollover obligations as an instrument, I find that a one-standard-deviation increase in foreign issuance steepens the domestic demand curve by 75%, increasing the price concession required to sell additional debt. In contrast, a one-standard-deviation increase in the presence of "Hub" issuers flattens domestic demand by 60%. I develop a model with domestic banks and risk-constrained global intermediaries that explains these opposing effects. Foreign issuance competes for scarce intermediation capacity, while overlapping dealer networks pool that capacity across otherwise segmented markets. Consistent with the model, crowding-out is concentrated in large domestic issuance on heavy foreign supply days when intermediary capacity tightens. High common dealer overlap between concurrent issuers leading to lower auction yields is further evidence for the network mechanism. Finally, counterfactual adjustments to issuance dates around predetermined rollover obligations suggest that sovereigns could reduce borrowing costs by accounting for global issuance schedules and dealer connections.

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1 Introduction

Do sovereigns compete for funding when issuing debt in primary markets? If markets are frictionless, one government's decision to borrow today should have little bearing on another's financing costs. But with intermediation frictions, foreign supply and the composition of other issuers may matter for domestic borrowing costs. Despite its importance, this question has been difficult to answer. Most existing work studies sovereign borrowing through low-frequency debt aggregates, secondary-market yields, or individual issuers, rather than examining the global primary market jointly. I make progress by assembling a new high-frequency dataset covering nearly all sovereign debt issuance across 28 countries, compiled from more than 100 sources, to study the anatomy of global debt issuance.

I document three new facts about daily issuance patterns that inform my empirical exercise later. (i) On the extensive margin, about 10% of daily global issuance cannot be explained by country size and issuance frequency but by governments selecting into issuance days on a common set of liquidity-related characteristics: mid-week days without major foreign holidays or domestic monetary-policy events. (ii) On the intensive margin, conditional on issuing on a given day, a country's issuance amount is essentially unrelated to foreign issuance at the same time, with large variation in foreign issuance. This is surprising because debt managers might issue less when foreign supply is large and demand is finite. (iii) On the issuer side, a small set of large "Hub" countries share many dealers with the rest of the world (ROW), so a non-Hub country issuing alongside them likely relies on the same dealers.

Next, I investigate empirically how foreign issuance and the presence of Hub countries issuing alongside the domestic sovereign affect its auction price. I find that (i) borrowing together is costly: using predetermined debt rollover needs as an instrument for domestic issuance, the domestic demand curve steepens by 75% when foreign issuance is 1 SD above its usual level (holding issuer composition fixed); and (ii) the domestic demand curve flattens by 60% when 1 SD more Hub countries are present than usual (holding foreign issuance fixed). A model with local and global banks, the latter subject to a risk limit, rationalises these results. When domestic issuance is large, the global bank must absorb residual supply, but its balance sheet also depends on foreign issuance, generating a "crowding out" channel. Consistent with the model, crowding out is concentrated on crowded days when domestic issuance is large, and the intermediary risk factor is tight. The model also rationalises the Hub presence result: holding competing supply and total intermediation capacity fixed, Hub countries in the market bring more dealers that are common to several issuers, so each issuer can draw on a larger share of the same capacity and the market is less segmented. A horse race regression using concurrent issuers' characteristics shows the importance of high common dealer overlap for the price, supporting this prediction. Finally, a counterfactual with optimal rollover of outstanding debt implies borrowing-cost savings. More broadly, the price of public borrowing depends on when other governments come to market.

I construct a new high-frequency dataset of the near-universe of sovereign bond issuance across 28 advanced and emerging economies from 2006 to 2025, compiled from more than 100 official and market sources. For each country, I collect event-level data on auctions, syndications, switches, buybacks and redemptions directly from the issuing authority. Because measuring foreign supply requires near-complete coverage, I validate the data by cumulating daily flows into a stock of debt: at the end of 2024 the constructed global stock is USD 51.7 trillion against an official USD 53.6 trillion. I measure the cost of borrowing by the *auction concession*, the yield at which an auction clears minus the yield of the same bond priced off the domestic curve at the previous close. I also collect historical primary dealer lists, which show which intermediaries each sovereign relies on.

This comprehensive data set allows me to map the anatomy of daily issuance patterns. I document three new facts that inform the empirical exercise later. First, daily global issuance is highly concentrated: the busiest 10% of days carry 40% of non-U.S. issuance. I decompose the daily issuance pattern into country size and issuance frequency as well as a systematic part which is about *when* sovereigns issue: relative to randomised calendars, they prefer to issue midweek, avoid domestic monetary policy meetings, and when major foreign markets are closed. Second, conditional on issuing, the amount a country issues is essentially unrelated to foreign supply around its auction, although competing supply varies widely. Third, a small set of large issuers—Germany, France, Italy, Japan, the United Kingdom and the United States—sit at the centre of the primary dealer network. A country issuing alongside these "Hub" countries likely draws on the same dealers.

I then show that foreign issuance and concurrent issuing "Hub" countries matter for the domestic price using ROW's predetermined rollover need as instrument for realised ROW issuance. The instrument is plausibly exogenous because redemption schedules are fixed when the bonds were issued, often years earlier. In advanced economies, one standard deviation more competing supply makes the domestic demand curve about 75% steeper; one standard deviation more Hub presence makes it about 64% flatter. For an auction 1.7 times the issuer's usual size, the two shocks move the concession by +0.73 and −0.66 bp, about an eighth of the typical daily move in the ten-year yield. So large foreign issuance makes the domestic price of risk rise, and concurrent Hub country issuing makes the domestic price of risk fall. Further heterogeneity analysis shows that the effects are concentrated in advanced economies, and foreign supply within the same trading region and maturity bucket matters more. Unlike a secondary-market price move, this cost is permanent: it is locked in at issuance and paid until the bond matures. Date fixed effects leave both effects unchanged.

A model with local and global banks, the latter subject to a risk limit, rationalises these results. Local banks absorb an issuer's usual supply; deviations must be placed with global banks, whose balance sheets also carry foreign supply. As foreign issuance rises, risk limits bind and domestic demand steepens—crowding out. Further analysis on advanced economies supports this mechanism. Crowding out falls only on large auctions on days that are crowded and is amplified when intermediary

capital is tight (as proxied by He et al. (2017)'s risk factor). To see why the presence of Hub countries reduces the price of risk, hold competing supply and total intermediation capacity fixed and compare a day with many Hub countries issuing with a day without. On the Hub day, more of the dealers in the market are common to several issuers, so each issuer can draw on a larger share of the same capacity. Without Hub countries the market is segmented: a small set of common dealers has to take on concentrated positions, so issuing large amounts is more costly. Further analysis supports this mechanism, as I find that large domestic issuance is particularly costly when just a few hub countries are present in the market. Replacing the hub presence variable with characteristics of concurrent issuers in a horse race regression shows further support for the interpretation that crowding in results from Hub country presence comes from more dealers that are common to several issuers. Crowding in is about connectedness, not size: the share of partners present, their dealer network, and the presence of partners that share dealers with the domestic issuer matters.

Finally, I move to a counterfactual exercise. Moving only the dates of auctions, re-issuing the USD 19 trillion of outstanding bonds of ten advanced economies on the best rather than a random calendar saves 13.4 bp of the stock, or USD 2.6 billion a year in interest, about 1% of the coupon bill. Moves of at most a month retain 80% of the gain. Yet observed calendars do no better than random ones.

Together, these results show that sovereign borrowing costs are not set country by country. The price of public borrowing depends on how much other governments borrow at the same time, and on which governments come to market alongside it.

Related Literature Need to update

This paper contributes to several strands of work on sovereign debt pricing, the information content of primary market auctions, the global transmission of policy events, and the role of intermediary capacity in fixed-income markets.

Price impact of issuance and auction dynamics. Lou et al. (2013) show that secondary market yields cheapen ahead of large U.S. Treasury auctions and reverse afterward, consistent with dealers requiring compensation for inventory risk. Droste et al. (2024) (Lengyel and Giuliodori (2022), Albuquerque et al. (2024))exploit the predetermined supply schedule and small-window intraday price changes around auction close to identify preferred-habitat demand shocks, showing effects that resemble large-scale asset purchases. My instrument construction follows a similar logic of exploiting predetermined supply-side variation, applied to the cross-country setting, but focuses on the varying steepness of the demand curve depending on rest-of-world issuance and measures outcomes over daily windows to incorporate global supply across the full panel. Gómez-Cram et al. (2025) identify fiscal news from legislative cost estimates and show that Treasury valuations respond to cash-flow news about future funding needs, with effects concentrated at longer maturities. Wong et al. (2026)

compile a unique data set on issuance events across 20 countries and investigate when countries enter or exit the debt market. We look at the auction outcome relative to who else issues.

Cross-border auction spillovers. Somogyi et al. (2025) document a permanent decline in the demand elasticity at U.S. Treasury auctions, attributing this to a fall in foreign investor participation identified by variation in overlapping auction days across countries. My paper complements theirs by studying how the simultaneous issuance decisions of *all* sovereigns—not just the U.S.—affect each individual auction's clearing price, and by measuring the effect directly in the primary market rather than through secondary market yield changes. Beetsma et al. (2018) document spillovers from foreign sovereign bond auctions into domestic secondary market auction cycles in the euro area, with mixed results across pre- and post-crisis episodes. I extend this in three dimensions: I study the global sovereign debt market across 28 advanced and emerging economies rather than the euro area alone; I measure outcomes directly via the auction yield spread rather than relying on secondary market yield changes; and I provide causal identification through a rollover-need instrument that exploits the predetermined nature of debt maturity schedules, addressing the endogeneity concerns that limit identification in Beetsma et al. (2018). Krohn and Vala (2025) link Treasury auction conditions to abnormal FX returns around macro announcements, and Lou et al. (2025) document pre-announcement yield drifts for UK gilts when issuance precedes macro news, both consistent with intermediary capacity shaping term premia. These papers study individual markets; I examine whether supply pressure propagates across sovereign issuers in global primary markets. More broadly, Longstaff et al. (2011) show that sovereign CDS spreads are driven primarily by a common global factor, commoving more strongly with U.S. equity and high-yield conditions than with local fundamentals. Jiang and Richmond (2025) propose that competition among sovereigns for reserve-asset market share generates strategic complementarities in issuance, producing a global fiscal cycle. Kim (2023) shows that U.S. fiscal deterioration depresses global risky-asset prices. Relative to this literature, my focus is on the primary market mechanism through which simultaneous issuance raises the cost of debt placement, rather than on the level of sovereign risk premia or their secondary market comovement. De Leo et al. (2026) offer a model where foreign investors have to buy local currency to buy local bonds, giving risk to correlated returns. They test it in Colombia using bidding data in exchange rate auctions.

Coordination of policy events. Mendoza-Fernández and Pelin (2025) show that emerging market central banks systematically schedule their monetary policy meetings after Federal Reserve meetings, using the Fed's decision as a signal to calibrate their own actions. I document an analogous structure in sovereign debt markets: a substantial share of non-U.S. sovereign auctions cluster within a narrow window of U.S. Treasury operations, and U.S. auction outcomes contain information about global demand conditions that is not priced into non-U.S. auctions beforehand but is reflected in them in

the days immediately after. The debt issuance calendar and the monetary policy calendar thus share a common organizing structure, with the United States serving as the anchor in both domains. This demand signal channel is consistent with Hillenbrand (2025), who documents that the long-run decline in U.S. Treasury yields is concentrated in narrow windows around FOMC meetings, suggesting a broader role of U.S. policy events as global information events across both monetary and fiscal dimensions. More broadly, an early literature with the pivotal work of Welch (1992) regarding the learning for IPOs from purchasing decisions of earlier investors can rationalise herding, where Bikhchandani et al. (2024) provides a review of the literature.

Preferred habitat and intermediary capacity. Vayanos and Vila (2021) provide the theoretical foundation for preferred-habitat demand, showing that segmented investor clienteles with maturity preferences generate downward-sloping demand curves that make bond prices sensitive to supply at each point of the yield curve. An extended version incorporating substitutions elasticities along the yield curve and emperical excersize about different demand curse of different types of investors can be found in Jansen et al. (2024). Greenwood and Vayanos (2014) and He et al. (2017) provide empirical evidence that bond supply shifts affect excess returns through this channel. I build on this by showing that supply sensitivity is amplified when global intermediary capacity is constrained, connecting the cross-country externality I document to the intermediary asset pricing literature (He and Krishnamurthy, 2013), which emphasizes that dealer balance-sheet constraints generate state-dependent price impacts of supply shocks. A complementary literature studies how government debt issuance crowds out private borrowing through the same supply channel: Graham et al. (2015) document a long-run inverse relationship between government and corporate leverage, and Pinardon-Touati (2021) on the crowding out of private financing by government debt. The externality I document operates within the sovereign sector rather than across the public–private boundary, but through the same constrained-balance-sheet mechanism.

Predetermined debt maturity as identification. My identification strategy connects to a literature that exploits predetermined debt maturity structure to isolate supply effects. Almeida et al. (2012) use the volume of long-term debt maturing during the 2007–09 crisis—fixed by issuance decisions taken years earlier—in a difference-in-differences design, and Xu (2018) exploits the timing of callable-bond refinancing. Greenwood et al. (2010) and Greenwood and Vayanos (2014) link corporate and government maturity choices to the maturity structure of outstanding debt. I apply the same predetermination logic across countries, instrumenting rest-of-world issuance with redemption schedules set years in advance.

2 Data

Studying the primary dealer markets globally requires granular, harmonised data on issuance timing and auction outcomes across countries. Such data do not exist in any single commercial or official source. Financial data providers lack comprehensive coverage of auction-level characteristics—particularly for earlier periods and emerging markets. I therefore construct a new dataset by collecting primary data directly from the monetary and fiscal authorities of 28 advanced and emerging economies.[1] The dataset draws on more than 100 official and market sources and covers the near universe of sovereign bond issuance across these countries, including auction operations, syndicated issuance, switch operations, redemptions, and buybacks.

2.1 Data Sources and Collection

For each country, I obtain event-level data from the primary issuing authority—typically the debt management office, treasury, or central bank— supplementing with secondary market data providers if possible where official records are incomplete. The data encompass all primary market issuance events where available (auctions, syndications, and direct placements), the associated bond characteristics (maturity, coupon type, issuance amount, currency denomination), and, where available, auction outcome variables (accepted yield, bidding amounts, bid-to-cover ratio, and allotment).[2] Using bonds' redemption dates together with, where available, data on buyback and switch auctions, I can track the *life cycle of each issuance*, covering the full lifecycle of each issuance event from operation date to maturity or early retirement. The resulting dataset combines more than 100 source-level inputs, harmonized into a common format and converted to US dollars using daily exchange rates. Table A40 in the Appendix provides a complete list of sources by country.

2.2 Validation

For the analysis, it is important that the data set of issuance is complete. A variable that measures ROW issuance and has considerable missing issuance events would introduce a bias into the estimate. Furthermore, the goal is to instrument ROW issuance at a given time point t with ROW rollover obligations at t. However, countries can engage in considerable buyback and switch operations, thus the amount of bonds that have to be rolled over at a given time point can be affected by how much the country conducts these operations. So it is important to capture the amount of expiring bonds at a given time point net of all the buy-back and switch operations that already happened. Beyond these identification requirements, harmonising more than 100 heterogeneous sources with various

[1] AUS, BRA, CAN, CHE, CHL, CZE, DEU, DNK, FRA, GBR, HUN, IDN, IND, ITA, JPN, KOR, MEX, MYS, NOR, NZL, POL, SGP, SWE, THA, TUR, TWN, USA, ZAF.

[2] Brazil does not report bidding data; CHE and DNK do not have data on announced offered amounts

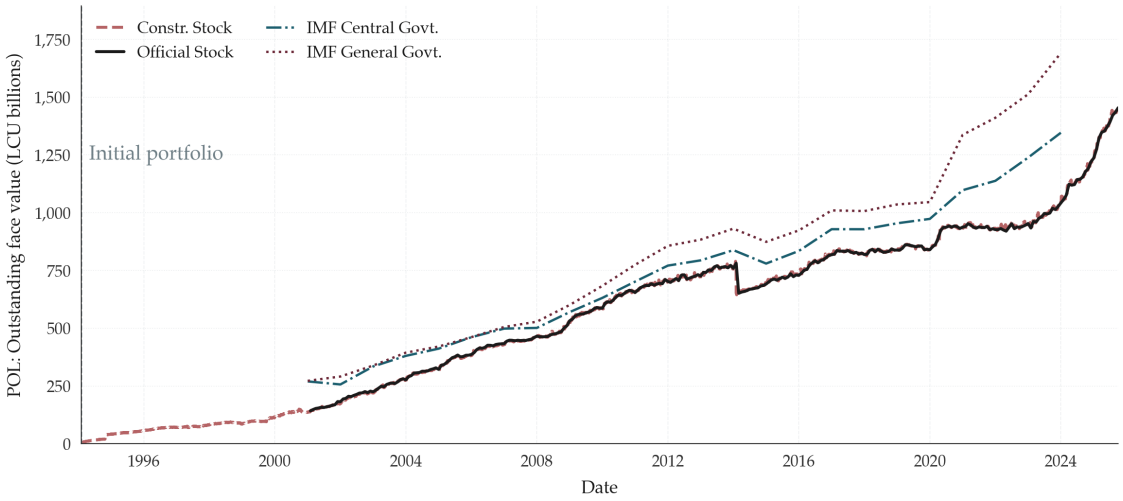
quality levels across 28 countries reqires validation. To validate that the data really captures the life cycle of each issuance, I construct the daily stock of debt based on inflows (issuances) and outflows (redemptions) of each country, and then compare these daily stock with lower frequency offical aggregate reported data. I construct the daily outstanding debt portfolio for each country by cumulating issuance and redemption events from an initial stock. The outstanding face value on day t is

$$D_t = D_0 + \sum_{\tau=1}^{t} \big(I_\tau - O_\tau + V_\tau\big), \tag{1}$$

where D_0 is the initial portfolio constructed from the universe of bonds available on Refinitiv at the start of the sample, which aligns closely with officially reported outstanding debt at that date, I_τ denotes inflows (auction operations, syndicated issuance, and the selling leg of switch operations), O_τ denotes outflows (redemptions, buybacks, and the buying leg of switch operations), and V_τ captures valuation adjustments for inflation-linked and foreign-currency instruments whose outstanding principal fluctuates with price levels and exchange rates. Where official sources do not systematically report certain flow types—such as external placements—I supplement with alternative sources, though some residual incompleteness remains. This is the one exercise in the paper that uses *every* issuance channel; the empirical work in Sections 3–5 uses competitive auctions only because we will see, these are the vast majority of issuance events.

I validate the constructed stock against officially reported debt outstanding from national debt management offices for all 28 countries. Figure 1 illustrates this for Poland: the flow-implied series (red) traces the reported aggregate (black) almost exactly across the full sample. The figure also reveals why broad flow coverage matters—large buyback operations in 2013 and significant volumes of switched and syndicated debt would be missed entirely if one relied on auction data alone. Results for all remaining countries are collected in Appendix B.

Figure 2 aggregates the validation exercise across all 28 countries. The constructed global debt stock (red) closely tracks the corresponding official aggregate (black): at the end of 2024 the two stand at USD 51.7 and 53.6 trillion respectively, and the mean absolute deviation between them over the sample is 4.3%. The figure also shows that most of the bonds are issued through auction events into the stock (yellow line). I therefore will restrict the empirical investigations to auctions. The fit between the official stock and the constructed stock is not an artefact of the United States' dominant share of global issuance and having good data quality: equal-weighted average of outstanding debt to GDP across all 28 countries moves almost identically for the constructed and the official series. T Across the 28 countries, 20 exhibit an excellent fit between constructed and official stocks, 4 exhibit a good fit, and 4 (Brazil, Chile, Malaysia, and Mexico) exhibit a weaker correspondence, reflecting



Notes: Total outstanding face value of government bonds, constructed by cumulating daily inflows (auction operations, syndicated issuance, selling legs of switch operations) and outflows (redemptions, buybacks, buying legs of switch operations) from an initial portfolio. Valuation adjustments for inflation-linked and foreign-currency instruments are included. The officially reported aggregate of outstanding bonds is shown for comparison.

Figure 1: Constructed Bond Debt Stock vs. Official Aggregate: Poland

known data limitations in those countries.[3] I retain all 28 countries in the dataset.

2.3 Auction Yield Spreads

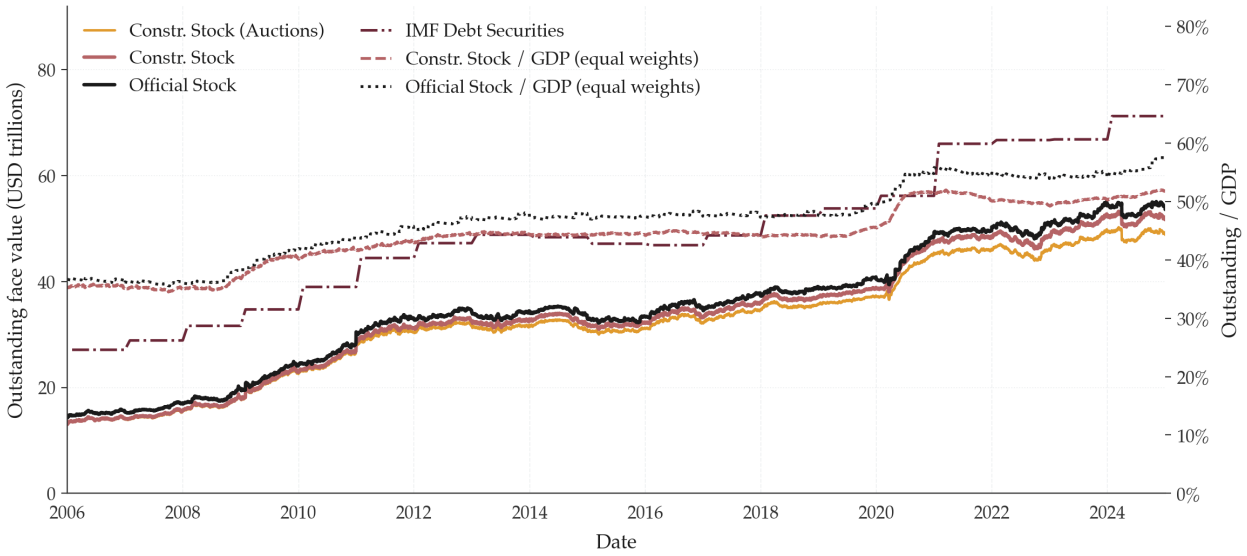
The outcome in the empirical exercise will be the auction concession, in basis points, defined as

$$\eta_{i,c,t} = \left[\tilde{y}^{\text{auc}}_{i,c,t} - y^{\text{ref}}_{i,c,t-1}\right]_{\text{bp}}, \tag{2}$$

where $y^{\text{auc}}_{i,c,t}$ is the auction outcome yield for auction event i. Countries use either the clearing yield or the accepted-amount-weighted yield if the auction is a Dutch or American auction, respectively. For $y^{\text{ref}}_{i,c,t-1}$, I price the exact bond auctioned based on its future cash flow and the domestic yield curve at the previous close. The auction yield had to be harmonised across countries to the same semiannual convention using each issuer's documented auction formula and define This construction makes the benchmark comparable across countries.

A positive value means that the auction cleared above the benchmark implied by the previous close. The appendix documents the country-specific convention registry, the cash-flow and settlement-date treatment, and external validation using published auction prices. It also discusses

[3]Brazil historically issued a large volume of floating-rate bonds and reports outstanding amounts that incorporate Selic-rate-linked coupon valuations; it also does not report bidding data. Chile and Malaysia suffer from partial coverage: Malaysian official records show extended periods of constant issuance amounts, and Chile does not comprehensively report syndicated issuance in machine-readable form. Mexico's auction data, obtained directly from Banco de México, does not encompass syndicated placements.



Notes: Left axis: sum across countries of the constructed and officially reported outstanding debt, in USD trillions. A country enters this sum only on days where both series are available, so the level rises partly because countries enter. "Constr. Stock" cumulates auctions, syndications, taps and both legs of switch operations net of buybacks and redemptions, with valuation adjustments; "Constr. Stock (Auctions)" cumulates the auction leg alone. The IMF series is general government debt securities outstanding. Right axis: equal-weighted average of outstanding debt to GDP across all 28 countries.

Figure 2: Global Sovereign Debt Stock: Constructed vs. Official

why a matched traded bond is not an appropriate common benchmark in this setting. I use this price outcome rather than bid-to-cover, whose denominator includes accepted quantities, which potentially introduces endogeneity and might not be a good proxy for demand because of country-specific dealer-participation rules (Appendix B.2).

The level of η need not be comparable across countries. To account for country-specific volatility, I scale the spread by a fixed, country-level robust SD measure:

$$\eta^{\text{gen}}_{i,c,t} = \frac{\eta_{i,c,t}}{\hat{\sigma}_c}, \qquad \hat{\sigma}_c = \frac{1.4826 \times \text{MAD}\left(\Delta_{20} y_c^{10\text{y}}\right)}{\sqrt{20}}, \tag{3}$$

where $\Delta_{20} y_c^{10\text{y}}$ is the 20-business-day change in country c's traded generic ten-year yield. MAD is the Median Absolute Deviation $\mid \mathit{median}(x) - x \mid$ and $\hat{\sigma}$ converges to the standard deviation. As it turns out, the results will not be sensitive to the choice of volatility measure. The scale is constant within country, so it does not introduce time-varying variation correlated with supply. Results using raw basis points and alternative scales are reported in the Appendix. Outlier treatment is applied only to the finished spread: the baseline excludes observations more than three country-specific standard deviations from the mean, while the winsorised and untrimmed specifications are reported as robustness checks. Finally, in the case of more than one auction on a given day, the daily mean is taken to form $\eta^{\text{gen}}_{c,t}$.

2.4 Domestic Issuance and Competing Supply

The specifications distinguish the domestic issuer's announced offering from the supply that other sovereigns actually place. The former is predetermined at the auction; the latter is the amount that competing dealers and investors must absorb. The construction of the rollover instrument, based on partners' actual outstanding eligible bonds that mature, is described with the identification strategy in Section 4.2.

Domestic issuance. For country c on auction day t, $loc_{c,t}$ is the total announced amount offered across that day's auctions, converted to U.S. dollars at the 30-day prior exchange rate. It enters as

$$\ell_{c,t} \equiv \log loc_{c,t} - \overline{\log loc_c}, \tag{4}$$

the log offered amount demeaned within country. The announced amount is used rather than the accepted amount because the latter is jointly determined with the clearing yield. Countries can e.g. add non-competitive top-ups after the competitive part of the auction. Because issuance amounts vary across countries by an order of magnitude, I use the log transformation.

Competing supply. Competing supply is the leave-one-out sum of other sovereigns' *accepted* issuance in the same auction segment. Thus, domestic issuance is the announced quantity chosen by the domestic treasury, whereas competing supply is the quantity actually placed and absorbed by the market.

The baseline measure averages accepted supply over the three business days centred on the auction:

$$ROW_{c,t}^{c3} = \frac{1}{3} \sum_{k=t-1}^{t+1} \sum_{c' \in \mathcal{P}(c)} acc_{c',k}, \tag{5}$$

where $acc_{c',k}$ is the actual accepted face value of country c''s eligible auctions. The centred window captures supply dealers must warehouse around the domestic auction; the same-day measure is reported alongside.

The baseline partner set $\mathcal{P}(c)$ varies across specifications. The baseline encompasses the domestic country's trading region. I exclude the U.S. from this set because I would like to treat it separately in the regression, but the results go through when including it. The three regions are AsiaPac, EMEA, and the Americas. The global ex-U.S. aggregate is the natural alternative and is reported throughout. Both measures are demeaned within country and divided by the pooled standard deviation of that demeaned series. Appendix B reports the regional classification, country-level distributions, and the decomposition of global competing supply.

Hub countries I define USA, GBR, DEU, FRA, ITA, and JPN as "Hub" countries and motivate this choice later. I track the average number of ex-U.S. foreign HUB countries issuing around the same 3-day window as

$$HUB^{c3}_{c,t} = \frac{1}{3} \sum_{k=t-1}^{t+1} \sum_{c' \in Hub(c)} \mathbf{1}\left\{acc_{c',k} > 0\right\} \tag{6}$$

where $Hub(c)$ denotes all foreign HUB countries (excl. c). Again, I will exclude the U.S. from the summation in the baseline because I would like to treat it in the regression separately.

2.5 Primary dealer list

I also collect historical lists of primary dealers from national authorities and supplementary archival sources, combining web scraping with manual collection. I consolidate dealers to their parent banking groups and assign each group to its headquarters country. These data proxy issuers' links to global intermediaries, rather than the residence of ultimate investors. As I collect the dealer list at different snapshots in time, I validate that the lists do not change much over time and the primary dealer network is quite persistent. Appendix B.3 reports this evidence and documents differences in coverage and definitions across markets.

2.6 Sample

The full data set covers all 28 countries and every issuance channel, January 2006 to September 1, 2025. It is used for the validation exercise about whether I capture the near universe of issuance and bond rollover. For documenting the facts in the next section, I restrict the sample to domestic-currency *competitive auctions* of nominal fixed-rate bonds with more than three years to maturity and an amount above USD 50 million. Wherever possible in Section 3, I report all more-than-three-years-to-maturity issuances as robustness checks in the Appendix. I exclude bills because sources are ambiguous whether the reported yield is yield to maturity or discount rate and more generally, the short-end of the secondary market yield curve seems to be illiquid in some EMs. Furthermore, bills seem to be of little importance for global intermediaries.

For the empirical exercise, I exclude inflation-linked and floating-rate bonds because their outcomes are measured in real yields and spreads and are not comparable to nominal auction yields. Auctions below USD 50 million are dropped as likely driven by idiosyncratic placement motives such as a test auction. These further restrictions on bond type and face value are a very small share, at XYZ% of the total issuance. For the regression, I have to drop Denmark and Switzerland additionally because they do not have pre-announced auction offering amounts, which I need for my identification. Turkey leaves the sample because there is no sufficiently long available secondary market yield curve data to construct the concession. Event-level data is collapsed to auction-day by same-day auctions by

one issuer are collapsed by averaging the concession and summing the offered amounts. Auction-day maturity and coupon are accepted-amount weighted[4]. Table A1 in the Appendix reports the sample span, auction frequency, size, maturity, duration and outcome moments for each of the 23 countries, and Figure A1 shows coverage by country and year. Norway leaves the panel after 2021 for the same reason: it continues to auction and to report accepted amounts and yields, but stops reporting the announced amount, so its own-issuance regressor is undefined from 2022 onwards even though it remains part of other countries' competing supply.

3 Three New Facts about Debt Issuance

This section documents three facts about the timing of sovereign debt issuance. The first fact is about the *extensive* margin of global debt issuance. Sovereigns systematically select auction days on a small set of calendar characteristics. This allows me to fully explain the concentration of the distribution of global debt issuance. The second fact investigates the *intensive* margin of global issuance. Once a country decides to come to the market, its choice of much to issue is essentially unrelated to the competing foreign supply on that day, suggesting limited strategic interaction in the global debt market. Coming from issuance to issuer, the third fact documents that a small set of "Hub" countries are both large and central in the primary dealer network: Many dealers that issue in those Hub countries also participate in auctions in other countries. Taken together these facts motivate our investigation in how prices are determined *jointly* by issuance amounts and type of issuers in the global market in the next section.

Throughout the main motivation figures, the domestic-auction sample consists of competitive auctions in the 27 non-U.S. countries. U.S. auctions provide a reference calendar and are excluded from the domestic-auction sample and daily issuance totals. The same security and size filters are used throughout.[5]

Fact I, extensive Margin: Countries select on day characteristics

Not all business days are equally attractive for a sovereign to issue debt. Figure 3 plots the excess likelihood that an observed auction day carries a given calendar characteristic, relative to a randomised counterfactual in which the sovereign's issuance days are re-drawn within the same month or within the same month and weekday. The counterfactual is constructed as follows. For each country, I take the cells defined by a stratum (baseline within calendar month) and re-draw, uniformly and without

[4]Poland and Indonesia report a daily offered total on every event row of the day rather than a per-bond amount; for those days the offered amount is the maximum across rows, not the sum.

[5]Appendix Figure A12 repeats Figure 3 for all recorded non-U.S. issuance types and for competitive auctions of the 24 estimation-sample countries only, excluding USA, TUR, DNK and CHE.

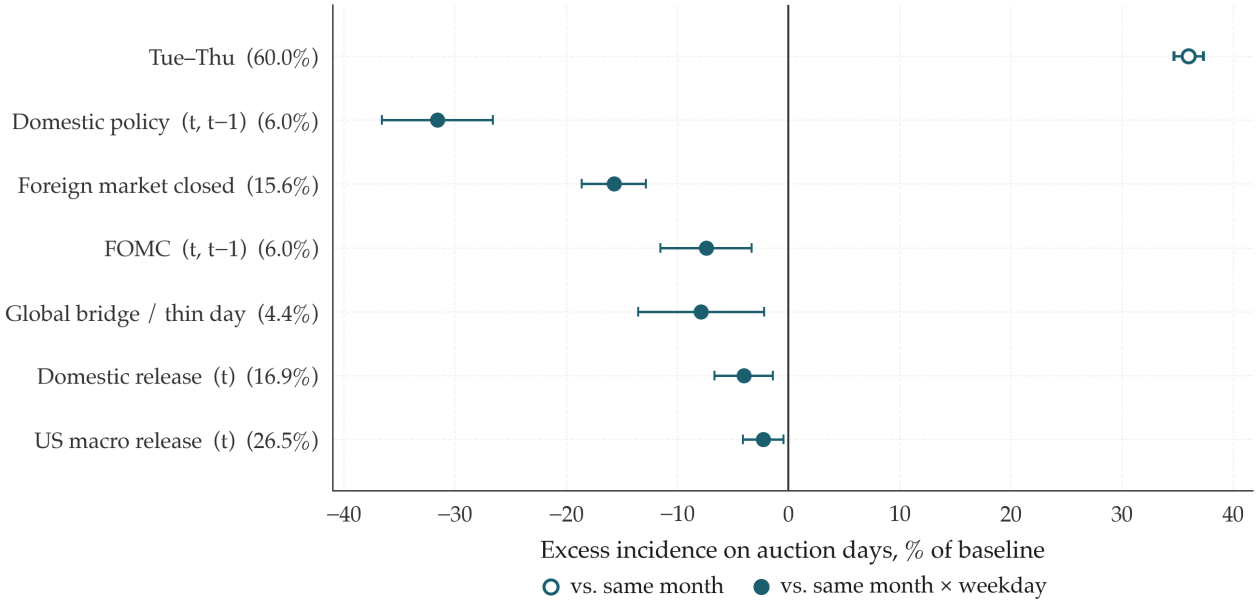
replacement, exactly as many auction days as that country actually held in that cell. The counterfactual therefore holds fixed, by construction, each country's issuance frequency, its issuance size distribution, its active sample period and its seasonality; what varies is only *which* eligible days within a month are used. The figure reports the excess incidence as a percentage of the counterfactual incidence, that characteristics with very different base rates are comparable, together with a 95% randomisation interval. The base rate itself is printed in each row label.

This revealed-preference approach shows a strong preference for the middle of the week. Sovereigns auction on a Tuesday, Wednesday or Thursday 36% more often than the random baseline of 60%, which means roughly 82% of all auction days are mid-week. Because the weekday preference is so dominant, the I hold for the other day characteristics also the weekday fixed. (filled markers): Sovereigns avoid days on which a major foreign market is closed (15% below baseline) and they avoid their own monetary policy events, on the day itself or the day before (32%). Other day characteristics are less large or more noisy. The pattern is consistent with issuers favouring days that are very deep and liquid market days where many investors are present because other big markets are open or uncertainty is smaller. From now on, we will desribe with the "top-3 characteristics", the three day characteristics that seem to matter most for governments' issuance calendar choice: mid-week, foreign market closure, and domestic monetary policy. Let us now see whether this selection can explain the entirety of the concentration of the distribution of global debt issuance.

Global debt supply is very unevenly spread across days. Figure 4a ranks all business days from the busiest to the quietest and plots global daily issuance of the non-U.S. sovereigns, scaled to 2025 GDP (Appendix Figure A13 repeats the exercise including the U.S.). If every sovereign spread its annual issuance evenly over all business days (dashed line), every day would carry about USD 7–10bn (depending on total issuance a year). Instead, the busiest 1% of days carry USD 44bn on average, six times the average day, and the busiest 10% of days carry 40% of all issuance. The amount of global issuance that is above the smooth calendar (dashed line), I call excess concentration in global issuance.

To understand where this concentration comes from, I build a sequence of counterfactual calendars. It starts from the smooth calendar, in which every sovereign spreads its annual issuance evenly over all of its business days (dashed line), and adds one feature of the observed calendar at a time. Every counterfactual keeps each sovereign's annual issuance. Each band in the figure is the concentration that one feature adds, so the bands are mutually exclusive and together add up to the observed curve. I also report the share of the excess concentration that each feature contributes.

The first three features capture heterogeneity across countries and over time. (i) Sovereigns issue more in some months than in others: I spread each sovereign's monthly issuance evenly over its business days in that month. (ii) Sovereigns differ in size and in how often they come to the market: each sovereign keeps its number of auctions in a month, every auction gets the same size, its monthly issuance divided by the number of auctions, and the auctions are placed so that they overlap as little



Notes: Excess incidence of each calendar characteristic on observed auction days, relative to a randomised re-timing counterfactual, expressed as a percentage of the counterfactual incidence. The counterfactual re-draws each country's auction days uniformly without replacement within cells, holding the number of auctions per cell fixed and keeping observed amounts attached; 500 draws. Hollow markers hold the calendar month fixed; filled markers additionally hold the weekday fixed. Horizontal bars are 95% randomisation intervals. The percentage in each row label is the mean simulated incidence under the same-month benchmark. Characteristics, in figure order: the day is a Tuesday, Wednesday or Thursday; a domestic monetary policy event on the day or the day before; a major foreign market is closed (actual closures only); an FOMC decision on the day or the day before; a bridge or thin trading day in a major market; a major domestic macro release on the day; and a major U.S. macro release on the day. Appendix B.1 and Table A2 document the source and construction of each characteristic.

Figure 3: Not all days are the same

as possible. I place them one at a time, largest first, each on the day of the month that so far carries the least issuance across all sovereigns. (iii) Within a country and month, some auctions are larger than others: I replace the equal sizes by the actual ones and place them in the same way. Because the auctions avoid each other in these three calendars, any concentration they produce comes from heterogeneity alone.

(iv) On top of heterogeneity, concentration arises mechanically from collisions. Even if every sovereign picked its auction days at random and independently of all others, some days would receive several auctions by chance and others none, just as random draws pile up in some cells of a binomial distribution. I therefore redraw each sovereign's auction days at random, without replacement, among its business days in the same month, keeping the observed auction amounts attached, and average over 100 draws. (v) Finally, sovereigns do not pick days at random but prefer the top-3 characteristics of Figure 3. I repeat the random draws but make each day more or less likely according to its type: a mid-week day without a foreign market closure or a domestic policy event is about 1.5 times as likely as an average day, and a day that has none of the three is about half as likely. These weights are the same

for all sovereigns and reproduce the observed incidence of the three characteristics. The additional concentration from this step reflects collisions that arise because sovereigns prefer the same kind of day.

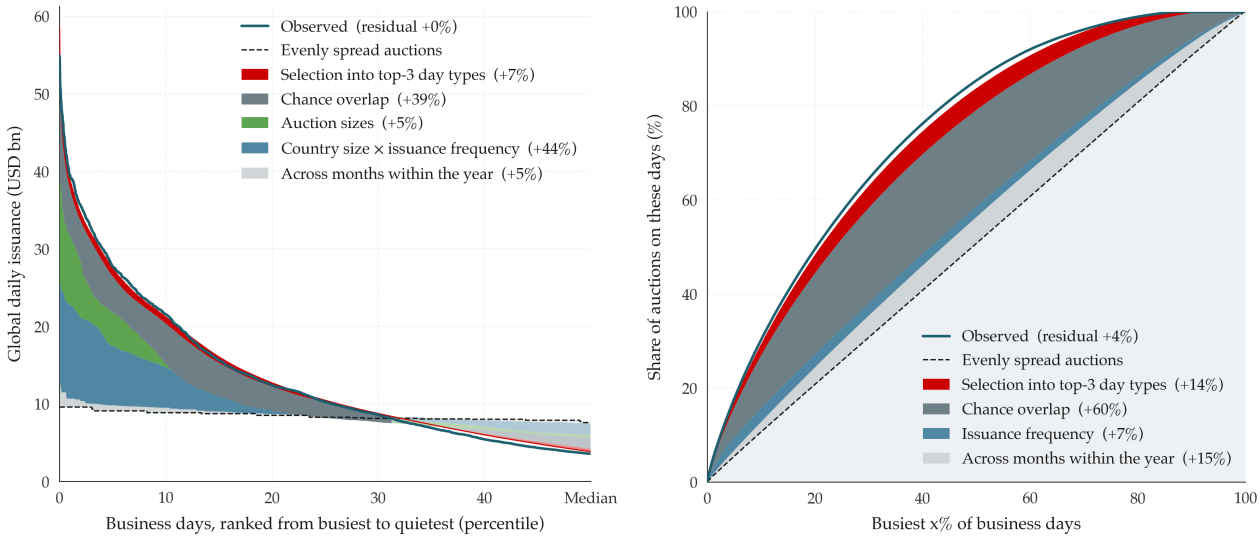
Most of the concentration in amounts is mechanical. Country size and issuance frequency account for 44%, the monthly pattern and auction sizes for another 9%, and chance collisions for 39%. The common preference for the top-3 characteristics adds 7%, and with it essentially nothing is left to explain. Since every counterfactual keeps each sovereign's annual issuance, the excess on busy days is exactly matched by a shortfall on quiet days (light shading). Amounts, however, are dominated by a few very large auctions that fill the busiest days whatever their timing. Figure 4b therefore repeats the decomposition on the number of auctions, the extensive margin, where every sovereign's auctions in a year weigh the same. It plots the share of all auctions held on the busiest x% of days: the busiest 10% of days hold 29% of all auctions, against 10% under an even calendar. Country size and auction sizes drop out, and the common preference for the top-3 characteristics now accounts for 14% of the concentration, twice its share in amounts. A residual of 4.5% remains. Global issuance is therefore highly concentrated, and the day preferences of Figure 3 are the systematic part of that concentration that comes from *when* sovereigns choose to issue rather than from *how much* and *how often* they issue.

Fact II, intensive Margin: Domestic issuance choice unrelated to ROW supply

The concentration of global issuance begs the question of whether countries condition their own issuance amount on foreign supply around the auction window. Conditioning on a country is issuing, Competing supply is the 3-day average of the leave-one-out sum of other non-U.S. sovereigns' issuance in the three-business-day window centred on the auction date from (5). After residualizing domestic issuance and competing supply within country and year, Figure 5 plots competing supply over domestic issuance decile. E.g the last estimates plot competing supply in the largest 10% of a domestic country's auction. The variation is massive. A country auctions large amounts when competing issuance is very large and very small. When comparing with magnitudes from global issuance from Figure 4a, the swings are as large as the 10 busiest days are year of global issuance. This large variation is constant across domestic issuance deciles and robust through out a battery of different specifications. Appendix Figures show that Figure A15c and A15eaccount for within-country-month variation and country-month-top-3 variation and yield identical results. It also remains unchanged when competing supply is standardised within country in Appendix Figure A15), indicating that cross-country differences in the level and dispersion of the leave-one-out measure do not drive the pattern[6].

This is a surprising result because one could imagine that sophisticated debt management officers

[6]Appendix Figure A15 repeats the intensive-margin exercise with ROW restricted to other non-U.S. issuers in the same trading region (Asia-Pacific, EMEA or the Americas), including the calendar-adjustment, same-day and within-country-standardisation checks and results are unchanged



(a) Issuance amounts

(b) Number of auctions

Notes: In both panels days are ranked from busiest to quietest (see Appendix Figure A13 for incl. U.S.). Panel (a) plots global daily issuance in USD bn at 2025 GDP, up to the median day. Panel (b) plots the share of all auctions held on the busiest x% of days; each sovereign's auctions in a year weigh one in total, and daily values are taken relative to the average business day of their year before ranking. The dashed line spreads each sovereign's annual issuance evenly over its business days. The bands decompose the excess of the observed curve over the dashed line into mutually exclusive sources, each adding one feature to the previous counterfactual: (i) monthly totals spread evenly within the month; (ii) each sovereign's actual number of equal-sized auctions, placed to avoid each other; (iii) actual auction sizes; (iv) auctions on random days within their month, 100 draws; (v) random days weighted by a common preference for Tuesday–Thursday, no major foreign market closure and no domestic monetary policy event on the day or the day before. Percentages in the legend are each source's share of the excess on the days where the observed curve lies above the dashed line. In panel (a), each source's excess on busy days equals its shortfall on quiet days (light shading). In panel (b), country size and auction sizes drop out.

Figure 4: Extensive Margin of Issuance: Global issuance is concentrated

know that demand or intermediation capacity is finite and therefore possibly adjust issuance amount to competing supply. The correlation is small. Summarising, the extensive margin - when countries issue - shows concentration of global issuance. However, conditioning on issuing on a certain day, the amount of issuance is essentially orthogonal to competing supply and countries seem to behave randomly on that dimension. Fact III will move from issuance to issuer and speak about how they differ in global markets.

Fact III, issuer: Small set of issuer have extensive dealer overlap with ROW

The last fact concerns who intermediates sovereign auctions. Primary dealers can be active only in their home market or in many markets at once, and they bid both at the request of clients and on their own account. Figure 6a plots the network of sovereign debt markets that share primary dealers, using the primary dealer lists described in Section 2. Two markets are linked when the overlap of their dealer lists is in the top quartile of all pairs. Figure 6b plots essentially the same but GDP over

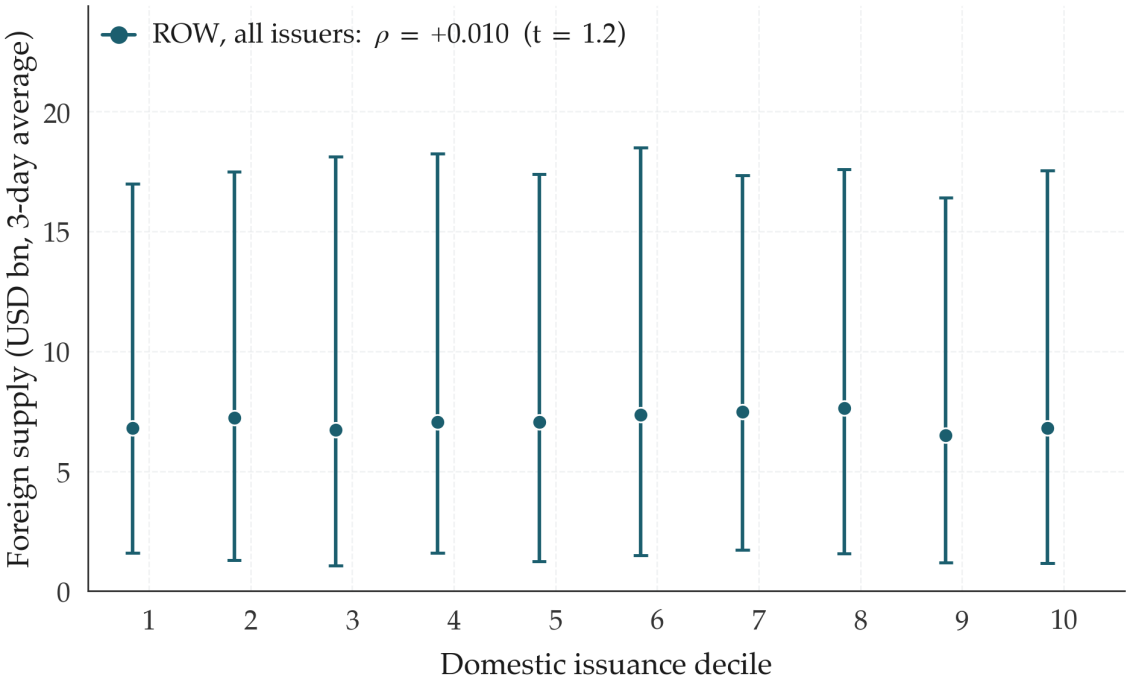


Figure 5: Intensive Margin:

Notes: Circles: Competing ROW supply from (5) over deciles of log domestic issuance size. Dot is median. Domestic issuance and competing supply are residualised by country and calendar month FE. ρ is the residual correlation.

the average connectivity of each country. A small group of markets are both large and sit at the centre of this network: the United States, the United Kingdom, Italy, France, Germany and Japan. I call them "Hub" countries. They are large and central at the same time: their dealer lists overlap most with those of all other markets.

Formally, let $\mathcal{D}_{j,t}$ be the set of parent banking groups on issuer j's latest primary dealer list dated strictly before t, so that no dealer information from after t is used. The dealer overlap of two issuers j and k is the Jaccard index

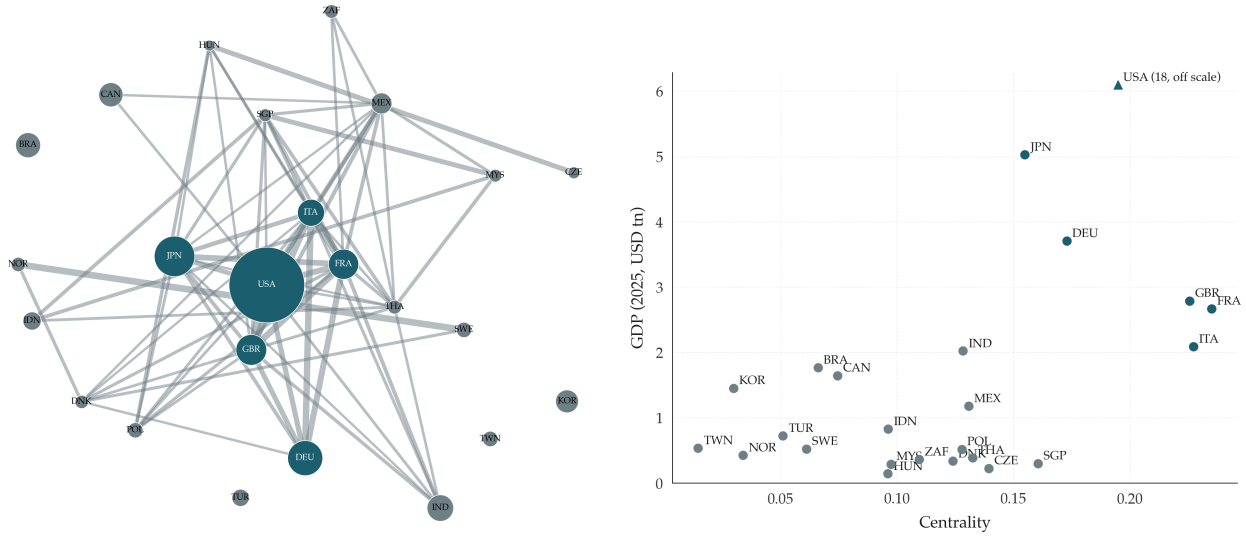
$$J_{jk,t} = \frac{|\mathcal{D}_{j,t} \cap \mathcal{D}_{k,t}|}{|\mathcal{D}_{j,t} \cup \mathcal{D}_{k,t}|}, \tag{7}$$

the share of all dealers on either list that are primary dealers for both. Two issuers are linked by an edge when their overlap is in the top quartile of all pairs,

$$E_{jk,t} = \mathbb{1}\{J_{jk,t} \geq 0.18\}, \tag{8}$$

and the centrality of issuer j is its mean overlap with the set $\mathcal{K}_{j,t}$ of all other issuers with dealer data at t,

$$\bar{J}_{j,t} = \frac{1}{|\mathcal{K}_{j,t}|} \sum_{k \in \mathcal{K}_{j,t}} J_{jk,t}. \tag{9}$$



(a) "Hub" countries share many common dealers (b) "Hub" countries share many common dealers

Notes: Panel 1: Snapshot on 1 July 2025. Node area is proportional to nominal GDP. An edge joins two issuers whose Jaccard overlap of primary-dealer lists is in the top quartile of all pairs (at least 0.18); edge width is proportional to the overlap. Appendix B.3 documents the dealer lists. *Panel b:* entrality is an issuer's mean Jaccard overlap of its primary-dealer list (parent banking groups) with every other issuer's list, averaged over annual snapshots on 1 July, 2006–2025. Jaccard = shared dealers divided by all dealers on either list. GDP is the real-time value on 1 July 2025. DEU, FRA, GBR, ITA, JPN and the US are highlighted.

The fact suggests that when a country is issuing at the same time when "Hub" countries are in the market, there is a bigger common dealer base for intermediation across issuing countries. So the market is in particular deep and liquid on such a day. The network is not an artefact of the 2025 snapshot: when each pair's dealer overlap is averaged over all years 2006–2025, the same six hub countries form the core of the network (Appendix Figure A16).

Altogether, Facts I and II have shown that there is large variation in global issuance across the year and that a country's own issuance choice is unrelated to foreign supply on the same day. Fact III showed that issuers differ by the extent to which they are central for global dealers. The next section will study the implication of foreign issuance and of the type of issuers in the market on the domestic demand curve an issuer faces.

4 Prices are jointly determined in a global market

Section 3 documents that (i) sovereigns selection into certain types of days allows to decompose the distribution of global daily issuance, (ii) domestic issuance choice is unrelated to foreign issuance and there is large variation in ROW variation holding domestic issuance fixed, and (iii) a small set of "Hub" countries are both large & have extensive dealer overlap with ROW. I now investigate whether the large variation in foreign issuance and the presence of foreign Hub countries around domestic auction events matter for the price. Next, I study how large foreign issuance and the presence of Hub countries around the domestic auction window affect domestic auction prices. Therefore, I will lay out the baseline empirical specification and present its results. Then, I will introduce a small toy model that rationalises the results. Lastly, I will test the prediction of the toy model.

4.1 Empirical specification

Regression. I estimate the following auction-day panel regression:

$$\begin{aligned}\eta_{c,t} = {} & \beta_R ROW^{3d}_{c,t} + \beta_{LR}\ell_{c,t}ROW^{3d}_{c,t} + \gamma_H HUB^{3d}_{c,t} + \gamma_{LH}\ell_{c,t}HUB^{3d}_{c,t} \\ & + \delta_U US_{c,t} + \delta_{LU}\ell_{c,t}US_{c,t} + \mathbf{C}'_{c,t}\theta \\ & + \alpha_{c,b(t)} + \lambda_{m(t)} + \mu_{d(t)} + \phi_c\ell_{c,t} + \varepsilon_{c,t}. \end{aligned} \tag{10}$$

The outcome is the mean auction yield concession relative to the bond-specific reference curve at the previous close, divided by the country's robust scale of generic ten-year yield changes. Local issuance, $\ell_{c,t}$, is the log total announced offering, converted to USD using the 30-day prior exchange rate, relative to the log of the issuer's average offering. I control for the country-specific concession responds to supply with $\phi_c\ell_{c,t}$ because I am interested in deviation from the usual demand curve on large issuance days or when hub countries are present in the market.

Foreign issuance, I capture by $ROW^{3d}_{c,t}$ which measures average 3-day realised issuance principal of other non-U.S. sovereigns, either globally or within the domestic issuer's trading region[7] from (5). Each measure averages daily supply over the preceding, current and following business days, capturing nearby issuance that may compete for the same intermediation capacity. Foreign supply uses the amount placed because this is the quantity investors must absorb.

For the presence of Hub countries, I use $HUB^{3d}_{c,t}$ from (6). which captures the average number of foreign non-U.S. Hub countries[8] issuing at the same time in a 3-day window around the auction. I exclude the domestic issuer. In the appendix, I show that your results are robust to different day

[7] Americas, EMEA or Asia-Pacific

[8] DEU, FRA, GBR, ITA, JPN: the five non-U.S. issuers with the largest GDP times dealer-network centrality (Figure 6b).

windows and inclusion of the U.S.

I treat the U.S. separately from $ROW_{c,t}$ and $HUB_{c,t}$. $US_{c,t}$ is the centred three-business-day mean of U.S. offered amounts relative to U.S. GDP. Its level and domestic-size interaction allow U.S. issuance to have distinct pricing effects. Each foreign issuance measure and its instrument is first demeaned within country and then divided by the pooled standard deviation of the demeaned series, so that one unit is one within-country standard deviation; interactions are formed last. This centres the interactions on each issuer's usual conditions while retaining common units across countries. Domestic size remains in log points because issuance differs by an order of magnitude across countries. Demeaning before interacting makes sure that country-specific means in other variables are not included in the interactions because they could be correlated with other country confounds. Thus, $\beta_{LR} > 0$ describes a steeper quantity–concession schedule when competing supply is high, whereas $\gamma_{LH} < 0$ describes a flatter schedule when hub activity is high (crowding in). The level coefficients β_R and γ_H apply to an auction of average size.

Controls and fixed effects. The controls include a cubic in maturity, the policy rate, industrial-production growth, a fiscal control, five auction-day lags each of concessions and domestic log offerings, the mean concession over the preceding twenty auction days, and five business-day lags of reference-yield changes. Table 1 defines these variables in detail. Appendix Tables A7 and **??** report the full substantive coefficients and country-specific slopes. Inference uses Driscoll–Kraay standard errors with bandwidth twenty.

Identifying variation. The interactions are identified by comparing the same issuer's larger- and smaller-than-usual auctions on days when competing supply or hub presence is high relative to that issuer's norm with those on days when it is low.

Supply and residual demand. Tracing residual demand requires supply variation that is orthogonal to unobserved demand innovations. Measuring concessions relative to the previous close narrows the relevant window, while the controls absorb observed price dynamics and market conditions. Domestic issuance is announced days before bidding, and as shown in Figure 5 essentially orthogonal to competing supply. Whether hub countries will be in the market is also known days up to quarters before and should therefore be incorporated in the previous days' reference yields. A more thorough discussion about the threat to identification and robustness checks follows after the results.

4.2 Instrument

Realised foreign issuance in $ROW_{c,t}$ poses an additional problem. Demand conditions affecting country c on day t may also affect other sovereigns' placements within the three-day window, including

the following day. Recorded placements may also measure investors' absorption imperfectly because of non-competitive tranches, direct placements and subsequent top-ups. I therefore instrument ROW and $\ell \times ROW$ jointly with predetermined foreign rollover need and its own-size interaction.

Predetermined rollover need. The excluded shifter is partners' scheduled redemption need. Maturity dates and principal obligations were fixed years before when the bonds were issued and generate funding years later. I map ROW rollover obligations to ROW issuance for the same type of bonds[9] use for issuance, and I hold exclude buybacks in the year up to the redemption date to avoid that strategic behaviour of countries could contaminate the instrument. The rollover rule is the following: For each eligible redemption, I allocate principal equally across the issuer's eligible auctions in the preceding ninety calendar days, excluding auctions on the redemption date. In that way, I acknowledge that countries might not use just the auction preceding the expiring bond to roll over debt. Principal is converted to USD at the start of that window, limiting exposure to contemporaneous exchange-rate movements. The instrument uses the same partner set and three-day aggregation as ROW and excludes the domestic issuer and the United States. The two excluded instruments are rollover need, $N_{c,t}$, and $\ell_{c,t}N_{c,t}$.

This allocation maps repayment obligations into predictable funding pressure; it does not require literal bond-by-bond refinancing. Appendix Table A8 reports both first stages and their cross-loadings. The first stage is strong, with Kleibergen–Paap statistics of 238 for global and 416 for regional supply. Alternative allocation windows and rules are discussed with the robustness results.

Exclusion. The exclusion restriction requires ROW rollover need to affect the domestic concession only through ROW issuance, conditional on the included variables. It must hold for both N and ℓN. The main threat is that rollover need also moves demand: Large future expected cash flow through large future ROW redemption could lead to higher contemporaneous domestic demand. Because redemption dates are known years in advance, such expected demand should already show up in the secondary market: investors anticipating the cash would bid up the domestic issuer's outstanding bonds. So the higher demand should not just show up at the auction itself but also on secondary market on previous days. I find that the instrument does not predict reference-curve changes over the five days before the auction (Appendix Table A16). To violate the exclusion restriction, the additional demand from future cash flow would therefore have to arrive exactly on the auction day and affect only the auction concession. In addition, an issuer's own recent auction concessions do not forecast rollover need (Appendix Table A18, Panel B).

[9] Matuirty above 3 years and vanilla local currency bonds.

Relevance. Rollover need might predict issuance mechanically simply because both are assigned to the same auction calendar. Appendix Table A18 holds recipient auction dates fixed, permutes redemption calendars across countries and rescales them to preserve issuer size. The first stage then collapses. Its relevance therefore comes from the alignment of each partner's repayment obligations with its own auctions, not from the shared calendar. Instruments rebuilt from disjoint redemption-maturity cohorts give similar estimates. Figure A19 separately reassigns countries to trading regions of the same sizes. Only three of 200 alternative partitions produce an estimate as strong as the actual trading regions, which supports their economic relevance.

4.3 Results

Table 1 reports estimates of equation (10), in basis points for an issuer with the median concession volatility. The highly significant positive interaction term of foreign issuance shows that the demand curve steepens when foreign issuance is 1SD above its usual country-specific level. In the regional 2SLS specification of column (4), one within-country standard deviation of additional competing supply raises the concession by almost one basis point more for each log point by which the offering exceeds the issuer's average. Larger-than-usual offerings therefore become disproportionately expensive when competing supply is high: the residual demand curve the issuer faces becomes steeper. The 2SLS estimates exceed their OLS counterparts. This could be because other sovereigns place more when demand is strong or because of measurement error in ROW issuance; both would bias the OLS towards zero.

Hub activity has the opposite effect. When more hub countries are in the market, larger offerings receive smaller concessions, and the interaction is of similar magnitude to the foreign issuance term in both the regional and the global specification and with date effects. Conditional on competing issuance, hub presence thus flattens the residual demand curve. The result does not depend on how hub activity is measured: GDP weights or an any-hub indicator give similar estimates (Appendix Table A31). Nor is it a property of any five issuers: against every five-country club of non-hub issuers, the actual hub set lies in the extreme tail of the placebo distribution, at both the three-day and the same-day window (Appendix Table A33, Panel A). I will later interpret these estimates through the lens of the model

Absorbing all common daily shocks with date effects leaves the interaction almost unchanged (column 4 vs. 5) which suggest that no common global shocks drive the steepening or flattening results. The level coefficients are small. They measure the effect of competing supply and hub presence on an auction of average size, and at that size neither channel matters much. One possible explanation is discussed in Section 4.7 which is that only for large domestic issuance does a country have to rely on global markets and therefore foreign issuance and the composition of foreign issuers is important. Another explanation is that ROW and HUB are also correlated with the type of days, which could be

already absorbed in the previous day reference yield.

U.S. issuance has a small and imprecise estimated domestic-size interaction in the regional specification; in the global specification it is positive but only about a quarter of the ROW interaction. This could be either because crowding-in and crowding-out effects offset each other or U.S. debt may be complementary to dealers' other positions.

Magnitude. The bottom rows of Table 1 translate the estimates into the effect of a one-standard-deviation increase in competing supply or hub presence on an auction one standard deviation larger than the issuer's average size ($\ell = 0.54$, about 1.7 times the usual offering). In the regional 2SLS specification, such an auction pays 0.73 bp more on a day with one standard deviation more competing supply, and 0.66 bp less on a day with one standard deviation more hub activity. These are about 13% and 12% of the typical daily movement in the ten-year yield, and 11% and 10% of the standard deviation of auction concessions.[10] Unlike a secondary-market price movement, this cost is locked in at issuance: the issuer pays the higher yield on the new bond until it matures. Section 5 considers the aggregate implications. For advanced economies, I have sufficient variation in domestic offered amount to trace out the demand curve and therefore can ask by how much foreign issuance and hub presence steepens or flattens the demand curve. In advanced economies, the concession rises on average by 1.26 bp for each log point by which an offering exceeds the issuer's average size.[11] One standard deviation more competing supply raises this slope by 0.95 bp, the $\ell \times ROW$ coefficient in column (4), so the residual demand curve becomes about 75% steeper. One standard deviation more hub activity lowers it by 0.81 bp, making the curve about 64% flatter.

[10] The benchmarks are observation-weighted medians of country-specific standard deviations: 5.48 bp for daily changes in the ten-year yield over the baseline sample period and 6.60 bp for auction concessions on the baseline observations. Both medians correspond to the United Kingdom. Appendix Table A9 reports the effects under alternative outcome normalizations.

[11] This average slope is the coefficient on domestic size in a regression of the concession on domestic size, the baseline controls and country × tenor-bucket, year–month and weekday fixed effects, estimated on the advanced economies of the baseline sample.

Table 1: Concurrent supply and sovereign auction pricing

	Global		Regional		Regional
	OLS	2SLS	OLS	2SLS	2SLS
ROW	0.105	−0.084	0.208**	0.218*	0.209
	(0.128)	(0.221)	(0.088)	(0.124)	(0.190)
$\ell \times ROW$	0.597***	1.399***	0.615***	0.945***	0.845**
	(0.200)	(0.383)	(0.166)	(0.263)	(0.420)
HUB	−0.182	−0.056	−0.214**	−0.223**	−1.368*
	(0.131)	(0.175)	(0.104)	(0.108)	(0.737)
$\ell \times HUB$	−0.844***	−1.413***	−0.675***	−0.807***	−0.835***
	(0.237)	(0.349)	(0.190)	(0.212)	(0.311)
US	−0.063	−0.112	−0.053	−0.051	–
	(0.085)	(0.100)	(0.079)	(0.083)	
$\ell \times US$	0.193	0.361**	0.146	0.187	0.159
	(0.156)	(0.178)	(0.149)	(0.153)	(0.211)
$\frac{\partial \eta^{\text{gen}}}{\partial ROW}$ $(\ell = \text{sd}(\ell))$ (bp)	0.430**	0.678**	0.543***	0.733***	0.669**
	(0.183)	(0.326)	(0.125)	(0.194)	(0.299)
$\frac{\partial \eta^{\text{gen}}}{\partial HUB}$ $(\ell = \text{sd}(\ell))$ (bp)	−0.642***	−0.826***	−0.582***	−0.663***	−1.823**
	(0.200)	(0.276)	(0.153)	(0.166)	(0.720)
Kleibergen–Paap rk Wald F	–	237.9	–	416.3	173.3
Observations	11,180	11,180	11,180	11,180	11,180
Year–month FE	Yes	Yes	Yes	Yes	–
Date FE	–	–	–	–	Yes
Weekday FE	Yes	Yes	Yes	Yes	–

Notes. Results from 10 Columns (1)–(2) use global ROW and columns (3)–(5) regional ROW. Columns (1) and (3) use OLS; the others use 2SLS. Column (5) replaces year–month and weekday effects with date effects. Global date-FE 2SLS is omitted because the first-stage rank statistic falls sharply. The marginal-effect rows evaluate $\beta_R + \beta_{\ell R}\ell$ and $\beta_H + \beta_{\ell H}\ell$ at $\ell = \text{sd}(\ell) = 0.54$, an offering one standard deviation (about 1.7 times) larger than the issuer's usual size. Effects and their full-covariance delta-method standard errors are multiplied by the median MAD scale across each column's estimation observations to report basis points (approx. volatility of NZL or GBR). Regional ROW restricts that sum to the domestic trading region. Controls are five auction-order lags of the domestic spread in basis points, the within-country mean of the previous 20 auction-day spreads (minimum eight observations), five auction-order lags of domestic log issuance, five business-day lags of the one-day reference yield change, a cubic in auction maturity, the policy rate, industrial-production growth, and the four-quarter change in the fiscal-surplus-to-lagged-debt ratio. Additionally, Country × ℓ and Country × tenor FE are included. ROW and its own-size interaction are instrumented by the matching predetermined rollover-need terms; HUB and US enter as included exogenous regressors. Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.4 Other threats to identification and Robustness

Domestic issuance announcement as bad control A country could announce higher issuance because it expects higher demand in the auction, leading it to be a bad control. Two observations help assess this concern. First, domestic issuance is essentially orthogonal to ROW issuance as demonstrated in Figure 5. After partialling out the baseline controls and FE, the correlations of domestic log

issuance with ROW, $\ell \times ROW$, HUB and $\ell \times HUB$ are 0.006, −0.034, 0.014 and 0.000, respectively, in the regional specification. Issuers do not, therefore, systematically announce larger offerings when they will face less competition. Second, demand information available to both issuers and investors can already be reflected in the previous close and the included yield histories. For the estimates to be biased, an issuer would have to know systematically more about auction-day demand than investors price into the reference curve the day before.

Issuer resizing of the competitive auction. The ideal auction for this experiment announces the issuance amount days before the auction, so that supply information is already incorporated into the previous day's reference yield. On the auction day, investors submit bids reflecting their private price signals, and the announced auction yield aggregates these different demand signals. Variation in the auction concession therefore likely reflects variation in demand shocks. Even additional supply allowed by some countries through non-competitive top-ups at the auction yield does not contaminate the estimates, because the non-competitive allocation takes place *after* bids have been submitted and the auction outcome is decided.

However, some countries allow resizing of the *competitive* part of the auction and could therefore affect the auction outcome by releasing additional supply when demand is high. As foreign issuance and hub presence capture demand shocks, this response could contaminate the coefficient estimates. Such a response lies downstream of competing supply and leaves the exclusion restriction intact, but it could change what the coefficients measure. Appendix D.9 classifies each country's auction rules and explains in detail why resizing is unlikely to contaminate the estimates. In short, (i) excluding countries that allow resizing does not change the estimates, (ii) resizing would introduce attenuation bias, and (iii) backing out this bias indicates that it must be small. The latter finding reflects the lack of correlation between resizing and the ROW and HUB variables. Additionally, the relevant variation for the regression comes from differences in investor behaviour *between* auctions, rather than from adjustments *within* an auction that accommodate additional bidders whose demand elasticities are likely similar to that of the marginal bidder.

Pre-auction cheapening. Anticipated auctions can also induce secondary-market price movements despite advance supply announcements (Lou et al., 2013). These movements may vary with auction design, investor composition and market development. Country-specific domestic-size slopes absorb persistent differences in the relationship between offering size and concessions, including systematic differences in pre-auction cheapening. To mitigate this concern further, Appendix Table A17 then applies the ROW 2SLS specification to one-, three- and five-business-day reference-yield changes ending at $t-1$. Joint tests of the level and slope effects of competing supply on these pre-auction yield changes are insignificant for every window, in the pooled sample and in advanced economies, which

makes me confident that pre-auction cheapening does not contaminate the estimates.

4.5 Robustness

The regional interaction remains positive and significant when concessions are scaled by the standard deviation instead of the MAD of yield changes, and when they are measured in raw basis points with or without trimming (Appendix Table A9). In raw basis points the interaction is about a quarter smaller. Scaling by country volatility makes concessions comparable across countries with different yield variability and reduces the influence of high-volatility markets; it is therefore not merely a change of units. The global effect at $\ell = \text{sd}(\ell)$ is imprecise in the raw basis-point regressions (Appendix Table A9). Table A32 varies same-day and three-day measurement.

The results are not driven by slow-moving country conditions. High-frequency supply variation accounts for most of the variance of the interaction, 87% regionally and 80% globally (Appendix Table A11), and an interaction built from high-frequency global supply alone is about as large as the global baseline (Appendix Table A11). Country trends, trends in the domestic-size slope, and detrending ROW and the instrument leave the interaction essentially unchanged; country × year effects reduce it by about a quarter (Tables A11 and A14). Subperiod estimates are positive throughout and most precise after 2021 (Table A13). Treating each maturity bucket that an issuer sells on a given day as a separate auction preserves both interactions when domestic size is the issuer's total offering that day, while the size of the individual tenor line adds no interaction of its own (Appendix Table A15). Crowding is therefore priced on how much the issuer brings to market that day, not on the size of a single line. Alternative backward-looking GDP normalisations of supply and rollover need also preserve the positive interaction (Table A12).

The results are also not sensitive to the exact rule from mapping rollover obligations to issuances for the IV. The redemption-allocation window is not decisive. Windows from sixty to 180 days give regional interactions within about 15% of the baseline. Using a forward-looking rule that allocates redemptions across the auctions between successive repayment dates gives a similar estimate (Appendix Figure A18) too. Allocating the expiring bond just to the earliest preceding auction in a short-shited rule gives noisy estimates but similar coefficients.

Adding U.S. issuance to ROW and HUB instead of the separate U.S. block keeps both interactions positive and significant, also when U.S. auctions enter as outcomes (Appendix Tables A34 and A34). Per standard deviation, both interactions become smaller. Because U.S. issuance dominates the variation of the inclusive measure, this implies that a dollar of U.S. issuance crowds out considerably less than a dollar of other sovereigns' supply.

Crowding out and crowding in are not features of small issuers. Splitting countries by GDP or by issuance per auction day gives similar interactions for small and large issuers, also within advanced economies (Appendix Table A20).

Next, we would like to interpret our estimates through the lens of a simple model that also lets us derive additional predictions for the data.

4.6 A model of shared intermediation capacity Model updated soon!

Consider two sovereign bond markets: a local market and the rest of the world (ROW). Bond supplies are $\bar{L} + L$ and $\bar{R} + R$, where $\bar{L}, \bar{R} > 0$ denote normal issuance and L, R denote deviations from these quantities. Terminal payoffs satisfy $\mathbf{v} = \bar{\mathbf{v}} + \boldsymbol{\varepsilon}$ where ϵ is mean-zero normally distributed and $\Sigma = \sigma^2 \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}$. With $0 \leq \rho < 1$ bonds are imperfect substitutes, Let

$$\boldsymbol{\eta} = \bar{\mathbf{v}} - \mathbf{p}$$

denote the vector of price concessions relative to expected payoffs (e.g. the auction concession). A larger concession corresponds to a lower issuance price and, holding bond characteristics fixed, a higher yield.

There will be two types of banks - the global and the local bank. There exists a continuum of global banks that are mean-variance optimisers and invest in both markets Their risk tolerance α is drawn from a uniform distribution. $\alpha \sim U(0, 1]$ and they face a risk limit friciton

$$\max_{\mathbf{x}_\alpha \geq \mathbf{0}} \left\{ \mathbf{x}_\alpha' \boldsymbol{\eta} - \frac{1}{2\alpha} \mathbf{x}_\alpha' \Sigma \mathbf{x}_\alpha \right\} \quad \text{subject to} \quad \mathbf{x}_\alpha' \Sigma \mathbf{x}_\alpha \leq \bar{\nu}^2.$$

The portfolio-risk limit $\bar{\nu}$ restricts each bank's risk-bearing capacity. This standard friction from the literature captures that due to regulation or excessive balance sheet costs there is a limit to risk that a bank can absorb. The local bank demands just the usual issuance $\mathbf{D} = (\bar{L}, \bar{R})'$.

I introduce one important parameter. Normalising the total mass of banks to one, χ is the mass of global banks, which are active in both markets; the remaining $1 - \chi$ are local banks. I call χ *shared intermediation capacity*: the share of the same total capacity that issuers can draw on across markets. It corresponds to the dealer overlap in Figure 6a. Holding competing supply and total capacity fixed, on some days the issuers in the market bring more dealers that are common to several issuers than on other days. So the composition of other issuers matters.

Market clearing and pricing. Let $\mathbf{q}$ denote the average portfolio held by global banks. Market clearing requires

$$\chi \mathbf{q} + (1 - \chi)\bar{\mathbf{s}} = \bar{\mathbf{s}} + \begin{pmatrix} L \\ R \end{pmatrix}, \qquad \text{so that} \qquad \mathbf{q} = \begin{pmatrix} \bar{L} + L/\chi \\ \bar{R} + R/\chi \end{pmatrix}.$$

Global banks thus absorb all deviations from normal issuance. Defining the risk from residual supply as $Q = (\mathbf{q}'\Sigma\mathbf{q})^{1/2}$, equilibrium concessions can be written as

$$\eta = \varkappa(Q)\Sigma\mathbf{q}, \qquad \varkappa(Q) = \begin{cases} 2, & 0 < Q \leq \bar{\nu}/2, \\ \dfrac{\bar{\nu}}{2Q(1 - Q/\bar{\nu})}, & \bar{\nu}/2 < Q < \bar{\nu}. \end{cases}$$

The coefficient $\varkappa(Q)$ is the equilibrium price of portfolio risk. It is constant when all banks are unconstrained and increases with inventory risk when some banks face binding risk limits.

Crowding out. Let us first study the effect of large foreign issuance on the local demand curve. Additional ROW issuance raises the inventory that global banks must absorb. When risk limits are slack and payoff correlation is positive, this increases the compensation required to hold the local bond through its covariance with the ROW position. Consequently, local inverse demand shifts parallel downward. If ROW issuance raises further, the most risk-tolerant one will hit the risk limit first, as they want to buy most bonds relative to the risk they entail. This leaves the unconstrained more risk averse banks to be the marignal buyer. Absorbing further issuance therefore requires a higher equilibrium price of risk to let the risk-averse bank absorb supply. Therefore, local inverse demand both shifts downward and becomes steeper.

$$\frac{\partial^2 \eta_L}{\partial L \, \partial R} > 0.$$

Competing issuance thus raises the marginal financing cost of local issuance. Tighter risk limits or higher common payoff volatility strengthen this crowding-out effect by bringing intermediaries closer to their risk-bearing capacity.

Crowding in Suppose risk limits bind, and hold competing foreign issuance and total intermediation capacity fixed. If χ is small, the markets are segmented: a small set of global banks has to intermediate deviations from usual supply with concentrated positions. As χ increases, more banks are common to both markets, so each issuer can draw on a larger share of the same capacity and deviations are spread across a broader intermediary base. This reduces the marginal compensation required to place local bonds and flattens local inverse demand, holding foreign issuance fixed

$$\left.\frac{\partial^2 \eta_L}{\partial L \, \partial \chi}\right|_{L=R=0} < 0.$$

The composition channel is especially transparent for an issuance reallocation $L = \varepsilon$ and $R = -\varepsilon$. Total issuance and total holdings per global bank remain unchanged, but the portfolio adjustment

required of each global bank is only $(\varepsilon/\chi, -\varepsilon/\chi)'$. A larger global-bank share allows the same reallocation to be absorbed with smaller changes in individual portfolios and relative prices.

Appendix A derives equilibrium pricing and proves that, for nonnegative issuance deviations, crowding out and crowding in hold throughout the feasible partially constrained region, with crowding out amplified by tighter risk limits and higher payoff volatility.

Other predictions in the update model

- Foreign issuance and Hub presence just matter for large local auctions because only for large auctions do they need to rely on global banks' intermediation capacity. More specifically for the crowding-in case: holding foreign issuance and total intermediation capacity fixed, a country loses from issuing large amounts on a day when the issuers present share few dealers. The market is then segmented, and few dealers common to several issuers can intermediate extra supply across auctions. If Hub countries issue, they bring more dealers that are common to several issuers, so each issuer can draw on a larger share of the same capacity.
- High volatility and intermediaries capacity constraints amplify crowding out.
- More connected countries in the market amplify crowding in.

4.7 Bringing the model again to the data

Crowding out and crowding in important for large issuance First, I would like to test where crowding out and crowding in are concentrated. As the model has shown, it should just matter for large auctions because then a domestic country relies on global banks. Equation (10) imposes that the effect of competing supply changes linearly with domestic size. To see which auctions bear the cost, I let the domestic-size interaction differ across four cells. An auction is *large* if its offering exceeds the issuer's average ($\ell_{c,t} \geq 0$) and *small* otherwise. A day is *crowded* if partners' predetermined rollover need around the auction exceeds its average for that issuer, and *quiet* otherwise. Splitting days on the instrument rather than on realised supply keeps the cell indicators exogenous, so each cell-specific interaction $\ell \times ROW \times \mathbb{1}\{\text{cell}\}$ is instrumented by $\ell \times N \times \mathbb{1}\{\text{cell}\}$. A single ROW level is retained, and the HUB and U.S. terms enter as in the baseline. For hub presence, which is not instrumented, the analogous split uses hub presence itself: on a *hub day* more hub countries are in the market than is usual for the issuer. For each cell I report the total effect of the cell's average competing supply on the cell's average domestic auction size, relative to a day with the issuer's usual conditions,

$$\Delta\eta_{\text{cell}} = \left(\beta_R + \beta_{LR}^{\text{cell}}\, \bar{\ell}_{\text{cell}}\right) \overline{ROW}_{\text{cell}},$$

in basis points, and analogously for HUB.

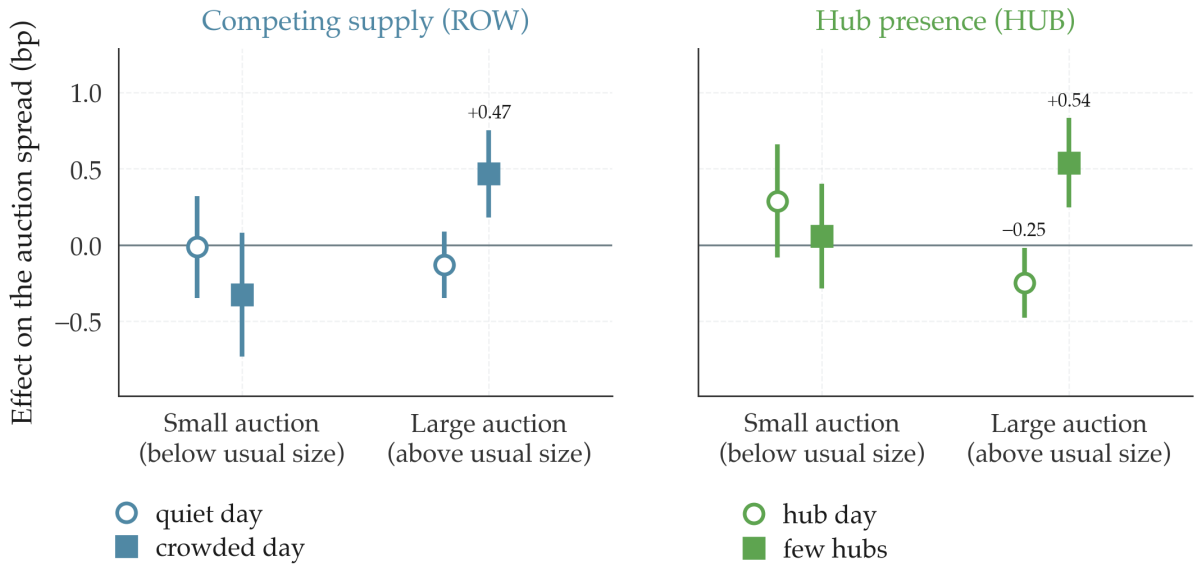


Figure 7: Who bears the cost of crowding: large auctions on crowded days

Notes. Effect of competing supply (left) and hub presence (right) on the auction concession of the average auction in each cell, relative to the issuer's usual conditions, in basis points at the median concession volatility. Small (large) auctions have offerings below (above) the issuer's average. Crowded days have above-usual predetermined partner rollover need; hub days have above-usual hub presence. The cell-specific domestic-size interactions with ROW are instrumented by the corresponding rollover-need interactions. The specification is otherwise that of Table 1, column (4). Whiskers are 95% confidence intervals based on Driscoll–Kraay standard errors.

Figure 7 shows that the cost of crowding falls on large auctions held on crowded days. Such an auction pays about half a basis point more than it would under the issuer's usual conditions. A large auction on a quiet day pays nothing extra, and small auctions show no significant effect on either kind of day. Crowded days therefore have no impact when domestic issuance is small: the effect of competing supply comes from large auctions on crowded days. The results are in line with the model that local investors absorb an issuer's usual supply; deviations from it must be placed with global banks, whose risk-bearing capacity depends on foregin issuance.

Hub presence works in the opposite direction. Holding competing foreign issuance and total capacity fixed, a large auction on a day with few Hub countries meets, through the lens of the model, a segmented market with few dealers common to several issuers, so it can draw on only a small share of the capacity. When many Hub countries are present, more of the dealers in the market are common to several issuers, each issuer can draw on a larger share of the same capacity, and the concession even drops slightly.

Crowding out is a same region advanced economy phenomenon Columns (1)–(4) of Table 2 estimate equation (10) separately for advanced economies (AE) and emerging markets (EM). Crowding out is concentrated in advanced economies. With regional ROW, the domestic-size interaction

is 1.31 in AE and with global ROW it is 1.89 both highly signifficant. Contrary, EMs coeffcients are imprecisely measured. This could have three possible reasons. (i) The concession for emerging markets is very noisily measured because yield curves are less liquid, (ii) they show much less variation in issuance announcements and therefore a demand curve is more difficult to be estimated, or (iii) finally there is no crowding out from foreign issuance.

Columns (5)–(6) let competing supply within the issuer's trading region and supply in the other regions enter jointly. Each component and its own-size interaction is instrumented by the matching rollover need, and both components are scaled by the within-country standard deviation of the global total, so that their coefficients are in common units. The same-region interaction is 1.99 in the pooled sample and 3.55 in AE, against 0.81 and 1.30 for the other regions. A unit of supply placed during the same trading hours therefore crowds out more than twice as much as a unit placed elsewhere, consistent with dealers managing sovereign inventory on regional desks. In EM neither component is significant (Appendix Table A30).

Table A23 looks at each region separately. Maturity matching provides complementary evidence. In advanced economies, supply in the domestic auction's maturity bucket crowds out almost twice as much per standard deviation as all eligible supply (Appendix Table A29), consistent with stronger competition between more substitutable bonds.

Hub presence is driven by connected countries in advanced economies In Figure 6a, we chose the hub status based on size and centrality in the dealer network. According to the model, it is not the overall centrality of the issuer; rather, what matters is shared intermediation capacity χ, i.e. how many of the dealers in the market are common to the domestic issuer and the issuers present, which the dealer overlap between countries proxies. I will test now whether size, centrality or a more model-informed measure of dealer overlap between countries at the same time in the market wins in a horse race regression when replacing the hub presence variable.

I use the dealer overlap $J_{jk,t}$, the edges $E_{jk,t}$ and the centrality $\bar{J}_{j,t}$ defined in Fact III, equations (7)–(9). For domestic issuer c, the centrality of a ROW country issuing j is its mean overlap with every other non-U.S. issuer, leaving c out. That is, $\bar{J}_{j,-c,t}$ is equation (9) computed over $\mathcal{K}_{jc,t}$, the issuers other than j, c and the United States with dealer data at t. Leaving the domestic issuer out ensures that a partner's centrality is not built from the domestic issuer's own dealer base.

Issuers and their primary dealer lists enter the panel over time, so counts of partners in the market, or their average centrality, drift as the panel grows. I therefore measure the market relative to full participation. Let $P_{j,t}$ be the share of the days $t-1$, t and $t+1$ on which partner j holds an auction, and $a_{j,t}$ indicate that j is an active issuer at t. For a partner weight $x_{j,t}$ (GDP, centrality, dealer overlap, count),

$$S^{x}_{c,t} = \frac{\sum_{j \neq c,\mathrm{US}} P_{j,t}\, x_{j,t}}{\sum_{j \neq c,\mathrm{US}} a_{j,t}\, x_{j,t}}$$

is the share of full participation that is in the market. With $x = 1$, $S_{c,t}$ is the share of active partners holding an auction. Weighting by GDP, by centrality $\bar{J}_{j,-c,t}$, or by a dealer link to the domestic issuer, $E_{cj,t}$ from equation (8) (the edges in Figure 6a), gives shares that mix how many partners are present with who they are. I therefore divide each weighted share by the unweighted share on the same set of partners,

$$S_{c,t} = \frac{\sum_{j \neq c,\text{US}} P_{j,t}}{\sum_{j \neq c,\text{US}} a_{j,t}}, \qquad R^{GDP}_{c,t} = \frac{S^{GDP}_{c,t}}{S_{c,t}}, \qquad R^{cen}_{c,t} = \frac{S^{J}_{c,t}}{S^{ros}_{c,t}}, \qquad R^{link}_{c,t} = \frac{S^{link}_{c,t}}{S^{ros}_{c,t}},$$

where S^{ros} is the unweighted share among partners with dealer data. R^{cen} is the mean centrality of the partners in the market relative to that of all active partners: above one, today's market is more central than the panel. It is a property of the partners and does not require dealer data for the domestic issuer. R^{link} measures whether the domestic issuer's own dealer-linked partners are over-represented; it needs a dealer list for the domestic issuer and at least one linked partner. Presence uses the same auction universe as HUB. The four measures are at most 0.40 correlated within country, and each is demeaned within country and divided by its pooled standard deviation.

Columns (7)–(9) replace HUB by the four measures, which enter jointly in levels and domestic-size interactions, with the numbers of active partners with dealer data and of active linked partners as controls.

In the pooled sample, issuer share flattens the demand curve significantly, with an interaction of −1.19. Additionally, holding the share of the issuer fixed, a market whose participants are more central in the dealer network flattens the residual demand curve, with an interaction of −0.51. Interestingly, GDP is insignificant which suggest that the size of Hub countries are not the characteristic that drives the Hub country result. Interestingly, focusing on advanced economies, the results are close to the model prediction. It is not the centrality of ROW issuers but rather whether many of ROW issuers are connected to the domestic country. In emerging markets the link interaction is positive (0.31), and neither breadth nor centrality is precisely estimated. The link interaction is the only one of the four that clearly differs between the two groups. Crowding in thus runs through a market populated by issuers that share dealers with the whole network and, in advanced economies, with the domestic issuer itself: their auctions bring to the market the global banks that intermediate across many sovereign markets. This supports reading HUB as a proxy for shared intermediation capacity: Hub days bring more dealers that are common to several issuers, so each issuer can draw on a larger share of the same capacity. The dealer lists do not, however, show which banks actually bid on a given day. Same-region crowding out remains, concentrated in advanced economies.

Crowded out amplified when global banks are constrained Table 3 tests the model's prediction for crowding out. I use the advanced economies for this exercise, as crowding out seems to be impor-

Table 2: Concurrent supply in advanced and emerging economies

	Regional ROW		Global ROW		Split ROW		Split ROW + who is in the market		
	AE	EM	AE	EM	All	AE	All	AE	EM
$\ell \times ROW$	1.307***	0.471	1.885***	0.517					
	(0.319)	(0.464)	(0.588)	(0.498)					
$\ell \times ROW_{same}$					1.990***	3.547***	1.948***	2.499**	1.023
					(0.718)	(1.148)	(0.708)	(1.034)	(0.999)
$\ell \times ROW_{other}$					0.812**	1.296*	0.749	0.919	0.549
					(0.402)	(0.736)	(0.478)	(0.736)	(0.678)
$\ell \times HUB$	−1.317***	−0.317	−1.985***	−0.533	−1.251***	−2.225***			
	(0.325)	(0.256)	(0.528)	(0.409)	(0.399)	(0.682)			
$\ell \times S$							−1.188***	−1.531***	−0.527
							(0.373)	(0.502)	(0.472)
$\ell \times R_{GDP}$							−0.279	−0.164	0.114
							(0.265)	(0.396)	(0.382)
$\ell \times R_{cen}$							−0.513***	−0.614**	−0.405
							(0.180)	(0.293)	(0.259)
$\ell \times R_{link}$							0.111	−1.124***	0.312*
							(0.168)	(0.371)	(0.165)
$\ell \times US$	0.212	0.271	0.375	0.335	0.223	0.357	0.296	0.206	0.442*
	(0.232)	(0.208)	(0.265)	(0.240)	(0.190)	(0.322)	(0.214)	(0.327)	(0.263)
Kleibergen–Paap rk Wald F	276.4	202.3	244.3	143.9	112.4	52.0	120.1	70.3	59.5
Observations	6,701	4,479	6,701	4,479	9,316	4,920	8,696	4,764	3,932
Dealer-data sample	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Test: $\ell\times$	*ROW*: AE/EM		*ROW*: AE/EM		*ROW*: same/other	*ROW*: same/other	*R*: cen/link	*R*: cen/link	*R*: cen/link
p-value	0.124		0.073		0.053	0.017	0.027	0.345	0.043
p-value, AE = EM in $\ell \times R_{link}$								< 0.001	

Notes. All columns use 2SLS. Columns (1)–(4) show regional and global ROW estimates for AE and EM on the full samples. Columns (5)–(9) use the dealer-data sample: (5) and (7) pooled, (6) and (8) AE, (9) EM. In (7)–(9), R_{link} is set to zero for issuers that never have an active dealer-linked partner (Korea and Taiwan), and dates on which a dealer list is missing are dropped. Split ROW includes same-region and other-region supply jointly, instrumenting all four level and interaction terms by the matching rollover need and scaling both components by the within-country standard deviation of the global total. Split ROW + who is in the market replaces HUB by the issuer share S (active non-U.S. partners with an auction in the three-day window, over all active partners) and three composition ratios: R_{GDP} (GDP-weighted over unweighted share), R_{cen} (centrality-weighted over unweighted share among partners with dealer data) and R_{link} (share of the domestic issuer's dealer-linked partners in the market, Jaccard overlap of at least 0.18, over the unweighted share among partners with dealer data). The final two rows report equality tests of interaction coefficients and their p-values: ROW across AE/EM (once per regional/global pair, from a fully saturated pooled model), ROW same/other in (5)–(6), and R_{cen} against R_{link} in (7)–(9). The last row tests equality of the R_{link} interaction across (8) and (9), from a fully saturated pooled model. Within-model tests use the joint covariance. The EM Split ROW specification appears in Table A30. The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes. Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

tant for them. For a continuous moderator M, I add its main effect and all products with domestic and competing supply to equation (10). ROW, $\ell \times ROW$, $ROW \times M$ and $\ell \times ROW \times M$ are jointly instrumented by the corresponding rollover-need products, and country-specific loadings allow the direct effect of M to vary across issuers. The triple interaction measures how a one-standard-deviation increase in M changes the effect of ROW on the domestic-size slope. The HUB and U.S. terms remain included; Appendix Table A24 additionally lets both HUB coefficients vary with M.

The main moderator is minus the cumulative He et al. (2017) capital-risk factor over the preceding twenty-one business days (column 2), so that higher values mean that intermediaries' capital has de-

teriorated. A one-standard-deviation deterioration raises the crowding-out interaction by 0.52, half of its value under average conditions (1.03). The $ROW \times M$ coefficient is small with large standard errors. This could be because the pre-determined risk factor used in the regression is already incorporated in the reference yield. At an offering one standard deviation above the issuer's average and a one-standard-deviation deterioration of intermediary capital, one standard deviation more competing supply raises the concession by 1.09 bp. This is the amplification the model predicts when global banks' risk limits tighten. A rise in volatility over the same horizon, the twenty-one-business-day change in log VIX (column 1), gives a similar triple interaction of 0.44. Appendix Table A22 reports other horizons and alternative intermediary measures.

The model's nonlinear channel operates once intermediaries become constrained. Column (3) therefore replaces M by an indicator for predetermined rollover need above its pooled median and omits the unrestricted $\ell \times ROW$ term, imposing zero crowding out below the threshold. The interaction in the high-supply state is 1.90. Appendix Table A25 and Figure A20 report the estimates across cut-offs from the 25th to the 90th percentile. Column (4) asks whether crowding out strengthens when an issuer brings more debt to market relative to its domestic economic base: the previous calendar year's eligible issuance per active issuance month, divided by nominal GDP and demeaned within issuer. The triple interaction is 0.72, consistent with greater reliance on marginal global buyers when issuance exceeds what domestic investors usually absorb. Appendix D.6 separates the within-issuer and between-issuer components and reports subperiods.

5 Quantification

How much does the timing of an auction cost an issuer? The estimates in Section 4 identify how competing supply and partner presence rotate an issuer's demand curve, but not how they shift its level. I therefore price only differences between calendars. Every exercise keeps an issuer's auctions, sizes and maturities, and moves only their dates; all other issuers' calendars stay at their realised dates, so the gains are unilateral.

5.1 Pricing a calendar

I use column (8) of Table 2, estimated on advanced economies, which separates crowding out and crowding in most finely. Its day characteristics are $X_t = (ROW_{same,t}, ROW_{other,t}, S_t, R_t^{cen}, R_t^{link})$, standardised within country: competing supply in the issuer's own and in the other trading regions, the share of partners in the market, the centrality of those present, and the presence of the issuer's own dealer-linked partners. Column (8) also contains R^{GDP} and the two coverage counts. I hold these at their country-year mean, so they do not enter any comparison: R^{GDP} has no effect, and the counts

Table 3: Predicted moderators of concurrent-supply crowding out in advanced economies

	Δ_{21} log VIX	−HKM risk factor, 21bd	1{*ROW* high}	Issuance / GDP within issuer
ROW	0.236	0.240	0.550	0.197
	(0.150)	(0.150)	(0.471)	(0.146)
$\ell \times ROW$	1.295***	1.026***		1.142***
	(0.319)	(0.289)		(0.327)
$ROW \times M$	−0.058	0.099	−0.576	0.328*
	(0.196)	(0.184)	(0.550)	(0.188)
$\ell \times ROW \times M$	0.441**	0.521**	1.899***	0.724**
	(0.200)	(0.227)	(0.582)	(0.324)
HUB	−0.153	−0.157	−0.148	−0.205
	(0.142)	(0.146)	(0.141)	(0.138)
$\ell \times HUB$	−1.302***	−1.063***	−1.244***	−1.232***
	(0.332)	(0.298)	(0.315)	(0.324)
$\frac{\partial \eta^{\text{gen}}}{\partial ROW}$ $(\ell = \text{sd}(\ell), M = 1)$ (bp)	1.031***	1.085***	0.925**	1.414***
	(0.342)	(0.296)	(0.382)	(0.377)
Country $\times M$	Yes	Yes	Yes	Yes
Kleibergen–Paap F	124	127	49	130
Observations	6,701	6,307	6,701	6,672

Notes. Advanced economies; regional ROW; 2SLS. Columns (1), (2) and (4) standardise the moderator within the estimation sample and include its main effect, $\ell \times M$, $ROW \times M$ and $\ell \times ROW \times M$. Country-specific moderator loadings are included. VIX is the preceding 21-business-day change in log VIX; the HKM measure is minus the cumulative capital-risk factor over the same horizon. Issuance/GDP is the previous calendar year's eligible issuance, divided by its number of active issuance months and nominal GDP, then demeaned within issuer. Column (3) uses an unstandardised indicator for rollover need above its pooled median. It omits the plain $\ell \times ROW$ term, imposing a zero crowding-out interaction below the threshold. All included ROW products have matching rollover instruments. HUB and US levels and domestic-size interactions remain in every column; Table A24 additionally allows the HUB coefficients to vary with the moderator. The marginal ROW effect at $\ell = \text{sd}(\ell) = 0.54$ (an offering one standard deviation larger than the issuer's usual size) and $M = 1$ is $\beta_R + \beta_{RM} + \text{sd}(\ell)\,(\beta_{\ell R} + \beta_{\ell RM})$, with $\beta_{\ell R} = 0$ in column (3). Both the effect and its full-covariance delta-method standard error are multiplied by the median MAD scale across the column's estimation observations to report basis points, treating that scale as fixed.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

move only when issuers or their dealer lists enter the data, which is not a margin an issuer chooses. The backward-looking exercises add $ROW_t \times M_t$, estimated with the same day characteristics, at the realised He et al. (2017) factor. The predicted cost of holding auction i of country c on day t is

$$c(i,t) = 10^{-4}\, m_c\, D_i F_i \sum_k \left(\beta_k + \gamma_k \ell_i\right) X_{k,t}, \tag{11}$$

where β_k and γ_k are the level and domestic-size coefficients, m_c converts the normalised concession into basis points and $10^{-4} D_i F_i$ is the bond's dollar value of a basis point (Figure A24 plots $m(\beta_k + \gamma_k \ell)$). The best calendar solves the linear assignment problem $\min_\pi \sum_i c(i, \pi(i))$ with at most one auction per day. Feasible days are any business day of the year, any day within one month (21 business days) of

the actual date, or only the issuer's own auction days, which re-orders auctions without moving them. The benchmark is the average random calendar, in which each auction falls on a random business day of its year. Since X_t enters linearly, a constant shift in any day characteristic adds the same amount to every calendar, so the unidentified levels cancel from every comparison.

5.2 Rolling over today's debt

The first exercise re-issues today's stock of bonds with more than three years to maturity of 10 advanced economies, USD 19 trillion, as it matures. Each issuer auctions its average annual redemptions in a representative year, at its own recent auction sizes and maturities and in the market observed from September 2024 to September 2025. No deficit issuance is planned or counted. The plan lowers the yield on each re-issued dollar by g_c basis points; since the concession recurs every year of a bond's life, the extra cash raised is g_c times the dollar duration of the re-issued debt.

Figure 8 reports it in basis points of today's stock. The best calendar saves 13.4 bp, USD 25.4 billion, and once the stock has been rolled over lowers interest payments by USD 2.6 billion a year, 1.05% of the coupon bill on these bonds. Moves of at most one month retain 80% of the gain. Re-ordering domestic auction days retains only 28%, so the gain comes from choosing different days, not from reshuffling auctions across the days already chosen. The gain is largest for Korea (26.4 bp), Singapore (24.6 bp) and France (22.4 bp), and smallest for Taiwan (7.0 bp). Japan, by far the largest stock, gains only 9.1 bp because its yields are among the least volatile; in dollars the largest gains accrue to France (USD 6.8 billion) and Japan (USD 5.9 billion). Switzerland and Denmark lack the data to enter the estimation sample, but priced with the common coefficients they would gain Switzerland (21.0 bp) and Denmark (22.1 bp), in the upper part of the in-sample range. Note that this estimate presumably has a large missing intercept as estimation came from daily asset price movements because of identification.

5.3 The costliest auctions

Most of an issuer's exposure sits in a few auctions. In every country-year from 2006–2025 I move only the five auctions with the highest predicted cost to the best free day of the year (958 auctions of 11 issuers). Panel (a) of Figure 9 shows that this saves 1.00% to 1.25% of these bonds' annual coupon, depending on whether moves are limited to a month, for the life of the bonds. The saving ranges from Japan (2.24%), Korea (1.79%) and Germany (1.63%) to Singapore (0.62%).

Panel (b) decomposes their cost in excess of the average day of the year, USD 3.1 billion, into channels, $e_{ik} = 10^{-4} m_c D_i F_i (\beta_k + \gamma_k \ell_i)(X_{k,t} - \bar{X}_k)$. Who is in the market accounts for 70%: the issuer share for 38%, the centrality of the issuers present for 20% and the issuer's own dealer-linked partners for 12%. Competing supply under intermediary stress accounts for 19%, and plain competing supply for 3% (same region) and 9% (other regions). The channels hit different auctions. 80% of the stress cost

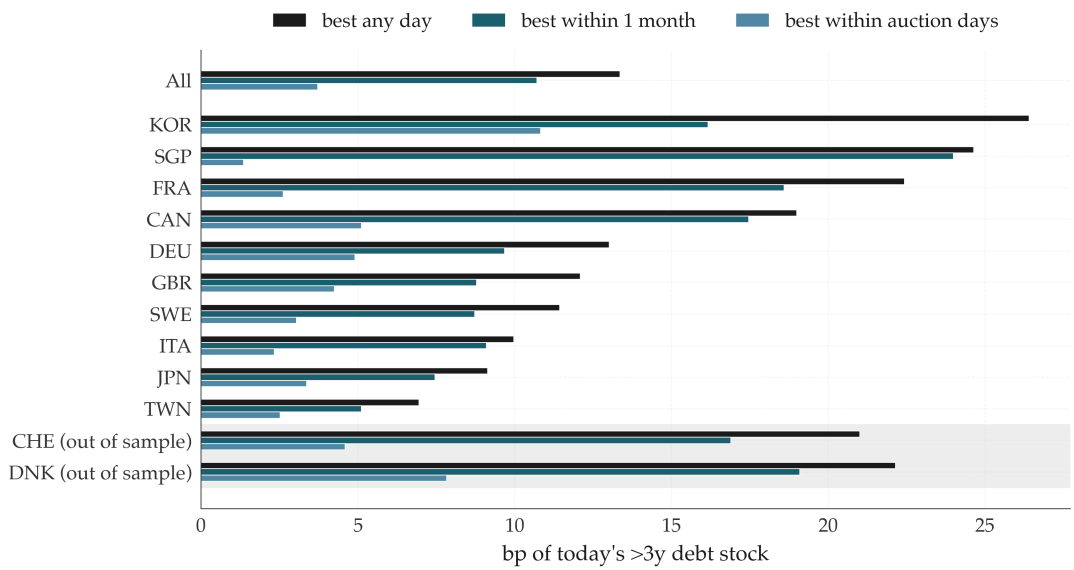


Figure 8: Rolling over today's debt stock: gain from a better calendar

Notes: Present value of the lower yield when each issuer re-issues its outstanding bonds with more than three years to maturity, in basis points of that stock, relative to the average random calendar. Average annual redemptions are auctioned in a representative year (September 2024 to September 2025) at the issuer's own auction sizes, at most one auction per day, priced with equation (11) without the intermediary-stress term. "All" divides the summed gain by the summed stock. Switzerland and Denmark (shaded) are out of sample.

falls on auctions larger than usual, brought to crowded markets while intermediaries are constrained. Of the cost from who is in the market, 58% falls on auctions smaller than usual held on days when much of the market is present; such a day lowers the cost of a large auction more than that of a small one, so it is wasted on the small one. The centrality channel instead falls mostly on large auctions held when the issuers in the market are peripheral. Who is in the market is the largest channel in Canada, Germany, France, the United Kingdom, Italy, Japan, Korea, Norway and Taiwan, supply under stress in Singapore, and plain competing supply in Sweden.

Four conclusions follow. First, issuers do not exploit the timing margin. Compared with 400 random calendars per issuer in 2021–2025 (Figure A25), the observed calendars cost +0.01% of the coupon bill relative to the average random one, while the best would save 0.90% and the worst would cost 0.97%. Second, the gain is feasible: most of it survives when no auction moves more than a month, so it requires neither bunching nor an unusual calendar. Third, it is concentrated in a few auctions a year. Fourth, the costly mistake is a mismatch between an auction's size and the day, not crowded days as such: large auctions belong on days when much of the market is present, the issuers present are central in the dealer network and the issuer's own dealer-linked partners are among them, and away from crowded markets when intermediaries are constrained.

The numbers have three limits. They are partial equilibrium: if every issuer re-planned at once, part of the gain would be competed away. The level of the concession is not identified, so a uniform

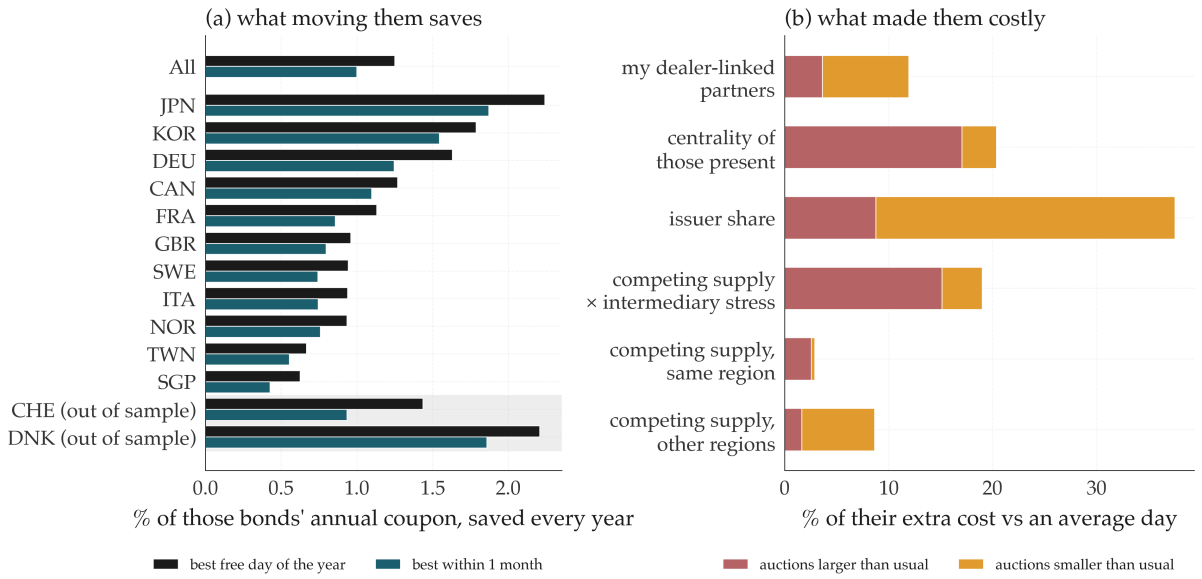


Figure 9: The five costliest auctions of each year

Notes: In every country-year, the five auctions with the highest predicted cost, equation (11) including the intermediary-stress term. (a): saving from moving only these auctions to the best free business day of the year or within one month, as a share of their annual coupon. Switzerland and Denmark (shaded) are out of sample. (b): each channel's share of their cost in excess of the average day of the year, by whether the auction is larger ($\ell > 0$) or smaller than usual.

increase in everyone's supply is not priced. And the rollover counts only the first round of re-issuance of today's stock, so it is a lower bound on its stakes.

6 Conclusion

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A Shared intermediation capacity: equilibrium and proofs

This appendix derives the equilibrium and comparative statics of the model in the main text. In particular, the crowding-in result extends beyond a neighborhood of normal issuance: it holds for all nonnegative issuance deviations for which a finite-price equilibrium exists. Strict crowding-out steepening additionally requires that some global banks are constrained.

A.1 Environment and equilibrium

Write $\bar{\mathbf{s}} = (\bar{L}, \bar{R})'$, with $\bar{L}, \bar{R} > 0$, and $\mathbf{d} = (L, R)'$. Total supply is $\bar{\mathbf{s}} + \mathbf{d}$. Payoffs have mean $\bar{\mathbf{v}}$ and covariance

$$\Sigma = \sigma^2 \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}, \qquad \sigma > 0, \quad 0 \le \rho < 1.$$

The total mass of banks is one. Global banks have mass $\chi \in (0, 1]$; local banks have mass $1-\chi$ and fixed aggregate demand $(1-\chi)\bar{\mathbf{s}}$. Thus χ is a population share, rather than the ratio of global to local banks. The vector $\bar{\mathbf{s}}$ specifies local-bank demand per unit of total local-bank mass, including the allocation of this mass between the two domestic markets. Market clearing fixes the average global-bank portfolio:

$$\mathbf{q} = \bar{\mathbf{s}} + \frac{\mathbf{d}}{\chi} = \begin{pmatrix} x \\ y \end{pmatrix}, \qquad x = \bar{L} + \frac{L}{\chi}, \quad y = \bar{R} + \frac{R}{\chi}. \tag{12}$$

Throughout, normal issuance, total bank mass, and all other primitives are held fixed in each partial derivative. We restrict attention to $x, y > 0$. This is automatic when $L, R \ge 0$.

Let $\boldsymbol{\eta} = \bar{\mathbf{v}} - \mathbf{p}$. Risk tolerance among global banks is uniformly distributed on $(0, 1]$. A bank of type α solves

$$\max_{\mathbf{x}_\alpha \ge \mathbf{0}} \left\{ \mathbf{x}_\alpha' \boldsymbol{\eta} - \frac{1}{2\alpha} \mathbf{x}_\alpha' \Sigma \mathbf{x}_\alpha \right\} \quad \text{subject to} \quad \mathbf{x}_\alpha' \Sigma \mathbf{x}_\alpha \le \bar{v}^2, \qquad \bar{v} > 0. \tag{13}$$

Proposition 1 (Equilibrium pricing)**.** *For $\mathbf{q} > \mathbf{0}$, a finite-price equilibrium exists if and only if $Q = (\mathbf{q}'\Sigma\mathbf{q})^{1/2} < \bar{v}$. Its concession vector is uniquely given by*

$$\boldsymbol{\eta} = \kappa(Q)\Sigma\mathbf{q}, \qquad \kappa(Q) = \begin{cases} 2, & 0 < Q \le \bar{v}/2, \\ \dfrac{\bar{v}}{2Q(1 - Q/\bar{v})}, & \bar{v}/2 < Q < \bar{v}. \end{cases} \tag{14}$$

In the second region, types $\alpha > \widehat{\alpha}$ are constrained, where $\widehat{\alpha} = 2(1 - Q/\bar{v}) \in (0, 1)$.

Proof. Positive definiteness of Σ makes each bank's objective strictly concave. All banks choose the same portfolio direction: conditional on portfolio risk, the direction maximizes expected excess payoff and does not depend on α. Because aggregate holdings in both assets are positive, this common

direction is interior to the nonnegative orthant. The first-order conditions therefore imply

$$\mathbf{x}_\alpha = \min\{\alpha, \widehat{\alpha}\}\Sigma^{-1}\boldsymbol{\eta}, \qquad \widehat{\alpha} = \frac{\bar{\nu}}{t}, \qquad t = (\boldsymbol{\eta}'\Sigma^{-1}\boldsymbol{\eta})^{1/2}.$$

When $t \le \bar{\nu}$, averaging over types gives $\mathbf{q} = \frac{1}{2}\Sigma^{-1}\boldsymbol{\eta}$ and $Q = t/2$. This yields the first branch of (14). When $t > \bar{\nu}$, averaging instead gives

$$\begin{aligned}\mathbf{q} &= \left[\int_0^{\widehat{\alpha}} \alpha\, d\alpha + \int_{\widehat{\alpha}}^1 \widehat{\alpha}\, d\alpha\right]\Sigma^{-1}\boldsymbol{\eta} \\ &= \left(\widehat{\alpha} - \frac{\widehat{\alpha}^2}{2}\right)\Sigma^{-1}\boldsymbol{\eta}, \qquad Q = \bar{\nu}\left(1 - \frac{\widehat{\alpha}}{2}\right).\end{aligned}$$

Solving for $\widehat{\alpha}$ yields the second branch. The resulting $\Sigma^{-1}\boldsymbol{\eta} = \varkappa(Q)\mathbf{q} > \mathbf{0}$ verifies the interior direction and hence the nonnegativity restrictions. The map from t to Q is strictly increasing, with range $(0, \bar{\nu})$, establishing existence and uniqueness on that range. No finite t can deliver $Q = \bar{\nu}$: a positive mass of sufficiently risk-averse banks remains below its limit. Nor can average portfolio risk exceed the individual bound, by convexity of the portfolio-risk norm. This rules out a finite-price equilibrium for $Q \ge \bar{\nu}$. □

A.2 Derivative identities

Define the local concession as a function of average holdings, $F(x, y) = [\varkappa(Q)\Sigma\mathbf{q}]_L$. Introduce

$$s = (x^2 + 2\rho xy + y^2)^{1/2}, \quad u = x + \rho y, \quad v = y + \rho x, \quad b = \frac{\sigma}{\bar{\nu}}, \quad z = bs = \frac{Q}{\bar{\nu}}.$$

In the partially constrained region $1/2 < z < 1$, let

$$C = \frac{\bar{\nu}\sigma}{2}, \qquad f(s) = \frac{1}{s(1 - bs)}.$$

Then $F(x, y) = Cuf(s)$, with b held fixed when differentiating in x, y. Since $s_x = u/s$ and $s_y = v/s$, direct differentiation gives

$$F_x = C\left[f + \frac{u^2}{s}f'\right] > 0, \tag{15}$$

$$F_y = C\left[\rho f + \frac{uv}{s}f'\right] > 0, \tag{16}$$

$$F_{xx} = C\left[\frac{3u}{s}f' + \frac{u^3}{s^2}\left(f'' - \frac{f'}{s}\right)\right] > 0, \tag{17}$$

$$F_{xy} = C\left[\frac{v + 2\rho u}{s} f' + \frac{u^2 v}{s^2}\left(f'' - \frac{f'}{s}\right)\right] > 0. \tag{18}$$

The signs follow from $x, y > 0$, $\rho \geq 0$, and

$$f'(s) = \frac{2z - 1}{s^2(1 - z)^2} > 0, \qquad f''(s) - \frac{f'(s)}{s} = \frac{3 - 9z + 8z^2}{s^3(1 - z)^3} > 0. \tag{19}$$

The quadratic $8z^2 - 9z + 3$ is strictly positive because its leading coefficient is positive and its discriminant is -15. These identities show both convexity in domestic holdings and an increasing domestic-holdings slope as foreign holdings rise.

A.3 Crowding out and amplification

Proposition 2 (Crowding out)**.** *For any $x, y > 0$ in the partially constrained region,*

$$\frac{\partial \eta_L}{\partial R} > 0, \qquad \frac{\partial^2 \eta_L}{\partial L \, \partial R} > 0. \tag{20}$$

In particular, these inequalities hold for all $L, R \geq 0$ such that $\bar{\nu}/2 < Q < \bar{\nu}$, including when $\rho = 0$. In the unconstrained region $Q < \bar{\nu}/2$,

$$\frac{\partial \eta_L}{\partial R} = \frac{2\rho\sigma^2}{\chi}, \qquad \frac{\partial^2 \eta_L}{\partial L \, \partial R} = 0. \tag{21}$$

Proof. Equation (12) and the chain rule give $\eta_{L,R} = F_y/\chi$ and $\eta_{L,LR} = F_{xy}/\chi^2$, where subscripts after the comma denote differentiation in issuance deviations. The constrained signs follow from (16) and (18). In the unconstrained region $F = 2\sigma^2(x + \rho y)$, which gives (21) directly. □

In price–quantity space, unconstrained crowding out is a parallel downward shift when $\rho > 0$. With binding limits, foreign supply also steepens local inverse demand. Even at zero payoff correlation, both positions use the same portfolio-risk budget, so a binding constraint transmits issuance pressure across markets.

Proposition 3 (Tighter limits and higher volatility)**.** *Let $B = \partial^2 \eta_L/(\partial L \, \partial R)$. Holding supplies, χ, ρ, and normal issuance fixed, throughout the partially constrained region,*

$$\frac{\partial B}{\partial \bar{\nu}} < 0, \qquad \frac{\partial B}{\partial \sigma} > 0. \tag{22}$$

The volatility comparison changes the common payoff standard deviation of both bonds.

Proof. Define two positive constants, independent of $\sigma, \bar{\nu}$,

$$A_1 = \frac{v + 2\rho u}{s^2}, \qquad A_2 = \frac{u^2 v}{s^4},$$

and two scalar functions

$$h_1(z) = \frac{2z-1}{z(1-z)^2}, \qquad h_2(z) = \frac{3-9z+8z^2}{z(1-z)^3}.$$

Substituting (19) into (18) gives

$$B = \frac{\sigma^2}{2\chi^2} H(z), \qquad H(z) = A_1 h_1(z) + A_2 h_2(z), \qquad z = \frac{\sigma s}{\bar{\nu}}. \tag{23}$$

Both h_1, h_2 are positive for $1/2 < z < 1$. Moreover,

$$h_1'(z) = \frac{4z^2-3z+1}{z^2(1-z)^3} > 0,$$
$$h_2'(z) = \frac{16z^3-19z^2+12z-3}{z^2(1-z)^4} > 0.$$

The first numerator has negative discriminant. For the second, setting $w = z - 1/2 > 0$ rewrites its numerator as $16w^3 + 5w^2 + 5w + 1/4 > 0$. Thus $H, H' > 0$, and differentiating (23) gives

$$\frac{\partial B}{\partial \bar{\nu}} = -\frac{\sigma^2 z}{2\chi^2 \bar{\nu}} H'(z) < 0, \qquad \frac{\partial B}{\partial \sigma} = \frac{\sigma}{2\chi^2} \left[2H(z) + zH'(z)\right] > 0.$$

□

A.4 Crowding in beyond normal issuance

Proposition 4 (Crowding in for nonnegative issuance deviations)**.** *For every $L, R \geq 0$ with $Q < \bar{\nu}$, and away from the boundary $Q = \bar{\nu}/2$, the domestic-issuance slope is positive and decreases strictly with the share of global banks:*

$$\frac{\partial \eta_L}{\partial L} > 0, \qquad \frac{\partial^2 \eta_L}{\partial L \, \partial \chi} < 0. \tag{24}$$

The result holds in both the unconstrained and partially constrained regions; it is not restricted to $L = R = 0$. In the partially constrained region, $\partial \eta_L / \partial \chi < 0$ if at least one deviation is strictly positive, whereas this derivative is zero at $L = R = 0$.

Proof. Because $x_\chi = -L/\chi^2$ and $y_\chi = -R/\chi^2$, the chain rule gives the exact identity

$$\frac{\partial^2 \eta_L}{\partial L \, \partial \chi} = -\frac{1}{\chi^2} \left[F_x + \frac{L}{\chi} F_{xx} + \frac{R}{\chi} F_{xy} \right]. \tag{25}$$

In the partially constrained region, all three derivatives in brackets are strictly positive by (15), (17), and (18). For $L, R \geq 0$ the bracket is therefore strictly positive, proving the result. The domestic-

issuance slope is $F_x/\chi > 0$. In the unconstrained region, $F_x = 2\sigma^2$ and $F_{xx} = F_{xy} = 0$, so the cross derivative equals $-2\sigma^2/\chi^2 < 0$. Finally,

$$\frac{\partial \eta_L}{\partial \chi} = -\frac{LF_x + RF_y}{\chi^2}.$$

Its sign follows from (15)–(16). At normal issuance, $\mathbf{q} = \bar{\mathbf{s}}$ for every χ, so the concession level is independent of χ. □

Equation (25) separates two effects. A larger global bank share spreads an additional unit of local issuance across more banks, producing the term $-F_x/\chi^2$. With nonnegative issuance deviations, it also reduces the inventories held by each global bank. Convexity of the local concession and its positive cross derivative make this second effect reinforce the first. Total bank mass and the risk limit of each bank remain fixed in this comparison.

Regime boundaries and scope. The equilibrium concession and its first derivatives are continuous at $Q = \bar{v}/2$: the constrained branch has $\kappa = 2$ and $\kappa' = 0$ there. Second derivatives generally have distinct one-sided limits, so the strict derivative statements above are made within open regimes. Nevertheless, for fixed nonnegative deviations, the domestic-issuance slope decreases continuously as χ increases, including across the boundary. At $\chi = 1$, comparisons use the derivative from the left. There is no finite-price equilibrium at $Q \geq \bar{v}$; thus the global result means all *feasible* positive deviations, not arbitrarily large issuance at fixed risk capacity. When one deviation is negative, (25) remains valid but its last two terms need not reinforce the first, so the proposition does not claim a global sign on that larger domain.

A fixed-total-supply reallocation. For $L = \varepsilon$ and $R = -\varepsilon$,

$$\mathbf{q} = \bar{\mathbf{s}} + \frac{\varepsilon}{\chi}\begin{pmatrix} 1 \\ -1 \end{pmatrix}, \qquad q_L + q_R = \bar{L} + \bar{R}.$$

Total issuance and total holdings per global bank are unchanged, while increasing χ reduces the absolute portfolio adjustment required of each global bank. This accounting identity illustrates the composition channel; it does not extend Proposition 4 to arbitrary negative deviations. Locally around $\varepsilon = 0$, the response of the relative concession to the reallocation is

$$\left.\frac{\partial(\eta_L - \eta_R)}{\partial \varepsilon}\right|_{\varepsilon=0} = \frac{1}{\chi}\mathbf{e}' J(\bar{\mathbf{s}})\mathbf{e} > 0, \qquad \mathbf{e} = (1, -1)',$$

where J is the Jacobian of η with respect to $\mathbf{q}$. Indeed,

$$J = \varkappa(Q)\Sigma + \frac{\varkappa'(Q)}{Q}(\Sigma\mathbf{q})(\Sigma\mathbf{q})',$$

which is positive definite because $\varkappa > 0$, $\varkappa' \geq 0$, and Σ is positive definite. At normal issuance J is independent of χ, so greater integration strictly attenuates the local relative-price response to a fixed-total-supply reallocation.

B Data appendix

This appendix documents the sample and the variables defined in Section 2. Unless stated otherwise, every figure and the table are built on the *auction sample* of Section 2.6—domestic-currency competitive auctions of nominal fixed-rate bonds with more than three years to maturity and an offered amount above USD 50 million, January 2006 to September 1, 2025. The stock-flow validation uses every issuance channel; the primary-dealer network collection has its own coverage, described below.

B.1 Calendar characteristics

The day characteristics used in Section 3 are built once, on a grid of country × business days covering every issuer's active sample window (113,289 country-days, 24 countries). Table A2 gives the source and the unconditional incidence of each; this subsection adds the details that matter for interpreting Figure 3.

Event windows. Macro releases are dated to the release day itself. Monetary policy events (the domestic decision and the FOMC) are flagged on the decision day *and the business day before it*, because an issuer avoiding a policy meeting plausibly avoids the eve as well; the same-day-only versions are weaker but point the same way.

Macro releases. The release calendar is the Bloomberg economic calendar, which carries a relevance index $R \in [0, 100]$ for each series—the share of terminal users tracking it—together with the survey median, the number of forecasters, and the realised value. For the *domestic* release flag I take, separately for each country, the series in the top tercile of R among that country's distinct series, and flag any day on which one of them is released. A within-country rule is necessary because R is not comparable across countries: the highest-relevance Czech series is far below the lowest of the eight U.S. series used here. For the *U.S.* flag the series are instead named explicitly (because there are so many releases): CPI month-on-month and year-on-year, GDP, initial jobless claims, non-farm pay-

Table A1: The estimation sample, by country

		Sample		Auction days			Auction spread (bp)			Competing
Country	Region	Span	Days/yr	Size	Mat.	Dur.	Mean	S.d.	Scale	supply ($bn)
Advanced economies										
CAN	Americas	2006–2025	21	2.86	5.4	5.2	1.03	6.08	4.44	0.5
USA†	Americas	2006–2025	57	30.26	7.0	6.5	0.11	7.62	5.10	0.7
AUS	AsiaPac	2006–2025	63	0.63	9.5	7.6	0.06	5.02	5.12	4.5
JPN	AsiaPac	2006–2025	49	14.52	19.8	15.8	1.01	3.77	1.67	0.9
KOR	AsiaPac	2014–2024	56	1.27	10.0	9.1	0.08	4.97	3.98	3.8
NZL	AsiaPac	2006–2025	29	0.20	8.2	6.8	-3.91	17.49	4.84	3.8
SGP	AsiaPac	2006–2025	7	1.49	9.5	8.3	7.94	12.91	3.90	1.7
TWN	AsiaPac	2010–2025	17	1.01	10.0	9.4	2.04	6.52	1.90	3.8
CHE†	EMEA	2006–2025	10	NA	15.5	14.0	1.28	6.23	NA	NA
DEU	EMEA	2006–2025	32	4.42	9.9	8.9	-0.11	5.53	3.95	3.8
DNK†	EMEA	2008–2025	19	NA	9.7	8.9	2.82	4.25	NA	NA
FRA	EMEA	2006–2025	22	26.69	9.5	7.9	1.00	4.00	4.08	2.1
GBR	EMEA	2006–2025	34	4.35	10.0	8.9	3.34	6.57	4.61	3.0
ITA	EMEA	2006–2025	22	6.78	8.2	7.4	-1.87	8.88	4.85	1.6
NOR	EMEA	2006–2021	12	0.43	9.2	8.0	2.67	5.74	4.54	3.1
SWE	EMEA	2006–2025	19	0.36	9.7	8.3	0.20	3.71	4.39	4.4
Emerging markets										
BRA	Americas	2007–2025	47	1.22	4.3	3.9	9.80	14.30	13.59	0.4
CHL	Americas	2015–2025	9	0.29	9.7	7.6	1.60	16.47	4.64	1.0
MEX	Americas	2012–2024	46	0.44	9.6	6.5	-0.69	8.73	6.96	0.3
IDN	AsiaPac	2016–2024	23	1.22	11.8	7.7	-1.60	9.95	7.16	4.1
IND	AsiaPac	2013–2025	43	2.49	15.2	8.9	-3.19	8.22	4.27	2.6
MYS	AsiaPac	2016–2025	14	0.81	13.9	10.4	-5.79	9.79	2.82	4.1
THA	AsiaPac	2007–2025	28	0.52	10.2	8.6	2.80	12.30	5.14	5.1
CZE	EMEA	2006–2025	19	0.34	9.3	7.9	5.36	10.11	5.20	4.3
HUN	EMEA	2006–2025	26	0.17	6.2	5.4	-2.63	10.02	8.29	4.1
POL	EMEA	2006–2025	11	1.48	6.7	5.9	2.01	5.72	5.60	4.1
TUR†	EMEA	2006–2025	14	NA	5.0	4.5	4.95	30.37	NA	NA
ZAF	EMEA	2012–2025	44	0.19	16.5	8.7	4.38	13.31	7.79	2.8
Panel		2006–2025	25	3.60	9.8	7.9	1.21	9.84	4.84	2.9

Notes: One row per country in the estimation sample; the unit of observation is a country × auction day. *Span* is the first and last year in which the country contributes an observation and *Days/yr* the number of auction days per year over that span. *Size* is the mean offered amount on an auction day in USD billions, *Mat.* the median accepted-amount-weighted maturity in years, and *Dur.* the implied modified duration on the par-bond convention. The three auction-spread columns report the mean and standard deviation of the outcome in basis points and the country's volatility scale $\hat{\sigma}_c$ of equation (3), which is the divisor used whenever the outcome is normalised. *Competing supply* is the mean of the regional, ex-U.S., three-day competing-supply measure of equation (5) met on the country's own auction days, in USD billions. The final row pools all 10,615 country-auction days.

rolls, ADP employment, the ISM manufacturing PMI, and Conference Board consumer confidence. Each of which carries $R \geq 90$.

Monetary policy. Domestic policy dates are the Bloomberg calendar entries categorised as `policy_rate` for the issuer's own central bank, with euro-area issuers mapped to the ECB. Singapore is the one country with no such series—the Monetary Authority of Singapore targets the exchange rate band rather than a policy rate—so its domestic policy flag is missing and Singapore contributes to every row of Figure 3 except that one (4.5% of the grid). FOMC dates are a fixed list of the 163 scheduled and unscheduled decision days between 2006 and 2025, which includes the intermeeting cuts of 22 January and 8 October 2008.

Closures, bridges and thin days. A "major foreign market closed" day is one on which the bond market of the United States, the United Kingdom, Germany, Japan or France is actually shut, or closes early. The closure set is deliberately a union of three sources, because each misses days the others catch: exchange and bond-market trading calendars (SIFMA for U.S. Treasuries, the London Stock Exchange for gilts, the Japan Exchange for JGBs—which alone carries the 31 December–3 January year-end break—and Eurex for Bunds), national and financial-centre public holidays (Hesse for Frankfurt, for instance, since desks observe German Unity Day even though Eurex trades it), and TARGET2 settlement closures for euro members.

The separate "bridge or thin day" flag is everything the soft closure definition adds to that hard set. It contains bridge days—a Friday following a Thursday holiday, a Monday preceding a Tuesday holiday, or a working day with a holiday on either side—and days on which the U.S. market is open but empty: the 26–31 December year-end stub that is not already a SIFMA closure or early close, and Rosh Hashanah and Yom Kippur. As Section 3 notes, the issuer's *own* bridge days turn out to be a weekday effect in disguise, since the construction only ever fires on a Monday, a Friday, or a sandwiched day.

U.S. auction days. These come from the paper's own issuance data: domestic-currency competitive auctions of nominal bonds above three years and above USD 50 million. The threshold matters. Including bills and short notes puts the United States in the market on 61.5% of business days rather than 22.3%, at which point distance to the nearest U.S. auction stops discriminating between days at all.

B.2 Auction yield spreads: construction and validation

This appendix provides the construction and validation record for the auction yield spread defined in Section 2.3. It documents the reference curve and cash-flow pricing, the country convention registry, the external price-inversion check, and the remaining measurement limits. Table A3 summarises the country-level evidence.

Table A2: Calendar characteristics: source and construction

Characteristic	Window	Rate	Source and construction
Tuesday–Thursday	day	60.0%	Calendar weekday.
Major foreign market closed	day	15.5%	Actual full closures and early closes in USA, GBR, DEU, JPN or FRA. `pandas_market_calendars` (SIFMA_US, XLON, JPX, EUREX) ∪ national/financial-centre holidays (`holidays` package) ∪ TARGET2 for euro members.
Global bridge or thin day	day	4.5%	Bridge days around those closures (Friday after a Thursday holiday, Monday before a Tuesday holiday, a working day with a holiday on each side), plus US thin sessions: the 26–31 December stub not already a SIFMA closure or early close, and Rosh Hashanah and Yom Kippur.
Domestic monetary policy event	t or $t-1$	5.8%	Bloomberg economic calendar, category `policy_rate`, for the issuer's own central bank; euro-area issuers are mapped to the ECB.
Major domestic macro release	day	16.0%	Bloomberg economic calendar, domestic country, series in the top tercile of the Bloomberg relevance index R across that country's distinct series.
FOMC decision	t or $t-1$	6.2%	Scheduled and unscheduled FOMC decision days, 2006–2025 (163 dates), including the January and October 2008 intermeeting cuts.
Major U.S. macro release	day	26.5%	Eight Bloomberg series, each with relevance $R \geq 90$: CPI MoM and YoY, GDP QoQ, initial jobless claims, non-farm payrolls, ADP employment, ISM manufacturing PMI, Conference Board consumer confidence.
U.S. auction	day	22.4%	U.S. competitive auctions from the paper's own issuance data, filtered to the same segment as the sample.

Notes: Window is the set of days on which the characteristic is flagged relative to the day t being classified. *Rate* is the unconditional incidence on the country × business-day grid (113,289 country-days, 24 countries, 2006–2025); it is not the same object as the base rate printed in the row labels of Figure 3, which is the mean incidence under the same-month randomisation and is therefore weighted towards the months and countries that actually auction. Sources: Bloomberg economic calendar for macro releases and monetary policy dates; `pandas_market_calendars` and the `holidays` Python package, plus TARGET2, for closures; the paper's own issuance data for U.S. auction days. The domestic monetary policy row is missing for Singapore (4.5% of the grid), which has no policy-rate series.

Reference curve and exact cash flows. The reference leg uses LSEG/Refinitiv par curves, quoted annually at up to 38 tenors per country and date. For each auction, the curve from the prior trading day is bootstrapped to a discount function. Nodes shorter than one year are used directly; beyond one year the curve is bootstrapped forward on an annual grid, imposing $D(0) = 1$, and $\ln D$ is interpolated linearly between nodes. On a flat input curve, this procedure reproduces the input to 0.00 basis points in all 2,700 test cells.

The auctioned bond's cash-flow schedule is generated from the country registry's coupon frequency, settlement convention, and ex-dividend rule, and equation (26) is inverted numerically for the semiannual yield to maturity. An auction is priced only when the preceding curve has at least four

tenors and covers the bond's final cash flow; 2,164 of 25,679 auctions in scope fail one of these conditions. Six countries have ex-dividend periods; the next coupon is excluded whenever settlement lies inside the relevant window. The adjustment is economically tiny, but it keeps the cash-flow and price calculations internally consistent. Points beyond the longest quoted tenor are extrapolated flat. The extrapolated share and the associated caveat for Canada, New Zealand, and South Africa are reported in Table A3.

For auction i of country c on date t, let $\{CF_{i,k}, \tau_k\}$ denote the auctioned bond's remaining cash flows and their timing from settlement, and let $D_{c,t-1}(\cdot)$ be the discount function bootstrapped from the country curve at the previous close. The reference yield is the semiannually compounded yield to maturity that prices those cash flows:

$$\sum_k \frac{CF_{i,k}}{\left(1 + y^{\text{ref}}_{i,c,t}/2\right)^{2\tau_k}} = \sum_k CF_{i,k} D_{c,t-1}(\tau_k). \tag{26}$$

Harmonising the auction leg. Published auction yields use different compounding conventions. The registry records each issuer's published formula, coupon frequency, and ex-dividend convention from primary sources; these cannot be inferred from the bond's coupon frequency. For a pure annual-to-semiannual conversion, the difference is

$$y_{\text{ann}} - y_{\text{semi}} = \tfrac{1}{4} y^2 - \tfrac{1}{8} y^3 + O(y^4), \tag{27}$$

so the correction varies with the level of interest rates rather than acting as a country-fixed shift. Figure A6 verifies the exact conversion identities. Twelve countries already quote semiannually; Japan, Mexico, Brazil, and Turkey require country-specific treatment described below.

The main external check uses published auction prices, available for 10,637 auctions in fourteen countries. I invert each price under candidate compounding, coupon-frequency, and day-count conventions and compare the implied yield with the reported one. Figure A7 shows that the documented convention is consistent with the price-implied compounding family in all eleven countries for which this is a meaningful test. Median absolute errors range from 0.013 to 0.28 basis points, consistent with rounding in the reported yield. I use the test to corroborate the primary-source registry rather than selecting a convention mechanically: in countries where rival conventions are numerically indistinguishable, a threshold rule would manufacture changes in convention over time.

Four countries require more than a standard compounding identity. Japan's simple yield is converted to a price and reinverted to a semiannual yield; Mexico's 182-day quote is mapped using its documented nominal convention; and Brazil's reference curve is priced on the same BUS/252 clock as its effective annual auction yield before the two completed yield levels are mapped to the common convention. Turkey's conversion is conventional, but its 32 auction prices are unusable for external

validation. The full convention registry and these country tracks are reported in Table A3.

Why not match a traded bond? A matched traded bond would not provide a common benchmark for this exercise. It would generally differ from the auctioned security in both coupon and maturity, preserving the coupon-related wedge that exact cash-flow pricing removes. Finally, the available traded-benchmark curves are much sparser and less complete than the par curves. They typically have five to eight quoted tenors per day, rather than fifteen to twenty, and several country series are absent or end before the sample. Pricing the auctioned bond's own cash flows from the full curve is therefore the consistent cross-country construction. Especially for emerging markets, I often would not find a reference on the run bond.

Settlement, levels, and event-time diagnostics. The reference curve is selected on the trading day before the auction and discounting begins at settlement. Eighteen countries publish settlement dates for every auction, Denmark for 52%, and the United Kingdom for 6%; seven countries publish none, in which case the auction date is used. Appendix Figure A9 reports the distribution of settlement lags and the sensitivity of mean spreads to alternative reference dates for the references yields. The latter is modest, indicating that cross-country mean differences are persistent levels rather than concessions that accumulate as an auction approaches.

Appendix Figures A10 and A11 show that the bond-specific reference yield and an independently sourced traded ten-year benchmark share the expected auction-cycle dynamics, firstly documented by Lou et al. (2013).

Outcome scaling and outliers. The baseline divides the raw spread by the fixed country-level scale in equation (3). The scale is estimated from a robust 20-business-day change in the traded generic ten-year yield, rather than from a rolling or maturity-matched divisor: the latter can move with the volatility regime or with the issuer's maturity choice. Raw-basis-point and alternative-scale results are reported in Appendix D. Outliers are flagged only after the complete spread is constructed. The baseline excludes observations more than three country-specific standard deviations from the mean (1.55% of priced auctions); the winsorised and untrimmed alternatives produce the reported robustness results.

Why the primary outcome is the auction yield spread. The auction yield spread is preferred to the bid-to-cover ratio for three reasons. First, bid-to-cover is total submitted bids divided by accepted auction volume. Since accepted volume is the issuance amount itself, regressing bid-to-cover on issuance amount places a right-hand-side quantity mechanically in the denominator of the outcome, inducing a negative relationship even without a demand effect.

Second, participation rules differ across auction systems for reasons unrelated to underlying demand. In France and the United Kingdom, primary dealers—*Spécialistes en Valeurs du Trésor* and Gilt-Edged Market Makers—must submit bids representing a minimum share of an auction. A low bid-to-cover ratio can therefore reflect the size of the dealer network or a binding participation requirement rather than weak investor demand. Conversely, U.S. primary dealers must participate but face no floor on the yield they can quote, so they can effectively opt out through prohibitively wide bids. In that setting, the clearing-yield concession registers weak demand while bid-to-cover can remain mechanically high.

Third, the yield spread directly captures the price at which the government sells the bond relative to the prevailing curve. Bid-to-cover records submitted quantity but not the price at which that demand is available—the margin on which the paper's crowding-out mechanism operates.

B.3 Primary-dealer networks

The historical collection covers comparable sovereign bond dealer programmes in 24 markets, including Denmark and Turkey; Australia, New Zealand, and Chile have no comparable dealer list in the collection, and Switzerland enters as a headquarters country but has no primary dealer list as an issuer. Sources include debt management offices, central banks, archived official lists, and supplementary industry sources. Dealer names are harmonized to parent banking groups and their headquarters countries. A seat is one group on one market's dealer list; a foreign country link connects an issuer to a headquarters country represented on its dealer list. Observations use the latest dealer list dated strictly preceding the reference date, with no backfilling before the first available list. National dealer mandates, source quality, and historical coverage differ, so primary dealer status measures intermediation links rather than auction allocations or ultimate investor holdings.

For Figure A17, a headquarters country qualifies as a hub in a given year if at least one of its banking groups appears on at least 20% of the observed dealer lists. Among countries in the auction dataset, the six meeting this criterion in a majority of the annual snapshots are the United States, United Kingdom, France, Germany, Japan (all years), and Switzerland (2006–2019). Canada qualifies only in 2013–2019 and Sweden only in 2007. The figure holds this six-country set fixed. Its stable aggregate share need not imply stable bilateral links, and carrying lists forward can itself smooth the series.

To assess the information lost between snapshots, I thin the more complete histories of Brazil, Italy, Mexico, and the United States to observations at least five years apart and compare the carried-forward list with the omitted source lists (Table A4). The average overlap of foreign headquarters-country sets is 0.91, measured by the intersection divided by the union of the reconstructed and observed sets. This supports using intermittent snapshots to approximate country links in these markets, while the firm-level overlap and dealer-count errors show that membership still changes. These four

Table A3: Auction yield spread: conventions, harmonisation and validation by country

Country	N	Quoted basis	Harmonisation		Price validation		Sample			
			$\overline{\Delta}$ (bp)	ratio to $y^2/4$	fit (bp)	margin (×)	settle (%)	extrap. (%)	$\overline{\eta}$ (bp)	MAD (bp)
Advanced economies										
DEU	739	Annual (ICMA)	-0.94	0.986	0.232	1.1	0	8.9	-0.10	2.3
DNK	399	Annual (ICMA)	-0.48	0.989	0.220	1.2	52	3.9	2.07	2.3
FRA	1,237	Annual (ICMA)	-1.30	0.984	0.228	1.3	100	4.3	0.70	2.4
CHE	287	Annual compound	-0.36	0.989	0.016	3.7	100	5.8	1.28	3.2
ITA	1,157	Annual compound	-2.60	0.980	0.233	9.7	100	2.8	-1.45	5.4
NOR	333	Annual compound	-2.08	0.983	0.183	2.1	100	9.0	2.39	3.0
SWE	550	Annual compound	-1.03	0.985	–	–	0	3.0	-0.08	2.2
TWN	282	Annual compound	-0.54	0.991	–	–	100	10.7	2.08	2.9
AUS	1,336	Semiannual	≡ 0	–	–	–	100	2.5	-0.00	3.2
CAN	695	Semiannual	≡ 0	–	0.046	2.6	100	11.9	1.14	2.9
GBR	781	Semiannual	≡ 0	–	0.032	4.4	6	2.8	3.74	3.2
KOR	845	Semiannual	≡ 0	–	–	–	0	0.6	-0.22	2.8
NZL	1,345	Semiannual	≡ 0	–	–	–	0	12.8	-2.95	3.9
SGP	173	Semiannual	≡ 0	–	0.013	26.1	100	2.3	6.70	5.7
USA	1,400	Semiannual	≡ 0	–	–	–	100	5.0	0.16	3.0
JPN	1,209	Simple	0.52	–	0.082	1.1	100	0.7	1.01	1.5
Emerging markets										
MEX	629	182-day	2.53	–	3.704	2.0	100	2.9	-0.73	4.5
CZE	759	Annual (ICMA)	-2.44	0.980	–	–	0	0.0	4.19	4.1
HUN	1,479	Annual (ICMA)	-7.99	0.965	0.278	1.7	100	2.5	-2.05	5.9
CHL	180	Annual compound	-6.89	0.973	–	–	0	17.8	-1.17	8.7
POL	622	Annual compound	-5.36	0.974	0.025	18.4	100	8.6	1.22	3.9
TUR	33	Annual compound	-16.10	0.959	351.054	1.2	0	3.0	7.85	14.5
BRA	2,759	Eff. ann., BUS/252	-30.57	–	–	–	100	11.0	8.46	8.5
IDN	885	Semiannual	≡ 0	–	–	–	100	3.5	-3.44	8.0
IND	1,541	Semiannual	≡ 0	–	0.067	2.9	100	3.3	-2.87	4.6
MYS	139	Semiannual	≡ 0	–	0.049	3.9	0	2.9	-5.20	4.9
THA	653	Semiannual	≡ 0	–	–	–	100	3.8	2.74	6.6
ZAF	2,428	Semiannual	≡ 0	–	–	–	100	13.0	2.27	5.9

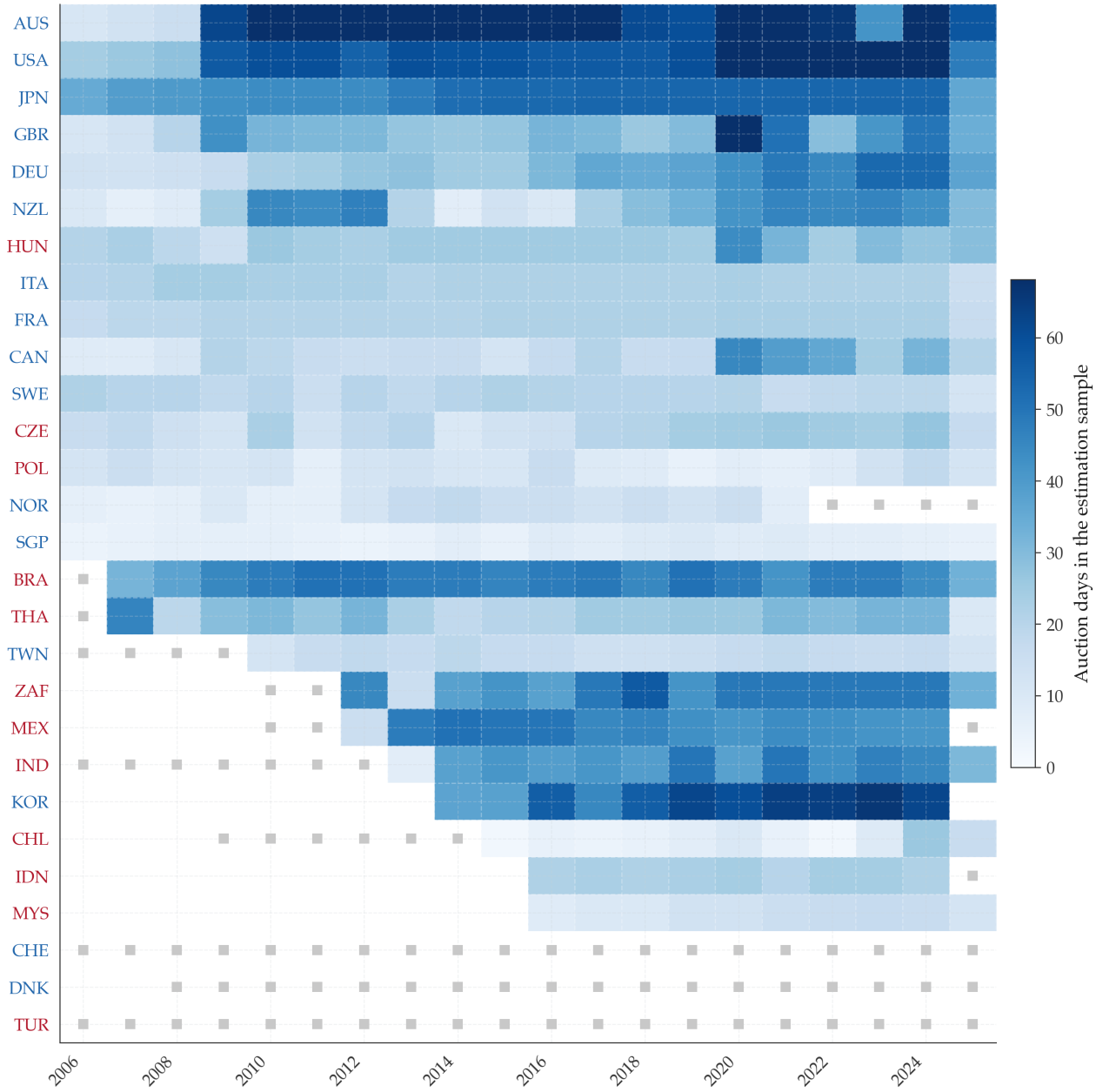
Notes: One row per country in the constructed spread panel. N is the number of priced auctions. *Quoted basis* is the country's documented convention for the published auction yield, taken from the issuer's or debt management office's own auction formula; every country in the table is sourced primary or official. $\overline{\Delta}$ is the mean adjustment harmonisation makes to the paid yield, in basis points, and *ratio* is $|\overline{\Delta}|$ divided by $\mathbb{E}[y^2]/4$, which equals one up to the third-order term of equation (27); both are undefined for the twelve countries already quoting semiannually, whose adjustment is identically zero, and for the three countries whose conversion is not a compounding identity (Japan, Mexico, Brazil). *Fit* and *margin* are the price-inversion test of Figure A7: the median absolute error of the documented convention in basis points, and the factor by which it beats the nearest candidate from a different compounding family; both are missing for countries that publish no auction price. Turkey's 32 auctions carry unusable prices. *Settle* is the share of auctions for which the source publishes a settlement date; where it is missing the auction date is used. *Extrap.* is the share of auctions whose bond matures beyond the longest quoted tenor of the country's yield curve. $\overline{\eta}$ and *MAD* are the mean and the median absolute deviation of the harmonised spread in basis points.

Table A4: Recovering Dealer Networks from Five-Year Snapshots

Market	Source lists	Retained lists	HQ-country overlap	Banking-group overlap	Dealer-count error (%)
Brazil	40	4	0.76	0.70	6.3
Italy	19	4	0.98	0.70	7.7
Mexico	70	3	0.93	0.94	3.2
United States	19	4	0.97	0.83	9.3

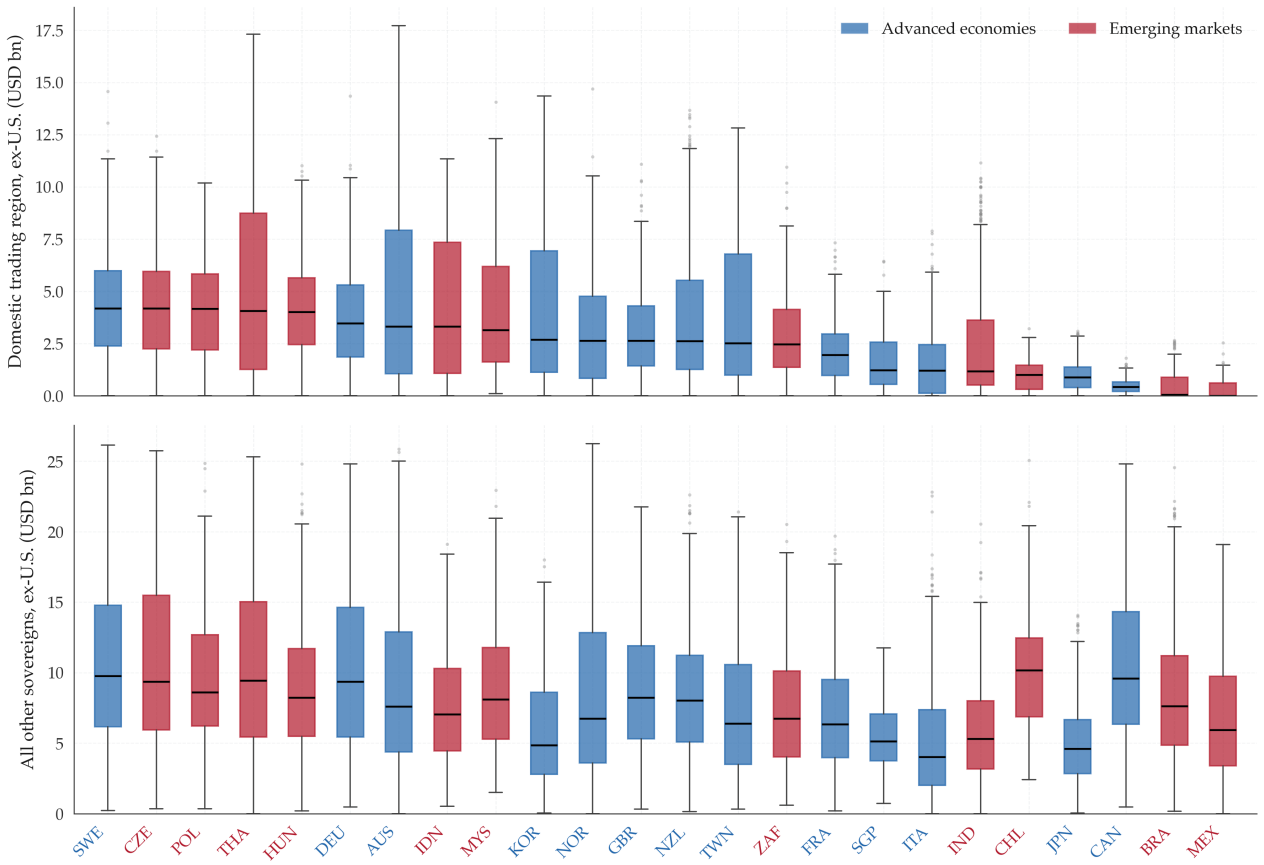
Notes: Comparable bond-programme dealer lists dated from January 2006 to 1 September 2025. Starting with the first available list in each market, retain the next list at least five years after the last retained date. Evaluate only omitted source dates, carrying forward the latest retained list. Overlap is the Jaccard index (one denotes identical sets); the headquarters-country measure excludes domestic groups' headquarters, while the banking-group measure includes all groups. Dealer-count error is the absolute difference in group counts divided by the observed count. Entries average over omitted source dates within each market; the average in the text weights the four markets equally. Markets qualify with at least twelve source lists in this period. Comparisons validate reconstruction of recorded lists, not the underlying source records themselves.

markets are not a random sample; the exercise neither establishes the same accuracy elsewhere nor detects changes between the original source dates.



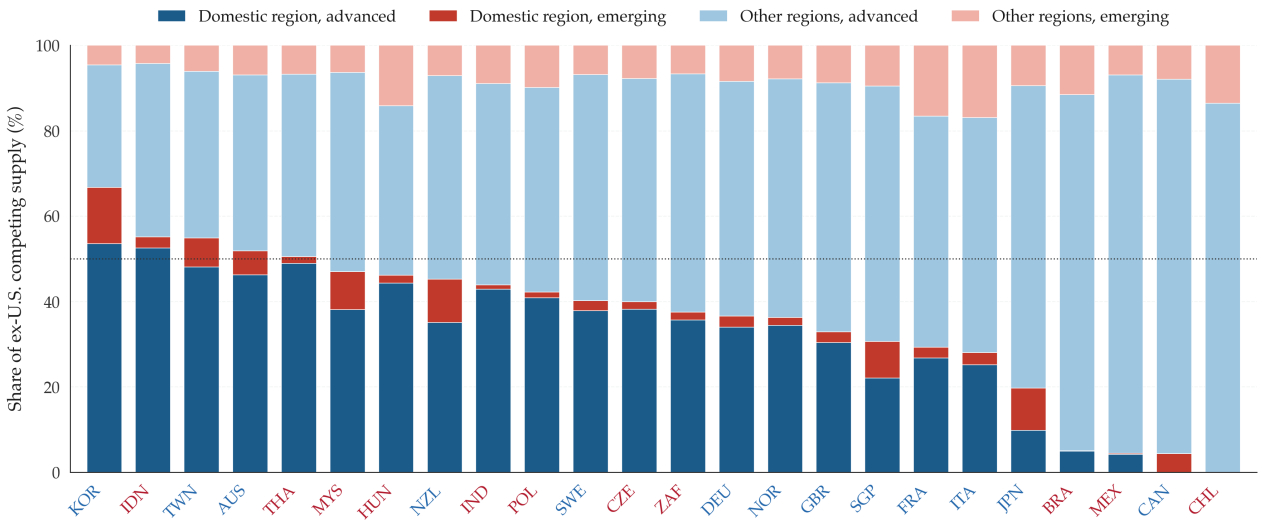
Notes: Number of auction days per country and calendar year in the estimation sample. Grey squares mark country-years in which the country holds auctions in the raw auction sample but contributes nothing to the estimation sample, either because no auction yield could be constructed (Chile) or because the source reports no auction-level offered amount (Switzerland, Denmark, Turkey throughout, and Norway from 2022); an empty cell means the country holds no qualifying auction that year. Countries are ordered by their first year in the estimation sample. Advanced economies are labelled in blue, emerging markets in red. The panel is markedly unbalanced: Korea, Indonesia, Malaysia, Mexico, South Africa and India enter well after 2006, which is why every specification carries country and year-month fixed effects and why the aggregate issuance series in Figure 2 should not be read as global debt dynamics. Norway is the one country that leaves the panel mid-sample. This is a reporting change, not a change in Norwegian issuance: Norway auctions more often after 2021, not less, and its accepted amounts and auction yields are complete throughout, but the *offered* amount stops being reported—coverage falls from 100% through 2020 to 45% in 2021 and to essentially zero from 2022. Because domestic issuance size enters as the announced rather than the accepted amount (Section 2.4), Norway drops out as a domestic issuer from 2022 while remaining in every other country's competing supply measure, which is built from accepted amounts.

Figure A1: Coverage of the estimation sample



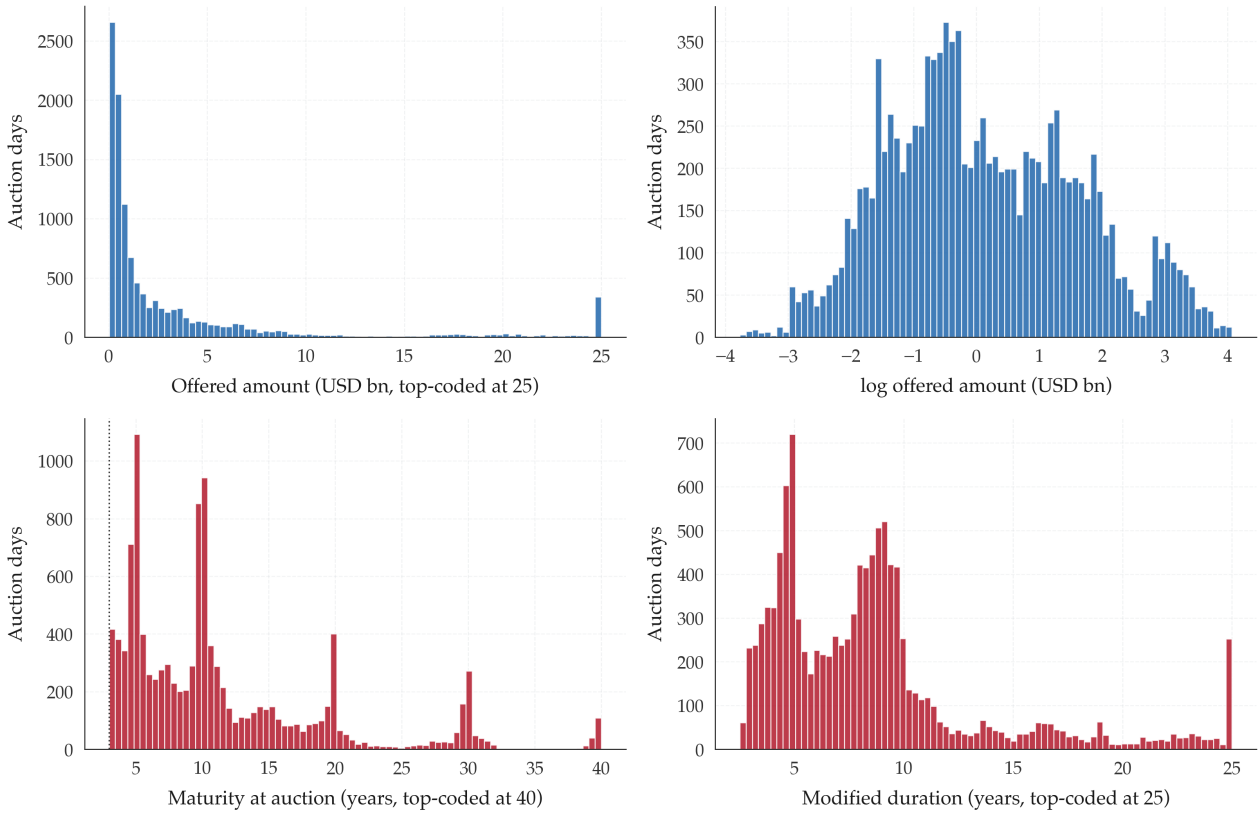
Notes: Distribution, across a country's own auction days, of the competing supply it meets. Panel (a) is the headline measure: the leave-one-out sum of accepted issuance by the domestic issuer's trading-region partners excluding the United States, averaged over the three business days centred on the auction. Panel (b) is the same object summed over all other sovereigns ex-U.S. Both are in USD billions and both are shown before the country-demeaning and standardisation that the regressions apply. Boxes span the interquartile range with the median marked, whiskers extend to the adjacent values, and dots are outliers. Countries are ordered by the median of panel (a); advanced economies are blue, emerging markets red. Two features matter for the analysis. First, the within-country dispersion is very large: the median country's tenth and ninetieth percentiles of regional competing supply are USD 0.6 and 7.4 billion, a factor of fifteen, and the median within-country coefficient of variation is 0.73. Second, the regional measure is thin for Canada, Mexico and Brazil, whose region contains only two partners each once the United States is removed; those three countries carry little identification of the regional effect.

Figure A2: Competing supply met on domestic auction days



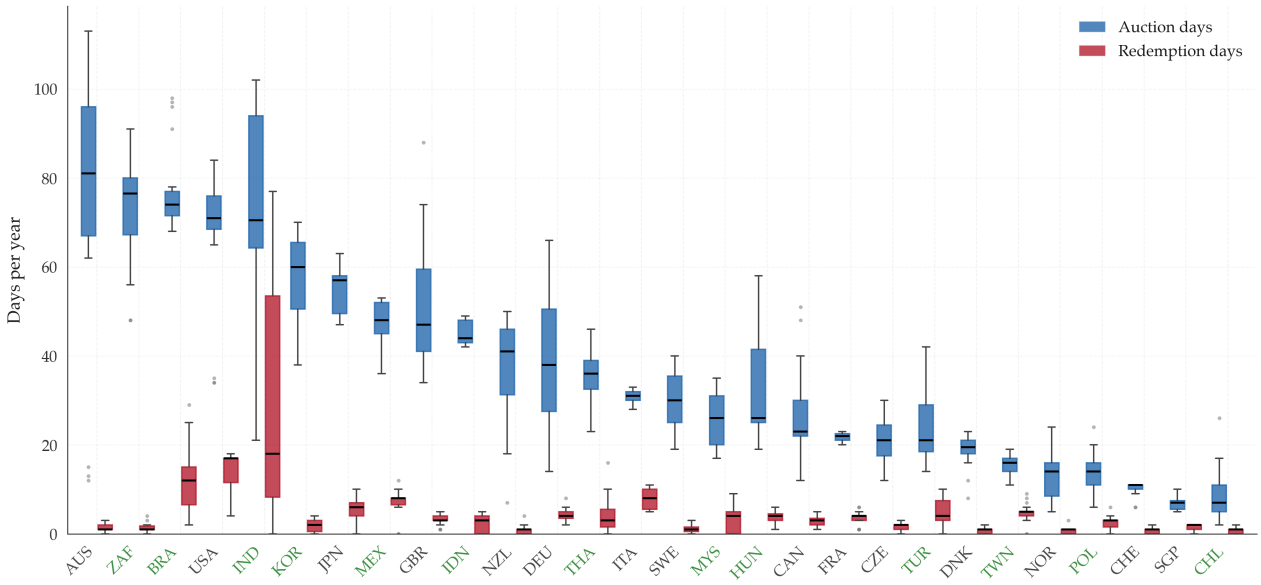
Notes: Decomposition of ex-U.S. competing supply by origin, averaged over each domestic country's own auction days. Bars sum to 100% and split the three-day leave-one-out sum into supply from the domestic issuer's trading region and from other regions, each further split into advanced and emerging issuers. Countries are ordered by the domestic-region share. The median domestic-region share is 39%, ranging from 4% for Mexico—whose region is Canada and Brazil only—to 68% for Korea. This is the measurement argument for the regional variable: the conventional global ex-U.S. aggregate loads a majority of its weight on issuance that is absorbed in a different trading session, so it is a diluted proxy for the supply that actually competes with a given auction, and the dilution is worst precisely for the smaller issuers.

Figure A3: Where competing supply comes from



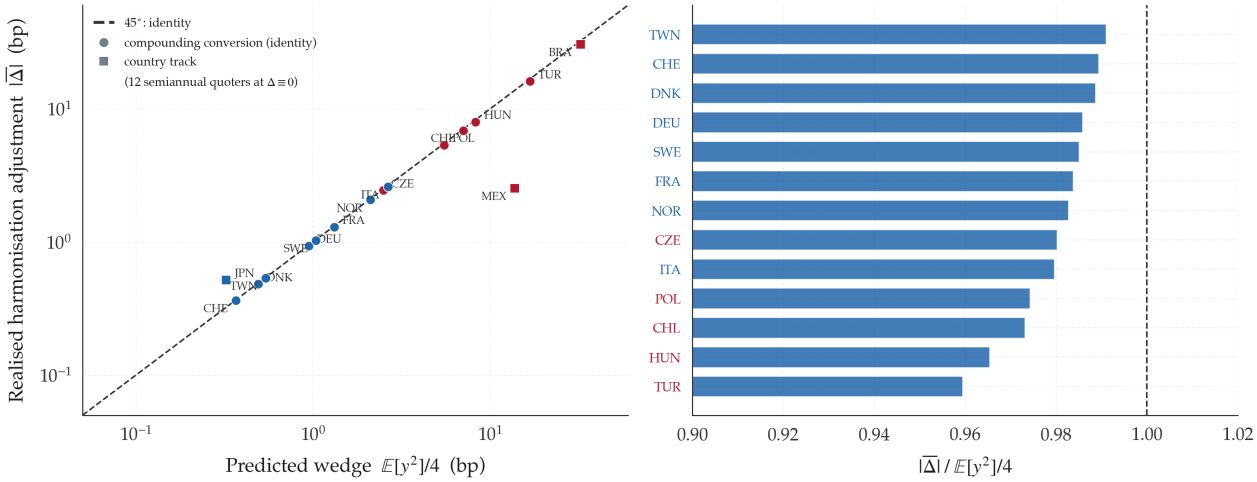
Notes: Distributions across the 10,615 country-auction days of the estimation sample. Panel (a) offered amount in USD billions, top-coded at 25; panel (b) its natural logarithm; panel (c) accepted-amount-weighted maturity in years, top-coded at 40, with the three-year sample threshold marked; panel (d) the implied modified duration on the par-bond convention, top-coded at 25. The level distribution of offered amounts has skewness 3.4 against 0.31 in logs, which is why domestic issuance enters in logs throughout. The maturity distribution is not smooth: mass concentrates at the 5-, 10-, 20- and 30-year benchmark tenors, and the gap between median maturity (9.7 years) and median duration (7.8 years) is the wedge that matters when basis points are converted into money in Section 5.

Figure A4: Auction size, maturity and duration



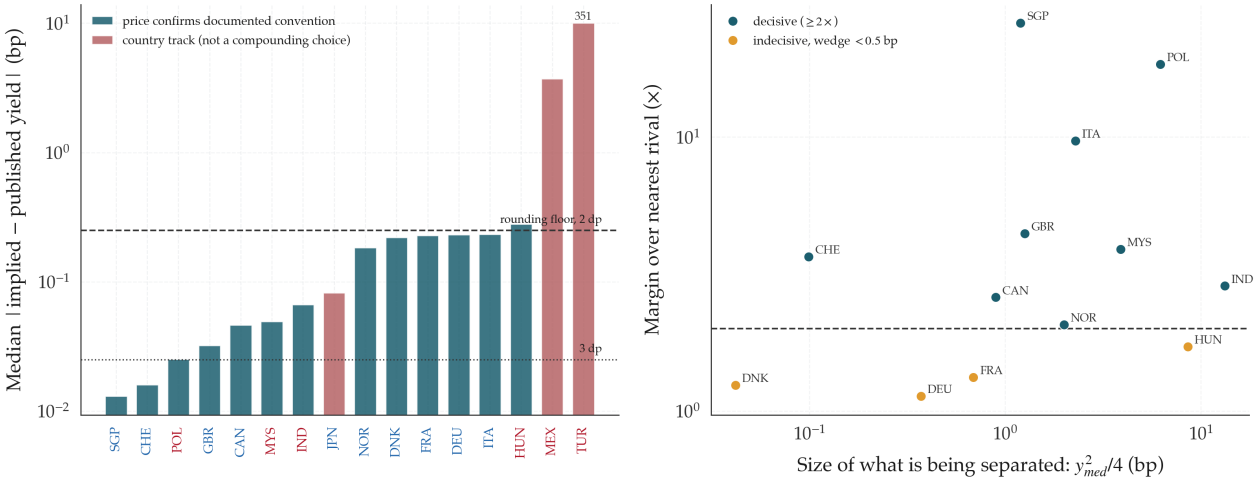
Notes: Box plots of the number of auction days (blue) and redemption days (red) per calendar year, by country, 2006–2025. Both series are restricted to the above-three-year segment: auction days are days with competitive auction proceeds above USD 50 million, redemption days are days on which domestic-currency bonds mature. Boxes span the interquartile range with the median marked, whiskers extend to the adjacent values, and dots denote outlier years; country-years with fewer than 240 covered trading days are dropped so that entry and exit years do not enter as low counts. Countries are ordered by median auction frequency and all 28 countries of the full dataset are shown, not only the 23 in the estimation sample; emerging markets are labelled in green. Median auction frequency ranges from about 80 days a year for the most active sovereigns (Australia, South Africa, Brazil, the United States) to fewer than ten for the least active (Chile, Singapore, Switzerland). Redemption days are far sparser — a median of three a year against 30 auction days — because debt matures in infrequent, lumpy blocks. That contrast is what makes rollover obligations a candidate instrument for issuance: they are large, they are known years in advance, and they arrive on a schedule that has nothing to do with the market conditions on the day the bond is finally rolled.

Figure A5: Frequency of auction and redemption days by country



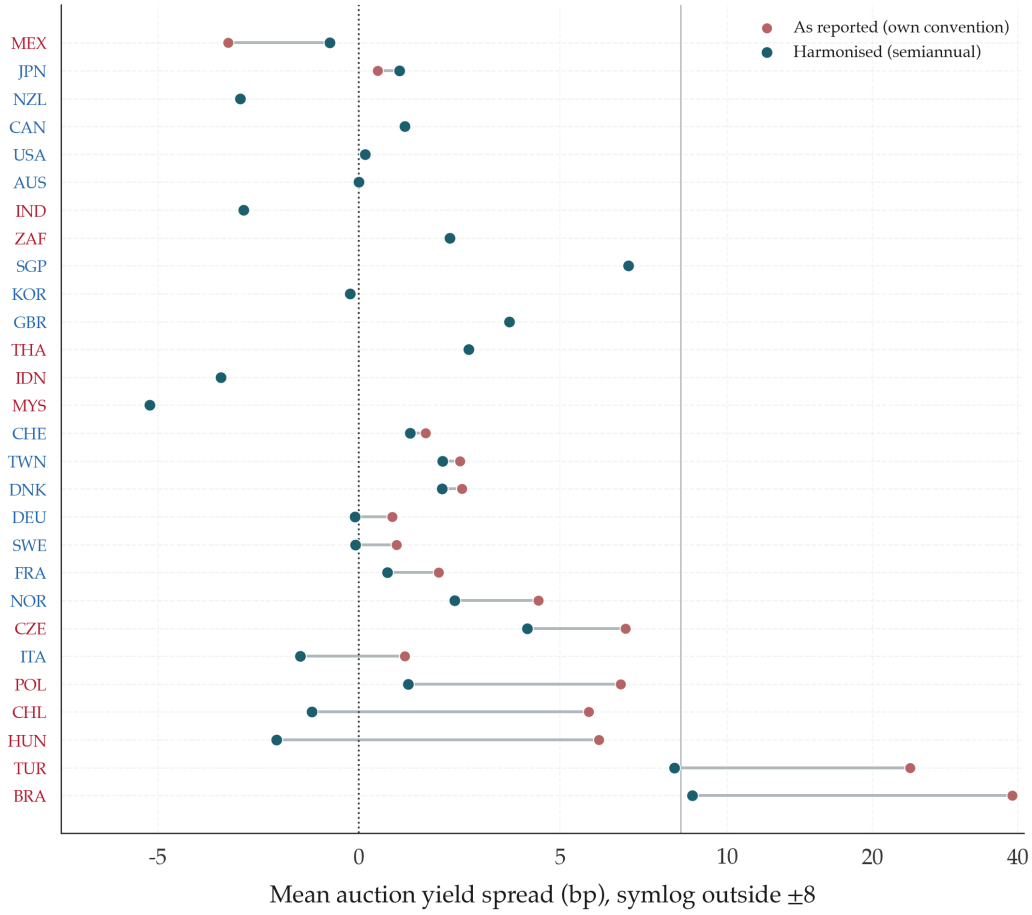
Notes: For each country requiring a pure compounding conversion, Panel (a) compares the mean realised adjustment with the leading term $\mathbb{E}[y^2]/4$ from equation (27); Panel (b) reports their ratio. The twelve semiannual quoters have a zero adjustment and are omitted. Japan, Mexico, and Brazil follow country-specific conversion tracks rather than a pure compounding identity. Country labels distinguish advanced and emerging economies.

Figure A6: The harmonisation adjustment is an identity, not a fitted correction



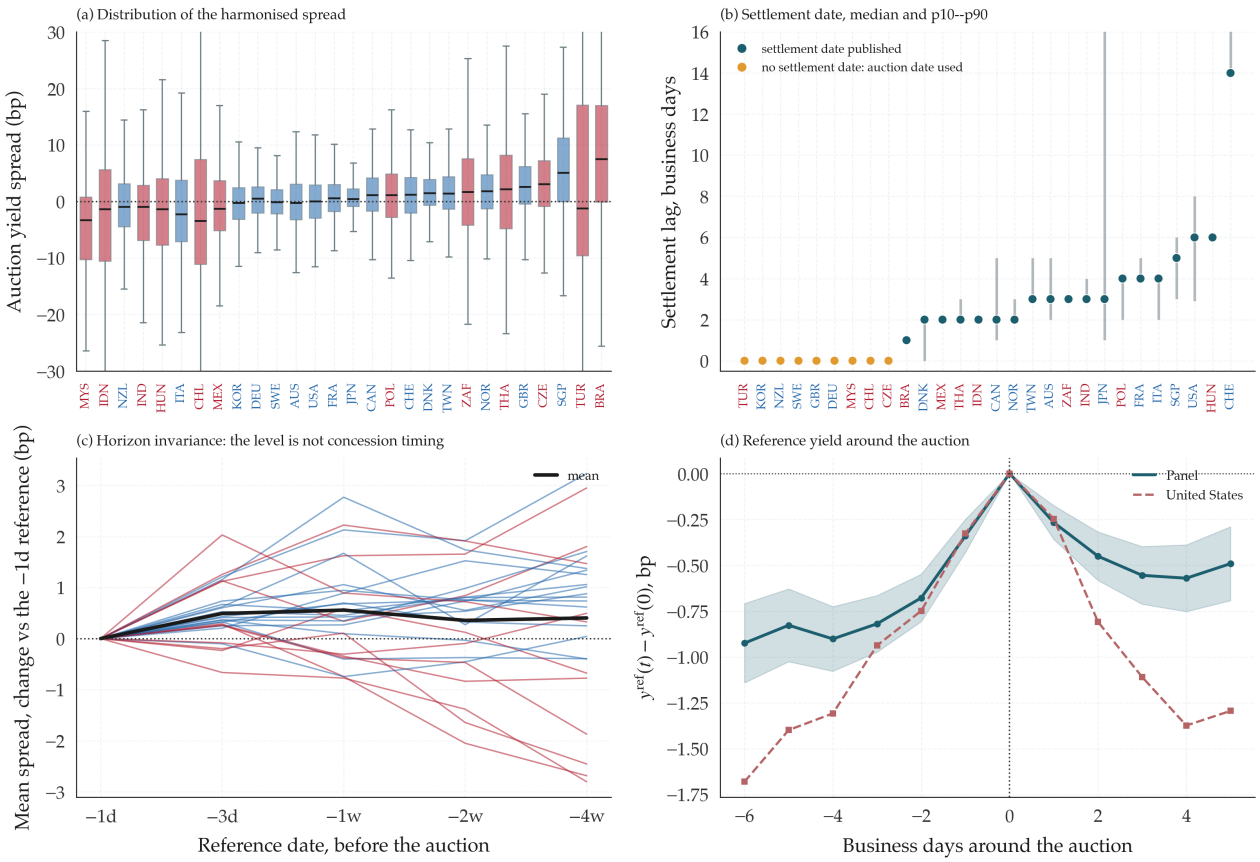
Notes: Published auction prices are inverted under candidate conventions and the implied yields compared with reported auction yields. Panel (a) reports the median absolute error of the documented convention; Panel (b) reports the margin by which it beats the nearest convention from a different compounding family. The test uses the fourteen countries and 10,637 auctions for which prices are available.

Figure A7: External validation: inverting the published auction price



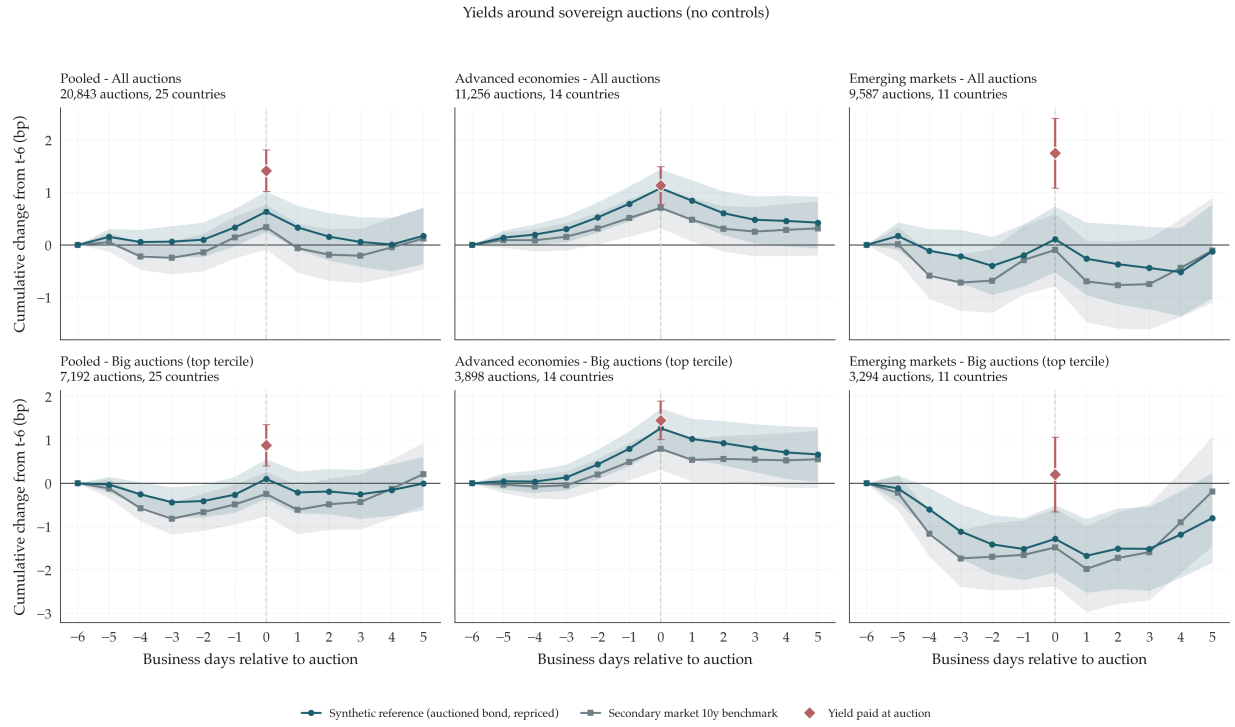
Notes: Mean auction yield spreads by country before and after harmonising the published auction yield to the common semiannual convention. Countries are ordered by the size of the adjustment; the horizontal scale is linear near zero and logarithmic in the tails.

Figure A8: Auction yield spreads before and after harmonisation



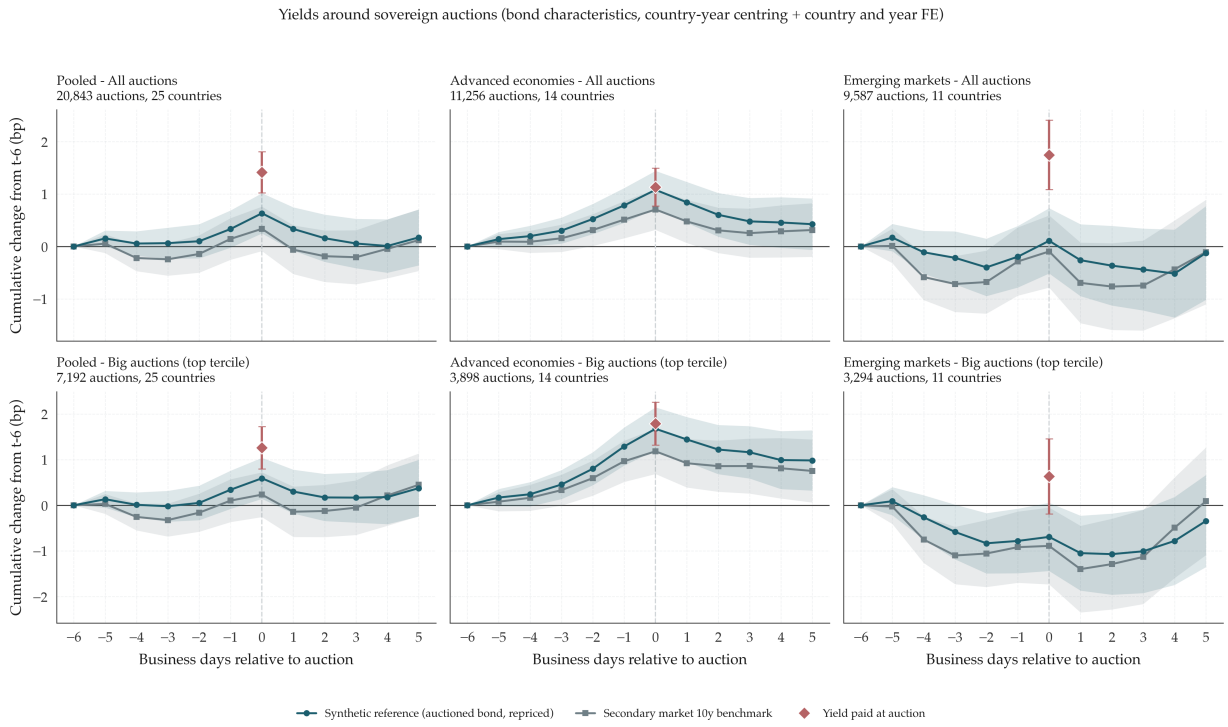
Notes: Panel (a): distribution of the harmonised auction yield spread by country, boxes at the quartiles and whiskers at the 5th and 95th percentiles, outliers suppressed, vertical axis truncated at ±30 basis points. Countries are ordered by their mean. Panel (b): median and 10th–90th percentile of the lag between the auction date and the settlement date, in business days. Countries in orange publish no settlement date and are assigned the auction date; Switzerland's long lag is a genuine deferred settlement of its late-November auctions in early January. Panel (c): the mean spread computed against a reference yield taken 1, 3, 5, 10 and 20 trading days before the auction, expressed as a change from the baseline one-day reference, one line per country. The mean line is flat: the average country mean moves 1.6 basis points across the whole range and no country moves more than 3.2, so the level of the spread is not a concession that accumulates as the auction approaches. Panel (d): the reference yield of the auctioned bond around its own auction, $y^{\text{ref}}(t) - y^{\text{ref}}(0)$ in basis points, holding the bond and the settlement date fixed so that movement isolates the curve at that bond's maturity point. Shading is a 95% confidence band. The inverted V of Lou et al. (2013) is present: +0.56 basis points over the five days before the auction and −0.48 over the five after, with panel t-statistics of 8 to 10 on the pre-auction leg. In all panels country labels are coloured blue for advanced economies and red for emerging markets.

Figure A9: Auction yield spread: distribution, settlement, and reference-yield dynamics



Notes: Cumulative yield changes in basis points from $t-6$ business days, on the balanced window of 20,823 auctions in 25 countries for which both yield legs are observed on every day from $t-6$ to $t+5$. Blue: the reference yield y^{ref} of equation (26), the auctioned bond's own cash flows repriced off the country's par curve each day, holding the instrument and the settlement date fixed. Grey: the country's traded ten-year benchmark yield, as of the same business-day grid, a fixed curve point common to every auction in a country and constructed from data that enters no part of η. Red diamond at $h=0$: the harmonised paid yield $\tilde{y}^{\text{auc}}$, plotted against the same $t-6$ base as the blue path, so its vertical distance to the blue line at $h=0$ is the auction yield spread measured against the auction-day close and its distance to the blue line at $h=-1$ is η itself. Bands and whiskers are 95% confidence intervals from a 500-draw block bootstrap over auction dates. Columns split the panel into all countries, advanced economies and emerging markets; the lower row keeps only auctions in the top tercile of log offered USD within country and calendar year. Rows share a vertical axis. The upper-left panel is the multi-country analogue of Figure 1 of Lou et al. (2013).

Figure A10: The auction cycle in the reference yield, the traded benchmark and the paid yield



Cumulative yield changes in bp from t-6 business days. Synthetic reference = the auctioned bond's own cash flows repriced off the sovereign par curve each day; secondary benchmark = the country's 10y on-the-run yield. Shaded bands and the auction-day whisker are 95% CIs from a block bootstrap over auction dates. Big = top tercile of log offered USD within country-year. Controls: the same three variables as deviations from their pooled country-year cell mean, plus country and calendar-year dummies. Each cut is evaluated at a typical bond for that country and year. By construction this leaves the AE and EM all-auction paths at their raw means.

Notes: As Figure A10, with the path evaluated at a common bond rather than at each cut's own average bond. For an intercept-only event-time path, additive controls and fixed effects cannot move the estimate—the fitted value at the sample's own covariate means is the sample mean—so the controls bite only through the point at which the path is evaluated. Log offered USD, maturity and maturity squared enter as deviations from their pooled country–year cell mean, together with country and calendar-year dummies, so each panel reports the path at a typical bond for that country and year. The control slope is fitted once on the full sample and then applied to each cut; fitting it inside the big-auction tercile would estimate it on truncated variation and then extrapolate back, which alone moves the advanced-economy big-auction path by two basis points and quintuples its standard error. The bootstrap is drawn over the two steps jointly. By construction this centring returns the pooled and the advanced-economy and emerging-market all-auction panels to their raw means, since the composition difference between the two groups is between-country and is absorbed by the country dummies; the informative comparisons with Figure A10 are therefore the four big-auction panels, where the largest movement anywhere on any path is 0.73 basis points. An alternative centring at the pooled sample means without fixed effects, which compares groups at a common bond by extrapolating across countries, moves no path by more than 0.28 basis points and is not shown.

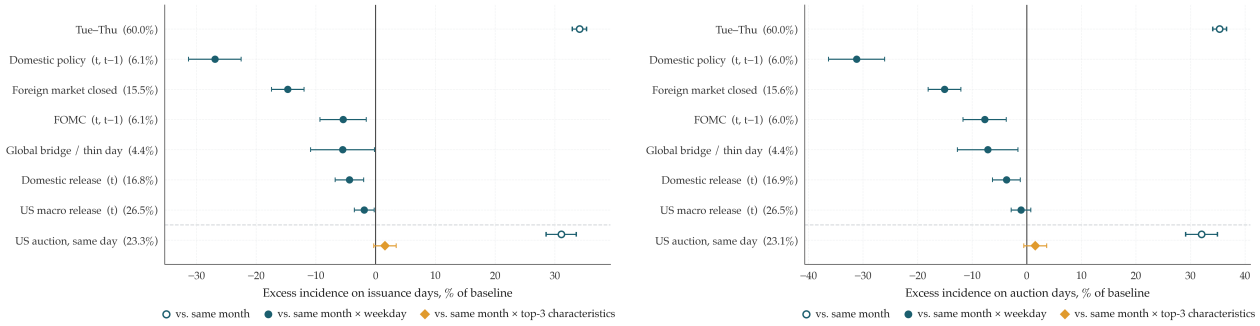
Figure A11: The auction cycle, holding auction size and maturity fixed

C Motivation: additional results

This appendix reports robustness checks for the three facts of Section 3.

C.1 Fact I: calendar selection and the concentration of issuance

Figure A12 repeats the calendar-selection exercise of Figure 3 on two alternative samples. Table A5 and Figure A13 quantify the concentration decomposition of Figure 4, the latter including the United States. Figure A14 shows that the auction days of the hub countries do not account for the calendar preferences, and Table A6 shows that the preference step of the decomposition has power.



(a) All issuance types

(b) Estimation-sample countries

Notes: As Figure 3. Panel (a) includes all recorded issuance types across the 27 non-U.S. countries except synthetic `start_point` records; panel (b) restricts competitive auctions to the 24 estimation-sample countries, excluding USA, TUR, DNK and CHE as domestic issuers, without any yield or regression-outcome requirement. Both retain domestic-currency nominal fixed-rate securities with remaining maturity above three years and event principal above USD50 million, 11 January 2006–29 August 2025, within each country's active span; each country-event day counts once. Hollow markers hold country and calendar year-month fixed; filled circles additionally hold weekday fixed; the orange diamond additionally holds Tue–Thu, foreign-market closure and domestic policy day fixed. Intervals are 1.96 times the standard deviation over 500 re-timing draws, scaled by the simulated baseline incidence.

Figure A12: Calendar selection: alternative samples

How large is the excess concentration? Table A5 decomposes the concentration of daily non-U.S. issuance behind Figure 4 into six sources, adding one at a time. It measures how much more issuance the busiest business days carry than if every sovereign spread its annual issuance evenly over its business days. Taking each sovereign's issuance pattern, auction sizes and auction frequency as given (rows 1–3), the timing of auctions concentrates a further 18.9% of issuance on the busiest 31% of business days (rows 4–6). Collisions that random timing within the month would produce by chance account for 84.3% of this timing concentration. Shared calendar preferences—issuing Tuesday to Thursday and avoiding days on which a major foreign market is closed or the domestic central bank sets policy—account for 14.8%, or 2.8% of issuance. Given this common calendar preference, sovereigns cluster slightly more than it implies (0.9%).

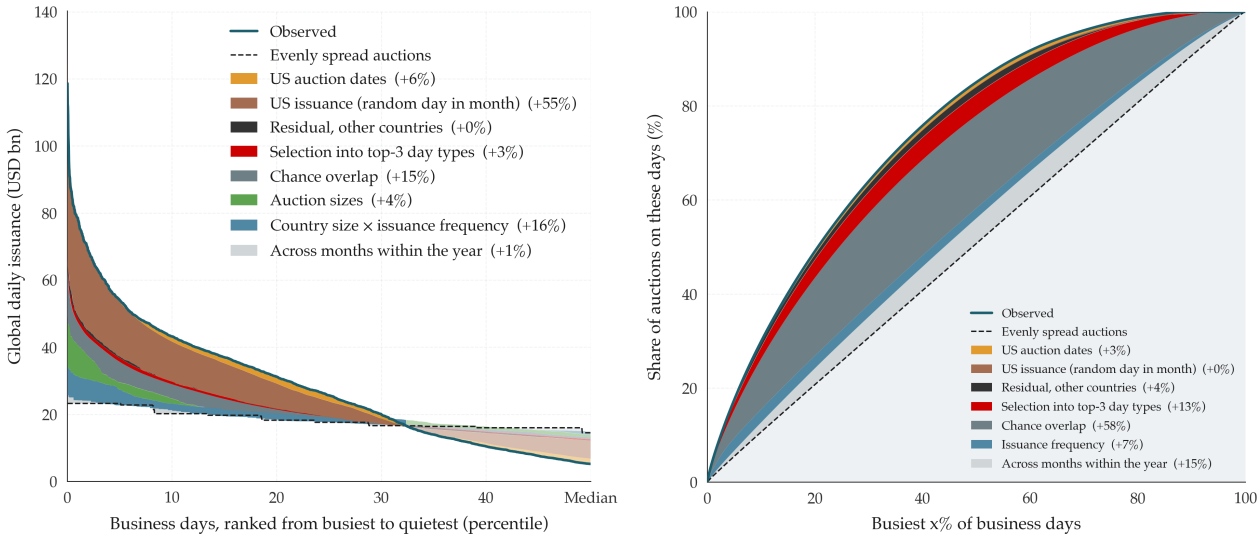
Table A5: Decomposition of daily issuance concentration

	bp of GDP per year	Share of total (%)	Share of timing (%)	USD trillion	Share of issuance (%)
Issuance structure					
(1) Within-year issuance pattern	9.2	4.6		0.63	1.9
(2) Discrete auctions: issuer size × frequency	88.2	44.2		6.60	18.1
(3) Auction-size differences within issuer	9.5	4.8		0.68	1.9
Timing					
(4) Chance collisions	78.0	39.1	84.3	5.95	16.0
(5) Calendar selection	13.6	6.8	14.8	1.05	2.8
(6) Residual beyond calendar selection	0.8	0.4	0.9	0.03	0.2
Issuance structure, (1)–(3)	106.9	53.6		7.91	21.9
Timing, (4)–(6)	92.5	46.4	100.0	7.04	18.9
of which coordination beyond chance, (5)+(6)	14.5	7.3	15.7	1.08	3.0
Total	199.4	100.0		14.94	40.8

Notes: Daily issuance is summed over the 27 non-U.S. sovereigns' eligible competitive auctions and divided by that year's panel GDP, as in Figure 4a. Concentration is the sum, over the busiest 31.2% of business days, of observed daily issuance in excess of a benchmark in which each sovereign spreads its annual issuance evenly over its business days in that year; days are ranked separately in each distribution. Rows add one source at a time, so each is measured given the rows above it. (1) each sovereign's monthly issuance spread evenly over the month's business days; (2) its actual number of auctions per month, of equal size, placed to avoid other auctions (largest first, on the least-loaded business day); (3) actual auction sizes, placed the same way; (4) the same auctions re-timed at random within the month; (5) re-timed at random within the month, with each day weighted by a common preference for its Tue–Thu, foreign-market-closure and domestic-policy-day status (one set of weights for all sovereigns, equal to the pooled share of auctions on each day type relative to its share of business days); (6) observed. No benchmark fixes the day of the week; only row (5) uses the Tue–Thu indicator. Rows (4) and (5) average 100 draws. Every benchmark preserves each sovereign's annual issuance; rows (1)–(5) also preserve its monthly issuance and rows (2)–(5) its auctions per month. *bp of GDP per year* averages over the 20 sample years. *Share of issuance* divides by total sample issuance, both measured in basis points of each year's GDP, so growth in issuance and GDP does not tilt it. *USD trillion* converts each day with its own year's GDP and sums over 11 January 2006–29 August 2025 (boundary years partial). Shares of total and of timing are in basis points of GDP. Negative entries mean the step lowers concentration.

Global concentration including the United States. Figure A13 repeats the decomposition of Figure 4 including the United States. The other 27 sovereigns' layers are stacked on U.S. issuance spread evenly over its business days, and two U.S. layers follow: U.S. auctions on random days within their month, and the actual U.S. auction dates. In amounts, the United States accounts for half of all issuance and four fifths of issuance on the busiest 1% of days. U.S. issuance on random days alone accounts for 55% of the excess concentration, and the actual U.S. auction dates add another 6%; the other sovereigns' layers together account for the remaining 39%. In the number of auctions, where every sovereign weighs the same, the United States is one of 28 issuers and its layers add only 3%; the decomposition is then essentially the one of Figure 4b.

Hub auction days and the calendar characteristics.



(a) Issuance amounts

(b) Number of auctions

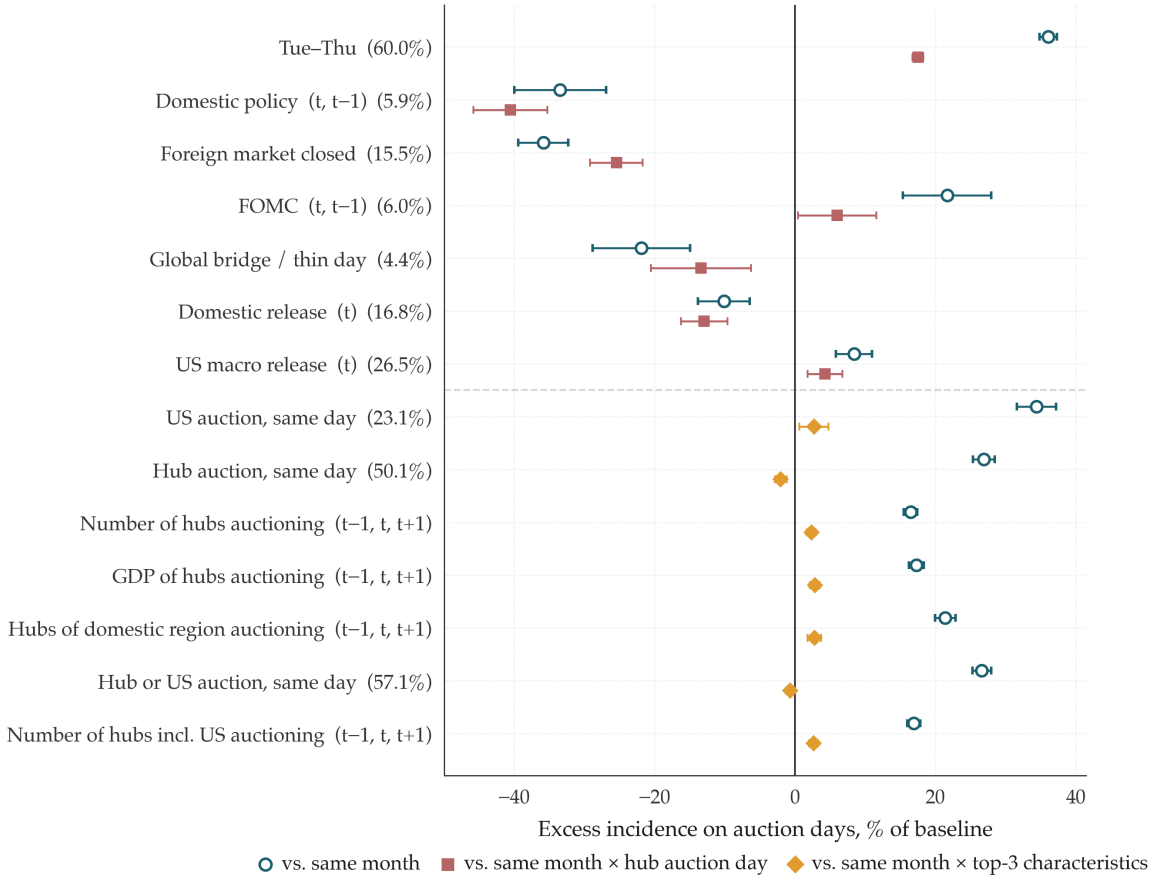
Notes: As Figure 4, but including the United States (28 sovereigns). Layers (i)–(v) refer to the 27 non-U.S. sovereigns and are stacked on U.S. issuance spread evenly over its business days. "Residual, other countries" is their observed calendar minus layer (v). "U.S. issuance" places the U.S. auctions on random days within their month (100 draws); "U.S. auction dates" replaces them by the actual dates. Panel (a) is in bp of the panel GDP including the United States, shown in USD bn at 2025 GDP.

Figure A13: Global issuance concentration including the United States

Does the preference step have power? Step (v) of Figure 4 re-draws auction days with weights that reproduce the observed incidence of the top-3 day types. A concern is that any stratification of the same shape would add concentration, whatever the days sovereigns actually chose. Table A6 tests this. The placebo permutes the top-3 tuple across each issuer's business days within its country × month cell, so every cell keeps its number of days of each type and every auction stays on its day, but the link between day type and the chosen days is broken. The type weights are re-estimated on the permuted labels and step (v) is re-run. In 20 permutations the step adds about 0.1% of the excess concentration, against 6.8% in amounts and 13.7% in auction counts with the actual day types. The preference band in Figure 4 therefore reflects where sovereigns place their auctions, not the shape of the counterfactual.

C.2 Fact II: the intensive margin

Figure A15 repeats Figure 5 for foreign supply from the domestic issuer's own trading region and under six alternative adjustments, for global foreign supply (left) and regional foreign supply (right). Panels (a)–(b) show the regional measure under the main figure's adjustment. Panels (c)–(f) add calendar characteristics to the adjustment, panels (g)–(j) adjust within country × year cells instead of country and year-month effects, and panels (k)–(n) standardise supply within country. The three-day window averages daily supply over the previous, current and next business day; the same-day window



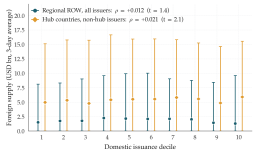
Notes: Figure 3 asked in both directions, on its sample (all non-U.S. sovereigns) and with its randomised re-timing counterfactual: excess incidence on observed auction days as a percentage of the counterfactual incidence, with 95% randomisation intervals from 500 draws. Upper block: the calendar characteristics of Figure 3 against the same-month counterfactual (hollow circles) and against a counterfactual that additionally holds fixed whether a hub country auctions that day (squares). Lower block: the auction calendars of the United States and of the hub countries against the same-month counterfactual (hollow circles) and against the same month × top-3 characteristics (diamonds). Hub countries are Germany, France, the United Kingdom, Italy and Japan (Figure 6b), joined by the United States in the last two rows; for a hub sovereign only the other hubs count. Counts and GDP are averaged over the auction day and the adjacent business days, as in the hub regressor; the domestic-region row counts only hubs in the sovereign's trading region. The hub-day stratum leaves more randomisation freedom than the top-3 stratum (no auction without an alternative day, against 4.8% under top-3), so the comparison is not tilted against hub days. The small positive residuals of the three-day rows come mainly from the hub sovereigns themselves (+4.9% for their own three-day count). Restricted to the 19 non-hub sovereigns, the same-day hub row is +0.3% ($z = 0.5$), the three-day count +0.3% ($z = 0.8$), and holding hub days fixed leaves Tue–Thu at +12.0%, foreign closures at −21.5% and domestic policy days at −61.0%.

Figure A14: Hub auction days do not explain the calendar

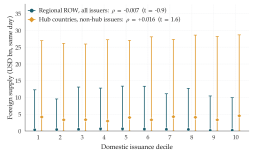
uses only the auction date.

C.3 Fact III: the primary-dealer network

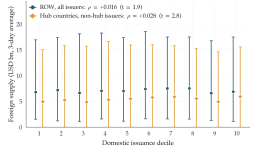
The network is concentrated in six headquarters countries—the United States, the United Kingdom, France, Germany, Switzerland, and Japan—whose banks account for approximately 72–78% of for-



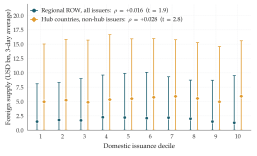
(a) Baseline, three days, regional



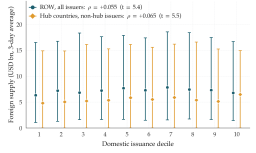
(b) Baseline, same day, regional



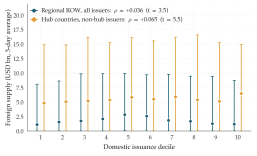
(c) Additive calendar, global



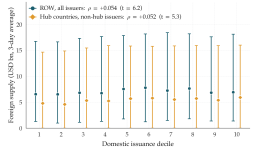
(d) Additive calendar, regional



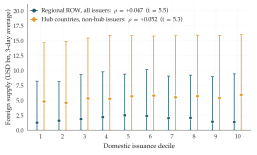
(e) Fully interacted calendar, global



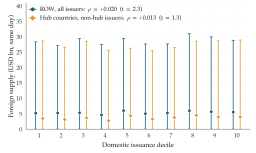
(f) Fully interacted calendar, regional



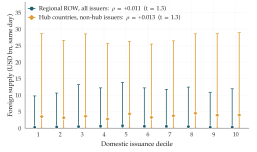
(g) Country × year, three days, global



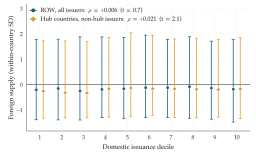
(h) Country × year, three days, regional



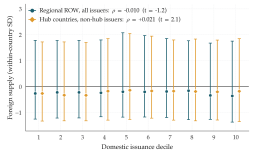
(i) Country × year, same day, global



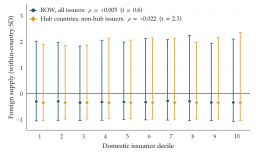
(j) Country × year, same day, regional



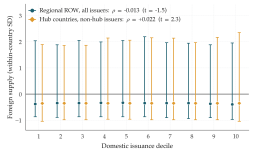
(k) Standardised, three days, global



(l) Standardised, three days, regional



(m) Standardised, same day, global



(n) Standardised, same day, regional

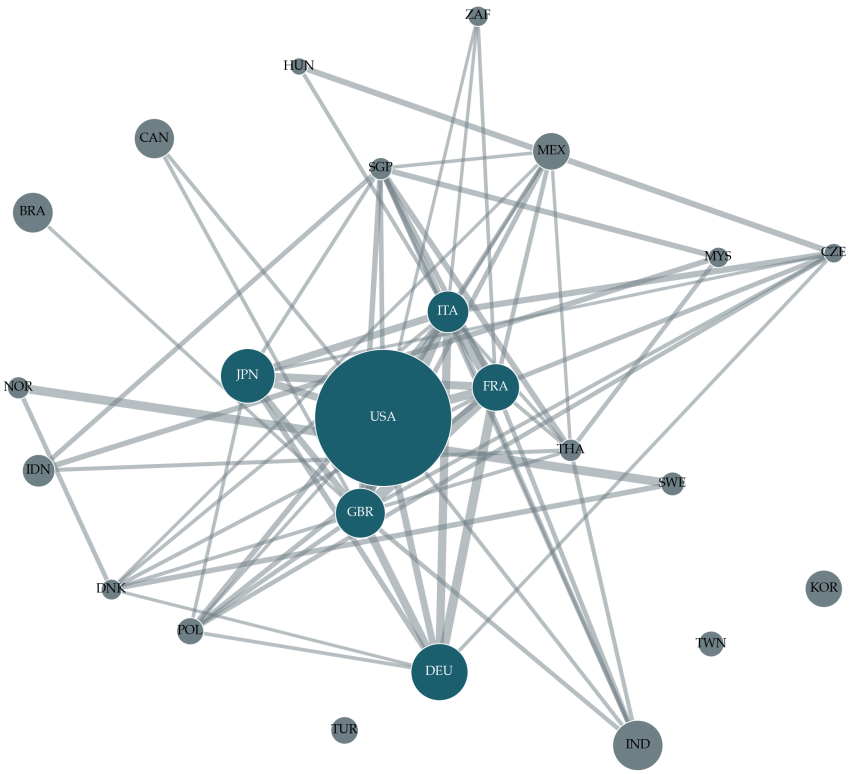
Notes: Each panel plots foreign supply over deciles of adjusted log domestic issuance. Circles: ROW supply (left: all other non-U.S. issuers; right and panels (a)–(b): other non-U.S. issuers in the domestic issuer's trading region, Asia-Pacific, EMEA or the Americas). Diamonds: supply from Germany, France, the United Kingdom, Italy and Japan at non-hub issuers' auctions. Markers are medians, whiskers the 5th–95th percentiles; ρ is the correlation of adjusted domestic issuance and adjusted supply, and $t = \rho\sqrt{N}$ is descriptive, not a clustered test. Baseline: separate country and year-month effects, as in the main figure. Additive calendar: separate country, year-month, Tue–Thu, foreign-market-closure and domestic-policy-day effects. Fully interacted: demeaned within country × year-month × the three characteristics, singletons omitted. Country × year: demeaned within country-year cells, no calendar controls. Standardised: supply centred on each issuer's mean and divided by its standard deviation, then adjusted for country and year-month effects. Supply is in USD billions (three-day window: daily average; same day: auction-day amount) except in the standardised rows.

Figure A15: Intensive margin: calendar adjustment, window and scaling

Table A6: Power of the day-type preference step

		Placebo: day types permuted		
	Actual	Mean	Min	Max
Issuance amounts	6.8%	0.09%	0.07%	0.11%
Number of auctions	13.7%	-0.11%	-0.13%	-0.09%

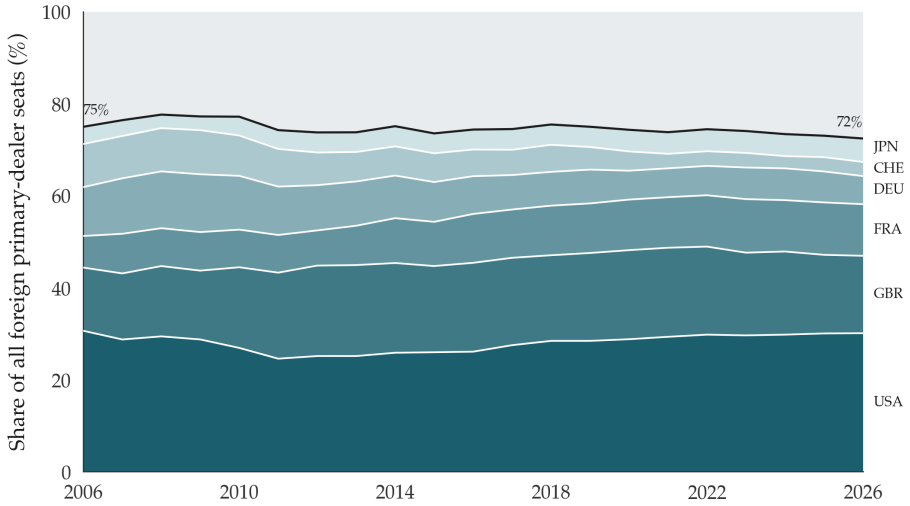
Notes. Share of the excess concentration of Figure 4 (observed minus the even calendar, on the days where the observed curve lies above it) contributed by step (v), the common preference for the top-3 day types. Actual: the paper figure. Placebo: the Tue–Thu, foreign-market-closure and domestic-policy-day tuple is permuted across each issuer's business days within country × month, the pooled type weights are re-estimated, and step (v) is re-run with 100 re-timing draws; 20 permutations. Non-U.S. sovereigns; amounts as in panel (a), equal-weight auction counts as in panel (b).



Notes: As Figure 6a, but each edge averages the annual Jaccard overlap of two issuers' primary-dealer lists (snapshots on 1 July, 2006–2025) over the years in which both dealer lists are available; missing years are excluded and observed zero overlap is included. Each pair is observed for 12–20 years. Edges show the top quartile of mean overlaps. Node area is proportional to GDP in July 2025, and node positions match Figure 6a.

Figure A16: Primary-dealer network, average 2006–2025

eign dealer seats in every annual snapshot (Figure A17).



Notes: Annual snapshots on 1 July, 2006–2026, using each market's latest dealer list dated strictly before that date. A foreign dealer seat is one parent banking group on the dealer list of a market outside its headquarters country. Shaded areas show each hub country's share of all foreign seats; the black line is their sum. Coverage expands from 18 markets in 2006 to 24 from 2014. Appendix B.3 details coverage and the hub definition.

Figure A17: Headquarters of Foreign Primary Dealers

D Additional Results for Section 4

This appendix reports specification details, identification diagnostics and robustness checks for Section 4. Unless stated otherwise, tables use the regional competing-supply measure, equal-weight presence of Germany, France, the United Kingdom, Italy and Japan over the centred three-day window, and continuous three-day U.S. offered amounts/GDP (d0 offered amounts in same-day specifications). Hub auctions include indexed and floating-rate bonds with issuance principal above USD 50 million. Country-specific domestic-size slopes, country, year–month and weekday effects, and the baseline controls enter as in equation (10). Driscoll–Kraay inference uses bandwidth twenty. Supply scopes and specification changes are indicated in each table; the final high-frequency-interaction row of Table A11 uses global competing supply.

D.1 The baseline specification

Table A7 reports every substantive coefficient of Table 1, Table A8 the first stages, Table **??** the country-specific domestic-size slopes, and Table A9 the main coefficients under alternative outcome normalisations, with effects in basis points.

Table A7: Baseline specification: all substantive coefficients

	(1)	(2)	(3)	(4)	(5)
Competing supply	Global	Global	Regional	Regional	Regional
Estimator	OLS	2SLS	OLS	2SLS	2SLS
ROW	0.105	−0.084	0.208**	0.218*	0.209
	(0.128)	(0.221)	(0.088)	(0.124)	(0.190)
$\ell \times ROW$	0.597***	1.399***	0.615***	0.945***	0.845**
	(0.200)	(0.383)	(0.166)	(0.263)	(0.420)
HUB	−0.182	−0.056	−0.214**	−0.223**	−1.368*
	(0.131)	(0.175)	(0.104)	(0.108)	(0.737)
$\ell \times HUB$	−0.844***	−1.413***	−0.675***	−0.807***	−0.835***
	(0.237)	(0.349)	(0.190)	(0.212)	(0.311)
US	−0.063	−0.112	−0.053	−0.051	–
	(0.085)	(0.100)	(0.079)	(0.083)	
$\ell \times US$	0.193	0.361**	0.146	0.187	0.159
	(0.156)	(0.178)	(0.149)	(0.153)	(0.211)
Domestic log issuance (ℓ)	1.478***	1.487***	1.476***	1.495***	1.837**
	(0.416)	(0.433)	(0.417)	(0.425)	(0.806)
Domestic spread, lag 1	0.128***	0.129***	0.127***	0.127***	0.156***
	(0.032)	(0.032)	(0.032)	(0.032)	(0.038)
Domestic spread, lag 2	0.139***	0.138***	0.139***	0.138***	0.142***
	(0.024)	(0.024)	(0.025)	(0.025)	(0.029)
Domestic spread, lag 3	0.066***	0.066***	0.066***	0.066***	0.074***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.024)
Domestic spread, lag 4	0.085***	0.084***	0.085***	0.085***	0.087***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.027)
Domestic spread, lag 5	0.018	0.018	0.018	0.018	0.021
	(0.017)	(0.017)	(0.017)	(0.017)	(0.021)
Domestic spread, previous-20 mean	0.245***	0.247***	0.245***	0.245***	0.207*
	(0.087)	(0.087)	(0.087)	(0.087)	(0.110)
Domestic log issuance, lag 1	−0.188	−0.181	−0.198	−0.200	−0.474
	(0.185)	(0.185)	(0.185)	(0.186)	(0.308)
Domestic log issuance, lag 2	0.107	0.077	0.115	0.109	0.203
	(0.178)	(0.177)	(0.179)	(0.179)	(0.288)
Domestic log issuance, lag 3	−0.418**	−0.389**	−0.415**	−0.403**	−0.303
	(0.172)	(0.172)	(0.173)	(0.174)	(0.257)
Domestic log issuance, lag 4	0.141	0.156	0.139	0.143	0.237
	(0.171)	(0.171)	(0.172)	(0.172)	(0.257)
Domestic log issuance, lag 5	−0.024	−0.025	−0.034	−0.039	−0.195
	(0.157)	(0.157)	(0.157)	(0.157)	(0.255)
Reference-yield change, lag 1	0.519	0.538	0.539	0.552	−4.314
	(2.150)	(2.149)	(2.142)	(2.141)	(2.679)

Continued on next page

Baseline specification: all substantive coefficients (continued)

	(1)	(2)	(3)	(4)	(5)
Competing supply	Global	Global	Regional	Regional	Regional
Estimator	OLS	2SLS	OLS	2SLS	2SLS
Reference-yield change, lag 2	−1.741	−1.747	−1.719	−1.708	−3.543
	(2.508)	(2.505)	(2.514)	(2.519)	(3.971)
Reference-yield change, lag 3	−0.347	−0.367	−0.397	−0.429	−2.581
	(1.595)	(1.578)	(1.608)	(1.611)	(2.132)
Reference-yield change, lag 4	−1.735	−1.700	−1.792	−1.800	−5.771***
	(1.866)	(1.854)	(1.868)	(1.866)	(2.115)
Reference-yield change, lag 5	−4.246**	−4.341**	−4.149**	−4.133**	−2.736
	(1.872)	(1.878)	(1.874)	(1.875)	(2.936)
Maturity (years)	0.342*	0.358*	0.346*	0.346*	0.205
	(0.196)	(0.199)	(0.195)	(0.194)	(0.317)
Maturity^2	−0.016699**	−0.017298**	−0.016864**	−0.016934**	−0.007948
	(0.008061)	(0.008132)	(0.007988)	(0.007973)	(0.012668)
Maturity^3	0.000227**	0.000235**	0.000229**	0.000232**	0.000086
	(0.000101)	(0.000102)	(0.000100)	(0.000100)	(0.000158)
Policy rate	0.065	0.070	0.050	0.051	0.183
	(0.193)	(0.194)	(0.192)	(0.192)	(0.281)
Industrial-production growth	0.021	0.020	0.023	0.023	0.008
	(0.018)	(0.018)	(0.018)	(0.018)	(0.020)
Fiscal surplus/debt change	0.025	0.024	0.027	0.027	0.028
	(0.025)	(0.025)	(0.025)	(0.025)	(0.034)
Kleibergen–Paap rk Wald F	–	237.9	–	416.3	173.3
Observations	11,180	11,180	11,180	11,180	11,180
Country × tenor FE	Yes	Yes	Yes	Yes	Yes
Year–month FE	Yes	Yes	Yes	Yes	–
Weekday FE	Yes	Yes	Yes	Yes	–
Date FE	–	–	–	–	Yes
Country × domestic issuance	Yes	Yes	Yes	Yes	Yes

Notes. The five columns are the same fitted models as Table 1. All substantive coefficients are displayed. Country and time indicators and country-by-domestic-issuance interactions are included as in Table 1 but not printed. The domestic-log-issuance coefficient is the reference issuer's slope (AUS); it is not an average across countries. No separate intercept is identified after absorbing the fixed effects. – denotes the US level absorbed by date effects. Spread and domestic-size lags follow auction order; reference-yield lags follow business days. Maturity-square/cube coefficients and standard errors use six decimal places. Driscoll–Kraay standard errors (bandwidth 20) in parentheses. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A8: First stage

	Global ex-U.S.		Regional	
	ROW	$\ell \times ROW$	*ROW*	$\ell \times ROW$
Rollover need N	0.567***	−0.006	0.696***	0.013**
	(0.017)	(0.004)	(0.014)	(0.005)
$\ell \times N$	0.006	0.506***	0.075***	0.629***
	(0.014)	(0.023)	(0.020)	(0.022)
Kleibergen–Paap rk Wald F	237.9		416.3	
Observations	11,180		11,180	

Notes. First stages of the global and regional baseline 2SLS models, conditional on the full baseline exogenous block. The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A9: Outcome normalisation and supply effects in basis points

	ROW		HUB			
Outcome	$\ell \times ROW$	Effect	$\ell \times HUB$	Effect	KP F	N
Regional competing supply						
MAD-normalised (baseline)	0.945***	0.733***	−0.807***	−0.663***	416.3	11,180
	(0.263)	(0.194)	(0.212)	(0.166)		
SD-normalised	0.909***	0.706***	−0.747***	−0.637***	416.3	11,180
	(0.238)	(0.178)	(0.192)	(0.156)		
Basis points, trimmed	0.691**	0.616***	−0.529**	−0.543***	410.6	11,153
	(0.277)	(0.196)	(0.230)	(0.185)		
Basis points, untrimmed	0.673**	0.570***	−0.559**	−0.614***	416.3	11,180
	(0.279)	(0.197)	(0.233)	(0.190)		
Global competing supply						
MAD-normalised (baseline)	1.399***	0.678**	−1.413***	−0.826***	237.9	11,180
	(0.383)	(0.326)	(0.349)	(0.276)		
SD-normalised	1.348***	0.656**	−1.331***	−0.795***	237.9	11,180
	(0.353)	(0.306)	(0.317)	(0.259)		
Basis points, trimmed	0.659	0.158	−0.703*	−0.372	234.9	11,153
	(0.444)	(0.333)	(0.373)	(0.284)		
Basis points, untrimmed	0.805*	0.255	−0.847**	−0.537*	237.9	11,180
	(0.444)	(0.338)	(0.377)	(0.299)		

Notes. Each row is a separate 2SLS regression of the outcome shown, with the baseline controls, country-specific domestic-size slopes and fixed effects of Table 1. All coefficients are in basis points. The $\ell \times ROW$ and $\ell \times HUB$ columns report β_{LR} and γ_{LH}; the effect columns report $\beta_R + \beta_{LR}\,\mathrm{sd}(\ell)$ and $\gamma_H + \gamma_{LH}\,\mathrm{sd}(\ell)$, the effect of one within-country standard deviation more competing supply or hub presence on an auction one standard deviation of ℓ (0.54 log points) larger than the issuer's usual offering. Standard errors of the effects use the full covariance matrix. MAD- and SD-normalised estimates are multiplied by the median normalisation scale of their estimation sample, 4.84 and 5.40 bp, treated as fixed; the basis-point rows need no rescaling. Trimming excludes concessions more than five within-country standard deviations from the country mean. Global competing supply excludes the United States. All rows contain 24 countries.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.2 Robustness of the baseline

Table A10: The window over which competing supply is measured

	Global		Regional	
Supply window	$\ell \times ROW$	KP F	$\ell \times ROW$	KP F
Same day (t)	0.162	1193.0	0.411**	304.4
	(0.168)		(0.190)	
Centred 3 days ($t-1, t, t+1$) – baseline	1.399***	237.9	0.945***	416.3
	(0.383)		(0.263)	
Centred 5 days ($t-2, \ldots, t+2$)	0.623**	366.4	0.725***	759.6
	(0.252)		(0.215)	
Observations	11,180		11,180	

Notes. Only the window of competing supply and of its matching rollover instrument changes; HUB is measured over the centred three-day window throughout. U.S. offered amounts are measured on the auction day in the same-day row and over the three-day window otherwise. Global competing supply excludes the United States.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A11: The result is not a time trend: trend controls and the slow/high-frequency split

Panel A. Trend controls, regional ROW			
	$\ell \times ROW$	Kleibergen–Paap F	N
R0 baseline	0.945^{***}	416.3	11,180
	(0.263)		
T1 + country linear trends	0.925^{***}	423.5	11,180
	(0.264)		
T2 + domestic size × time	0.931^{***}	427.2	11,180
	(0.262)		
T3 + country domestic size × time	0.899^{***}	439.1	11,180
	(0.257)		
T4 country × year FE	0.714^{**}	452.2	11,180
	(0.292)		
T5 ROW and IV detrended	0.972^{***}	439.2	11,180
	(0.264)		
T6 *placebo*: calendar time	-0.086^{**}	–	11,180
	(0.034)		
R1 country FE (previous baseline)	1.091^{***}	411.4	11,180
	(0.271)		
Panel B. Slow and high-frequency components of ROW			
	Global	Regional	
$\ell \times ROW$ (total)	1.395^{***}	0.945^{***}	
	(0.384)	(0.263)	
ROW^{slow}	0.496	0.128	
	(0.574)	(0.592)	
ROW^{hf}	−0.103	0.222^{*}	
	(0.219)	(0.127)	
$\ell \times ROW^{hf}$ alone	1.329^{***}	–	
	(0.373)		
Share of var($\ell \times ROW$), slow	17.3%	12.1%	
Share of var($\ell \times ROW$), high-frequency	80.3%	87.2%	
Kleibergen–Paap F	159.4	288.9	

Notes. Panel A adds the trend controls labelled to the regional baseline: T1 country-specific linear trends; T2 and T3 domestic size interacted with calendar time, common and by country; T4 country × year fixed effects; T5 ROW and its instrument detrended within country; T6 replaces competing supply by calendar time. R1 is the previous baseline with country instead of country × tenor fixed effects. Panel B splits ROW and rollover need into a slow (country-year mean) and a high-frequency (within country-year) component, each instrumented by the same split of rollover need, with the domestic-size interaction on total supply; the last coefficient row enters only the high-frequency interaction. Global competing supply excludes the United States. The shared HUB and continuous US blocks remain included.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A12: GDP-normalised competing supply and rollover need

	Global ex-U.S.			Regional		
Normalisation	*ROW*	$\ell \times ROW$	KP F	*ROW*	$\ell \times ROW$	KP F
Nominal USD (baseline)	−0.084	1.399***	237.9	0.218*	0.945***	416.3
	(0.221)	(0.383)		(0.124)	(0.263)	
÷ global GDP, entered countries (common)	−0.139	0.990***	274.8	0.196	0.747***	245.3
	(0.208)	(0.335)		(0.122)	(0.255)	
÷ matched partner GDP, smoothed (rt)	−0.166	0.994***	363.9	0.241**	0.895***	51.2
	(0.211)	(0.334)		(0.119)	(0.247)	
÷ matched partner GDP, last released	−0.145	0.995***	300.3	0.246**	0.874***	51.1
	(0.213)	(0.338)		(0.119)	(0.246)	
÷ domestic trailing 3y mean (no GDP)	−0.148	1.132***	263.3	0.173	0.850***	4.0
	(0.231)	(0.375)		(0.171)	(0.224)	
Observations	11,180			11,180		

Notes. The competing-supply and instrument denominators vary as labelled, using the same eligible partner set in numerator and denominator. HUB and US retain their baseline definitions.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A13: Sub-period stability

Window	$\ell \times ROW$	*ROW*	Kleibergen–Paap F	N
2006-01 – 2013-11	0.695	0.383	117.9	2,828
	(0.452)	(0.269)		
2013-11 – 2021-05	0.462	−0.014	282.4	5,090
	(0.346)	(0.135)		
2021-05 – 2025-09	1.184***	0.135	131.6	3,262
	(0.448)	(0.262)		

Notes. The estimation years vary as labelled. Supply scales are fixed before subsampling.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A14: Saturated fixed effects

	Global ex-U.S.			Regional		
	$\ell \times ROW$	KP F	N	$\ell \times ROW$	KP F	N
Baseline (country × tenor, year–month, weekday FE)	1.399***	237.9	11,180	0.945***	416.3	11,180
	(0.383)			(0.263)		
+ country × year FE	1.032**	262.6	11,180	0.716**	463.4	11,180
	(0.411)			(0.280)		
Country FE and country domestic-size slopes	1.487***	237.3	11,180	1.091***	411.4	11,180
	(0.400)			(0.271)		

Notes. Fixed effects vary as labelled; common daily levels are omitted when exactly absorbed.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A15: Issuer × day × maturity-bucket panel

	Issuer-day	Bucket panel, all days			Bucket panel, by buckets sold that day		
	Baseline	Size in the interaction			One	Several	
		Bucket	Day	Bucket + day	Bucket	Bucket	Day
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ROW	0.207	0.217*	0.201	0.199	0.099	0.240	0.107
	(0.127)	(0.131)	(0.133)	(0.130)	(0.141)	(0.264)	(0.272)
$\ell^{bucket} \times ROW$		0.477**		−0.154	1.034***	0.197	
		(0.213)		(0.270)	(0.310)	(0.331)	
$\ell^{day} \times ROW$	0.991***		0.918***	1.033***			0.682
	(0.267)		(0.257)	(0.334)			(0.599)
HUB	−0.217*	−0.281**	−0.247**	−0.273**	−0.037	−0.443*	−0.355
	(0.113)	(0.122)	(0.122)	(0.121)	(0.129)	(0.243)	(0.233)
$\ell^{bucket} \times HUB$		−0.532***		−0.186	−1.103***	−0.215	
		(0.142)		(0.157)	(0.275)	(0.159)	
$\ell^{day} \times HUB$	−0.841***		−0.760***	−0.620***			−0.305
	(0.213)		(0.189)	(0.218)			(0.321)
Effect of moving ROW from its p25 to p75 (bp)							
p25-size auction	−0.209	−0.020	−0.185	–	−0.384**	0.138	−0.178
	(0.161)	(0.163)	(0.162)		(0.195)	(0.270)	(0.422)
p75-size auction	0.426***	0.323**	0.403***	–	0.324**	0.280	0.259
	(0.140)	(0.137)	(0.144)		(0.146)	(0.284)	(0.249)
Effect of moving HUB from its p25 to p75 (bp)							
p25-size auction	0.201	−0.023	0.110	–	0.696***	−0.480	−0.321
	(0.195)	(0.191)	(0.202)		(0.259)	(0.329)	(0.414)
p75-size auction	−0.591***	−0.586***	−0.606***	–	−0.415**	−0.707*	−0.609*
	(0.183)	(0.185)	(0.188)		(0.195)	(0.369)	(0.331)
Kleibergen–Paap rk Wald F	409.6	580.9	451.5	289.1	361.5	320.0	198.0
Observations	10,775	14,376	14,376	14,376	7,800	6,576	6,576
Issuer-days	10,775	10,775	10,775	10,775	7,800	2,975	2,975
Countries	22	22	22	22	22	15	15
Country × tenor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year–month, weekday FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × domestic issuance	Yes	Yes	Yes	Yes	Yes	Yes	Yes
U.S. block, controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes. Column (1) is the baseline of Table 1, column (4), on one row per issuer and auction day. Columns (2)–(7) instead use one row per issuer, auction day and maturity bucket of the auctioned bonds (remaining maturity (3, 6], (6, 8.5], (8.5, 12.5] and above 12.5 years, the tenor buckets of the fixed effects). Each row has its own spread (unweighted mean over the bucket's bonds, same normalisation), offered amount, maturity cubic and reference-yield lags. ROW, HUB, the U.S. block, the rollover instruments, the macro controls and the lagged domestic-spread and domestic-size controls are measured at the issuer-day level and repeat across a day's buckets. Poland and Indonesia are excluded from every column because they report only a daily offered total. ℓ^{day} is the issuer's total offered amount on the day, relative to its mean daily offering (the baseline ℓ); ℓ^{bucket} is the bucket's offered amount, relative to the issuer's mean bucket offering. In columns (2)–(7) the country-specific domestic-size slopes use ℓ^{bucket}; the columns differ only in the size that interacts with ROW, HUB and U.S. supply. Column (4) includes both interaction sets, each ROW product instrumented by the matching rollover-need product. Columns (5)–(7) split the bucket panel by whether the issuer sold one bucket or several that day; several buckets are sold on 28% of issuer-days. On one-bucket days ℓ^{bucket} and ℓ^{day} differ only by a country constant. Effect rows move ROW (HUB) from its within-country 25th to 75th percentile (0.97 (1.43) within-country standard deviations, issuer-day sample of column (1)) for an auction at the 25th or 75th percentile of the column's size measure (0.65 and 1.26 times the mean daily offering for ℓ^{day}, 0.61 and 1.28 times the mean bucket offering for ℓ^{bucket}), in basis points at the median MAD scale of the column's sample, with delta-method standard errors. Column (4) combines two size measures and is not evaluated. Driscoll–Kraay scores sum all rows on a date, so buckets of the same issuer-day share one score.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.3 Pre-auction curve test

This subsection reports two related checks. The first examines whether the rollover-need instrument predicts pre-auction secondary-market repricing, a diagnostic relevant to the exclusion restriction. The second examines whether the estimated ROW coefficients continue an earlier auction-cycle movement in the reference curve.

Rollover need and exclusion. Scheduled rollover need may predict secondary market prices before the auction. This could reflect anticipated issuance or portfolio adjustments after redemptions. Table A16 enters rollover need N and $\ell \times N$ directly in an OLS reduced-form regression, retaining the HUB and US blocks and country-specific domestic-issuance slopes. The outcome is the change in the auction-specific synthetic reference yield from $t-6$ to $t-1$. The table also retains the auction-minus-pre-auction comparison for rollover need and its interaction with domestic issuance. This difference is estimated on the same observations and with the same controls by regressing the difference between the two outcomes on the common regressors; its standard error accounts for their within-auction covariance.

Only outcome-history controls dated strictly before $t-6$ are retained in both equations. The available reference-change lags end at $t-1$ through $t-5$ and are therefore omitted; prior auction-outcome lags are screened by their auction dates, and the twenty-auction mean uses only its pre-cutoff constituents. Lagged reference levels inside the outcome window are not included. Neither rollover-need coefficient is individually significant in the full-sample five-day regression, with joint p-values 0.141 (regional) and 0.970 (global). This provides no evidence of systematic pre-auction repricing associated with the rollover-need instrument in that window. It does not establish exclusion: anticipated issuance can legitimately affect the earlier curve, and a null cannot rule out other direct channels operating at the auction.

Table A16: Scheduled rollover need and pricing before and at the auction

	Advanced economies		All countries	
	Regional	Global	Regional	Global
Rollover need (N)				
Pre-auction, $t-6 \longrightarrow t-1$	0.192	−0.048	0.197	−0.039
	(0.169)	(0.308)	(0.127)	(0.227)
Auction minus pre-auction	−0.023	0.063	−0.038	−0.013
	(0.202)	(0.365)	(0.152)	(0.266)
$\ell \times N$				
Pre-auction, $t-6 \longrightarrow t-1$	−0.228	−0.141	−0.214	0.053
	(0.321)	(0.480)	(0.224)	(0.290)
Auction minus pre-auction	1.106***	1.066*	0.859***	0.650*
	(0.406)	(0.586)	(0.285)	(0.357)
Joint pre-auction p-value	0.399	0.940	0.141	0.970
Auction days	6,701	6,701	11,175	11,175

Notes. Rollover need and its interaction with demeaned log domestic issuance enter directly in OLS, replacing the corresponding realised ROW terms. The HUB and US blocks, fixed effects, country-specific domestic-issuance slopes and normalisation follow the main specification. The pre-auction outcome is the reference change from $t-6$ to $t-1$; the other outcome is the auction concession minus that change. Both equations use the same sample and date-screened controls. Original auction-outcome lags dated at or after $t-6$ are zeroed with separate exclusion indicators. The trailing mean uses the pre-cutoff subset of the original twenty outcomes. No reference-change or reference-level controls inside the outcome window are included; other baseline controls are retained. The joint test covers N and $\ell \times N$ in the pre-auction equation. Driscoll–Kraay standard errors (bandwidth 20) are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Auction-cycle effects. Lou et al. (2013) document secondary market price declines before auctions despite advance supply announcements. Such auction-cycle effects may vary with market conditions and auction design. Our baseline permits country-specific slopes on domestic issuance, allowing size-related concessions to differ across issuers. This exercise assesses whether the ROW level and its interaction with domestic issuance also explain secondary-market yield movements before the auction.

Table A17 replaces the auction concession with the change in the auction-specific synthetic reference yield from $t-2$, $t-4$ or $t-6$ to $t-1$. The endpoint $t-1$ is the benchmark used in the auction concession. Reference yields are averaged over exactly the same eligible auction events as the baseline outcome, and the outcome normalisation, supply variables, rollover instruments, fixed effects and country-specific domestic-issuance slopes are retained. Only outcome-history controls dated strictly before each window's starting date are used: overlapping reference-yield changes and prior auction outcomes are excluded, while earlier observations remain. The trailing auction-outcome mean is recomputed from the remaining pre-window observations in its original twenty-auction history. No new reference yields are required.

Neither coefficient is individually significant in any full-sample window; joint p-values range from 0.145 to 0.970. The full-sample regressions use the same 11,175 auction days from 24 countries. Panel B reports the advanced-economy sample: the interaction is not significant in any window, and only the regional ROW level from $t-2$ ($p = 0.078$) is marginally significant; no joint test is significant (global three-day $p = 0.136$). These results provide no clear evidence that the crowding-out interaction simply continues an earlier reference-yield movement. They are a timing diagnostic, not a separate validation of the instrument's exclusion restriction, and do not rule out all auction-cycle effects.

Table A17: ROW supply and pre-auction reference-yield changes

	Regional ROW			Global ROW		
Reference window	$t-2 \to t-1$	$t-4 \to t-1$	$t-6 \to t-1$	$t-2 \to t-1$	$t-4 \to t-1$	$t-6 \to t-1$
A. All countries						
ROW (β_R)	0.114	0.190	0.290	0.126	−0.188	−0.068
	(0.082)	(0.140)	(0.183)	(0.180)	(0.294)	(0.401)
$\ell \times ROW$ (β_{RL})	−0.173	−0.343	−0.375	−0.021	−0.135	0.105
	(0.179)	(0.270)	(0.356)	(0.277)	(0.447)	(0.574)
Joint-test p-value	0.249	0.156	0.145	0.780	0.781	0.970
Auction days	11,175	11,175	11,175	11,175	11,175	11,175
B. Advanced economies						
ROW (β_R)	0.196*	0.175	0.279	0.295	−0.465	−0.087
	(0.111)	(0.185)	(0.240)	(0.261)	(0.385)	(0.535)
$\ell \times ROW$ (β_{RL})	−0.234	−0.421	−0.382	−0.276	−1.203	−0.277
	(0.278)	(0.368)	(0.492)	(0.503)	(0.752)	(0.941)
Joint-test p-value	0.165	0.334	0.400	0.462	0.136	0.940
Auction days	6,701	6,701	6,701	6,701	6,701	6,701
Earlier curve-change lags	3–5	5	None	3–5	5	None
Earlier auction history	Yes	Yes	Yes	Yes	Yes	Yes
Country × domestic size	Yes	Yes	Yes	Yes	Yes	Yes

Notes. 2SLS estimates using the current ROW, HUB and US definitions and the normalisation of Table 1. Outcomes are changes in the auction-specific synthetic reference yield from $t-k$ to $t-1$, in basis points divided by the country's generic-yield MAD; t denotes the auction date and offsets are business days. ROW and $\ell \times ROW$ are instrumented by their matching rollover-need terms. Country-specific domestic-issuance slopes and country, year–month and weekday fixed effects are retained. Outcome-history controls must be dated strictly before $t-k$. Curve-change controls therefore retain lags 3–5, lag 5, and no lags for $k = 2, 4, 6$, respectively. Each of the original five auction-outcome lags is retained only if its auction date precedes the cutoff; excluded values are set to zero with separate exclusion indicators. The trailing mean averages the pre-cutoff observations among the original twenty prior auction outcomes (at least seven remain in this sample). Other baseline controls are unchanged. No additional reference yields are constructed. The joint test is $H_0 : \beta_R = \beta_{RL} = 0$. Driscoll–Kraay standard errors (bandwidth 20) are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.4 Instrument diagnostics

Table A18: Instrument robustness

	Global ex-U.S.	Regional
A. Placebo instrument: partner redemption calendars permuted, scale preserved		
True t on $\ell \times ROW$	3.65	3.59
Placebo t: mean (s.d.)	0.14 (0.64)	0.07 (0.60)
Placebo $\lvert t \rvert$: 90th pct / max	1.08 / 1.83	0.96 / 2.28
$\Pr(\lvert t_{perm} \rvert \geq \lvert t_{true} \rvert)$	**0.000**	**0.000**
True Kleibergen–Paap F	237.9	416.3
Placebo F: median	0.6	0.2
$\Pr(F_{perm} < 10)$	0.97	0.98
$\Pr(F_{perm} \geq F_{true})$	0.000	0.000
B. Forecastability from the country's own five lagged auction spreads		
Rollover need N (the instrument)	1.99 / 0.0009	0.83 / 0.0004
Competing supply ROW (the regressor)	0.93 / 0.0004	0.57 / 0.0003
Domestic issuance size ℓ (benchmark)	6.59 / 0.0030	6.59 / 0.0030
reported as $F(5)$ / partial R^2		
C. Instrument rebuilt from disjoint redemption cohorts		
3–7y bonds only	0.268^{***} [118]	0.221^{***} [253]
>7y bonds only	0.307^{***} [163]	0.172^{***} [291]
Kleibergen–Paap F in brackets		
Permutation draws	200	200

Notes. Panel A permutes partner redemption calendars over all non-US supply countries while preserving their mean scales (200 draws). Panel B reports joint F statistics and partial R-squared for the five domestic-spread lags. Panel C rebuilds the instrument separately from 3–7-year and above-seven-year redemption cohorts, holding the endogenous ROW block and baseline controls fixed.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

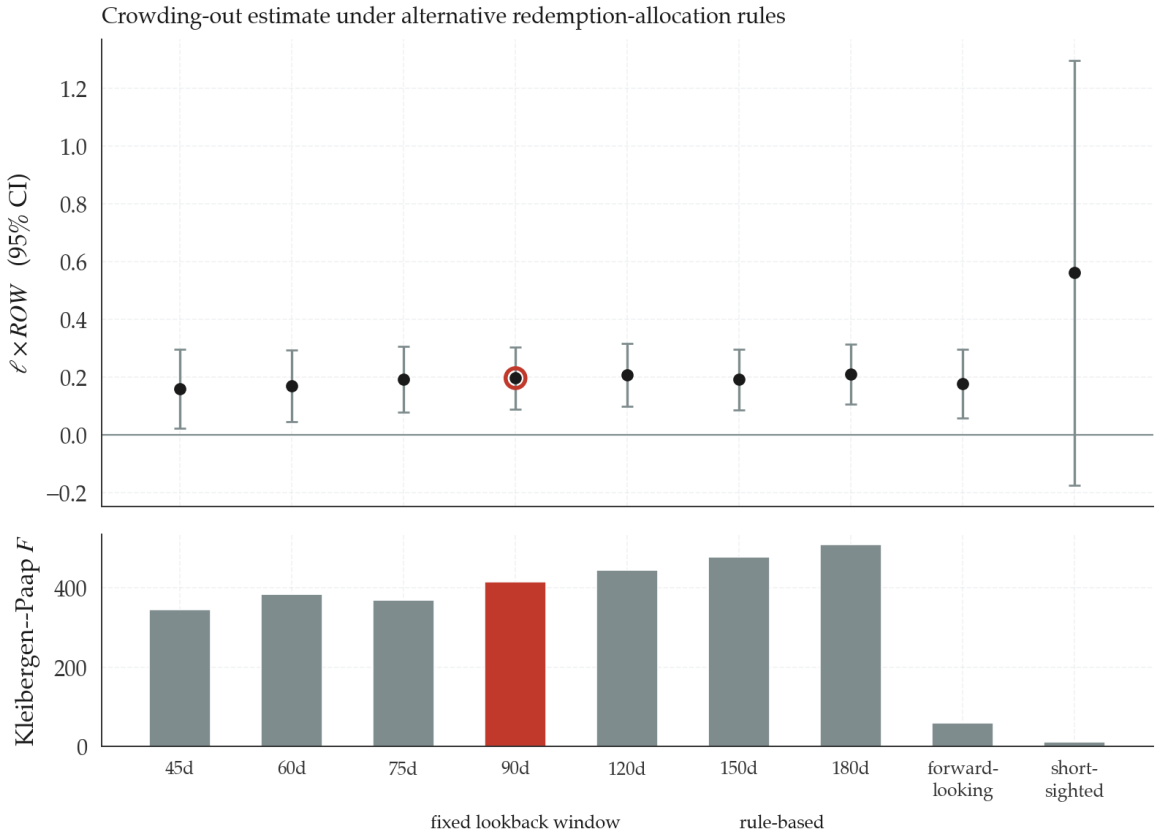


Figure A18: Sensitivity to the redemption-allocation rule

Notes: Each point re-estimates equation (10) using regional competing supply and a rebuilt rollover instrument. The first seven allocate redemptions over eligible auctions in the stated preceding calendar-day window; the last two use auctions between successive redemptions or the single preceding auction. Same-day redemptions are excluded. The baseline ninety-day window is marked in red; bars report KP statistics. Across sixty- to 180-day windows the interaction ranges from 0.169 to 0.210. All specifications retain the current HUB and three-day US offered-amount controls.

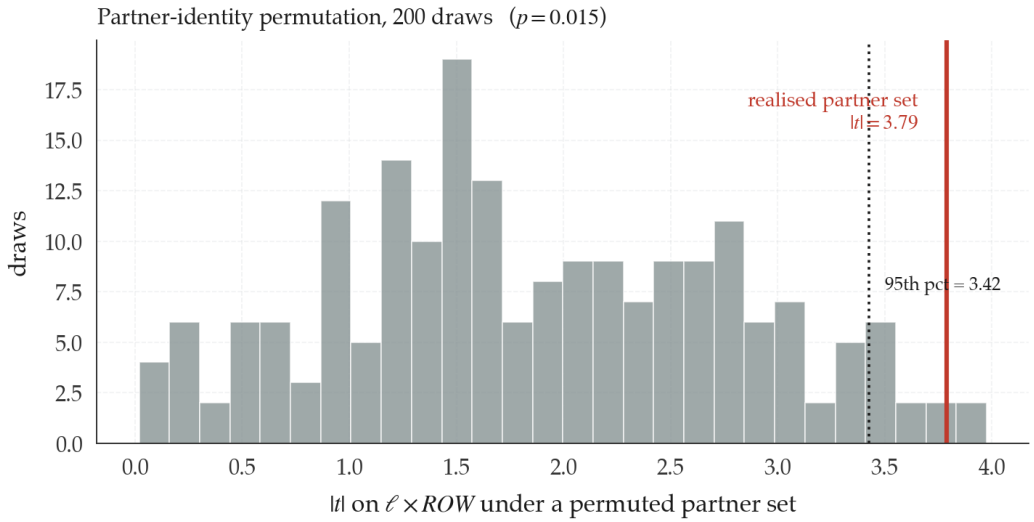


Figure A19: Trading-region partitions as a reference distribution

Notes: The histogram reports the absolute t-statistic of the regional interaction in 200 partner-identity permutations, preserving region sizes and each country's calendars. The US remains excluded from partner sums. The actual absolute t-statistic is 3.79; 3 draws reach it (tail frequency 0.015). 2 draws reach the actual coefficient of 0.216 (frequency 0.010). KP is 521 for the actual partition and averages 627 across permutations. These are descriptive label-reference diagnostics, not random assignment or a test excluding regional common shocks.

D.5 Advanced and emerging issuers, and intermediary capacity

The tables in this subsection ask who is crowded out and when. Main-text Table 2 reports the advanced–emerging comparison using the fully saturated specification. Table A19 asks whether that contrast can be replaced by a country characteristic, and Table A20 splits issuers by size. Table A21 estimates the capacity moderators of Table 3 on all issuers and on emerging markets. The remaining tables report alternative moderator measures, competing supply by region, and the high-supply threshold across cut-offs.

Table A19: Can a country characteristic replace the advanced–emerging split?

	Low	High	High − low
Openness p50, regional	0.490	1.368***	0.878*
	(0.379)	(0.357)	(0.510)
Openness p75, regional	1.006***	0.739	−0.267
	(0.273)	(1.208)	(1.316)
Openness p50, global	0.407	2.138***	1.731**
	(0.481)	(0.576)	(0.721)
Openness p75, global	1.366***	1.577**	0.210
	(0.442)	(0.780)	(0.850)
Annual issuance/GDP p50, regional	0.710**	1.174***	0.464
	(0.353)	(0.408)	(0.537)
Annual issuance/GDP p75, regional	0.656**	1.673***	1.017
	(0.326)	(0.561)	(0.642)
Annual issuance/GDP p50, global	0.841*	1.638***	0.797
	(0.447)	(0.595)	(0.734)
Annual issuance/GDP p75, global	0.972**	2.488**	1.516
	(0.387)	(1.080)	(1.126)
Issuance/day/GDP p50, regional	0.599**	2.081***	1.482*
	(0.257)	(0.802)	(0.824)
Issuance/day/GDP p75, regional	0.786***	2.239	1.454
	(0.271)	(1.649)	(1.577)
Issuance/day/GDP p50, global	1.089***	2.140**	1.051
	(0.370)	(0.838)	(0.870)
Issuance/day/GDP p75, global	0.970***	2.795**	1.825
	(0.359)	(1.370)	(1.286)

Notes. Country characteristics are cut at p50/p75 with one country, one vote. High minus low is tested in a fully saturated model. Supply scales remain fixed across groups.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A20: Crowding out and crowding in within small and within big issuers

	All		AE		EM	
	Small	Big	Small	Big	Small	Big
Panel A. Size: GDP						
$\ell \times ROW$	0.899*	0.834***	0.872**	1.231**	1.000	0.298
	(0.485)	(0.309)	(0.419)	(0.533)	(1.142)	(0.508)
$\ell \times HUB$	−1.041***	−0.676***	−0.922***	−1.328***	−1.223*	−0.139
	(0.384)	(0.246)	(0.350)	(0.487)	(0.699)	(0.247)
Kleibergen–Paap rk Wald F	121.0	394.5	181.3	147.9	51.1	169.3
Observations	3,824	7,356	2,664	4,037	1,675	2,804
Countries	12	12	6	7	5	6
Big − small, $\ell \times ROW$: p	0.909		0.598		0.558	
Big − small, $\ell \times HUB$: p	0.404		0.506		0.129	
Panel B. Size: issuance per auction day						
$\ell \times ROW$	0.826**	1.014**	1.039***	1.506	0.402	0.603
	(0.355)	(0.427)	(0.320)	(1.116)	(0.587)	(0.842)
$\ell \times HUB$	−0.880***	−0.850***	−0.731**	−1.872***	−0.591	0.148
	(0.268)	(0.311)	(0.321)	(0.705)	(0.399)	(0.303)
Kleibergen–Paap rk Wald F	232.7	284.1	233.9	106.0	102.1	223.4
Observations	5,292	5,888	3,175	3,526	2,225	2,254
Countries	12	12	6	7	5	6
Big − small, $\ell \times ROW$: p	0.727		0.700		0.833	
Big − small, $\ell \times HUB$: p	0.939		0.152		0.151	

Notes. Regional ROW; 2SLS. Each Small or Big column re-estimates the baseline on that subsample, including country-specific domestic-size slopes. Size is one number per country (mean over its panel years): GDP in Panel A, issuance per auction day in Panel B. Big countries are at or above the median of the column group (all issuers, advanced or emerging), one country, one vote. Big minus small is tested in a fully saturated model in which every coefficient and fixed effect is interacted with the big dummy. Supply scales remain fixed at full-panel units.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A21: Capacity moderators in the pooled sample and in emerging markets

	Δ_{21} log VIX	−HKM risk factor, 21bd	1{*ROW* high}	Issuance / GDP within issuer
Panel A. All issuers				
ROW	0.215*	0.245**	0.418	0.155
	(0.123)	(0.123)	(0.390)	(0.121)
$\ell \times ROW$	0.955***	0.721***		0.801***
	(0.262)	(0.263)		(0.274)
$ROW \times M$	−0.126	0.055	−0.344	0.182
	(0.152)	(0.149)	(0.455)	(0.135)
$\ell \times ROW \times M$	0.257	0.176	1.187**	0.531**
	(0.171)	(0.182)	(0.468)	(0.226)
HUB	−0.225**	−0.240**	−0.215*	−0.232**
	(0.109)	(0.114)	(0.111)	(0.107)
$\ell \times HUB$	−0.800***	−0.702***	−0.732***	−0.735***
	(0.213)	(0.204)	(0.203)	(0.208)
Kleibergen–Paap *F*	162	165	119	153
Observations	11,180	10,535	11,180	11,116
Panel B. Emerging markets				
ROW	0.083	0.094	0.726	0.026
	(0.206)	(0.211)	(0.700)	(0.215)
$\ell \times ROW$	0.474	0.149		0.535
	(0.465)	(0.516)		(0.467)
$ROW \times M$	−0.270	−0.003	−0.697	−0.017
	(0.186)	(0.201)	(0.759)	(0.168)
$\ell \times ROW \times M$	0.058	−0.353	0.217	0.181
	(0.333)	(0.384)	(0.770)	(0.306)
HUB	−0.197	−0.196	−0.204	−0.154
	(0.172)	(0.183)	(0.182)	(0.176)
$\ell \times HUB$	−0.304	−0.274	−0.245	−0.248
	(0.258)	(0.269)	(0.245)	(0.246)
Kleibergen–Paap *F*	71	68	92	34
Observations	4,479	4,228	4,479	4,444
Country $\times M$	Yes	Yes	Yes	Yes

Notes. The four columns of Table 3, estimated on all 24 issuers (Panel A) and on emerging markets (Panel B). Column (3) omits the plain $\ell \times ROW$ term. ROW products have matching rollover instruments, country-specific moderator loadings are included, and the continuous US and HUB blocks are retained.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A22: Alternative moderators of crowding out

	AE	EM	All
Panel A. Intermediary capital			
−capital ratio, Δ_{21}	0.534**	−0.078	0.250
	(0.245) [127]	(0.320) [108]	(0.196) [213]
−capital ratio, Δ_{10}	0.395*	−0.109	0.136
	(0.221) [129]	(0.351) [92]	(0.198) [189]
−dealer return, 21bd	0.438**	0.092	0.241
	(0.202) [139]	(0.302) [111]	(0.166) [214]
−dealer return, 10bd	0.529***	−0.137	0.233
	(0.190) [59]	(0.378) [39]	(0.172) [54]
−capital risk factor, 10bd	0.566**	−0.347	0.208
	(0.222) [20]	(0.416) [17]	(0.200) [15]
Leverage ratio^2, Δ_{10}	0.836***	−0.026	0.433*
	(0.313) [12]	(0.336) [22]	(0.233) [10]
Leverage ratio^2, Δ_{21}	0.524	−0.573	0.079
	(0.388) [7]	(0.619) [8]	(0.249) [8]
Panel B. Volatility: levels and other horizons			
log VIX, level	−0.177	−0.906**	−0.390**
	(0.200) [135]	(0.390) [118]	(0.170) [229]
Δ_5 log VIX	0.123	−0.186	−0.050
	(0.228) [106]	(0.411) [73]	(0.207) [199]
Δ_{42} log VIX	0.167	−0.185	−0.000
	(0.196) [135]	(0.353) [37]	(0.186) [129]
Δ_{63} log VIX	−0.059	0.039	0.014
	(0.198) [132]	(0.423) [21]	(0.175) [98]
log MOVE, level	−0.125	−0.111	−0.185
	(0.238) [124]	(0.394) [28]	(0.194) [150]
Δ_{10} log MOVE	0.305	−0.338	0.032
	(0.187) [139]	(0.439) [89]	(0.189) [205]
Δ_{21} log MOVE	0.207	−0.166	−0.039
	(0.197) [142]	(0.336) [76]	(0.180) [190]
Panel C. Issuance intensity			
Annual issuance / GDP	0.534	0.196	0.519
	(0.731) [123]	(0.367) [62]	(0.543) [163]
Issuance / active month / GDP	0.581	0.255	0.549
	(0.728) [127]	(0.374) [57]	(0.539) [164]
Issuance / active week / GDP	0.075	−0.196	−0.127
	(0.697) [65]	(0.357) [41]	(0.403) [76]
Issuance / auction day / GDP	0.220	−0.207	−0.075
	(0.605) [58]	(0.357) [40]	(0.344) [73]
Auction days / year	0.182	0.878	0.340*
	(0.259) [100]	(0.545) [101]	(0.182) [147]
Panel D. Financial openness			
Openness $(A + L)/GDP$	−0.181	−0.023	0.002
	(0.403) [55]	(0.326) [28]	(0.300) [72]
Panel E. Global competing supply			
Δ_{10} VIX	0.472*	−0.431	−0.160
	(0.279) [117]	(0.283) [74]	(0.196) [113]
Δ_{21} VIX	0.193	−0.366*	0.016
	(0.254) [115]	(0.217) [71]	(0.162) [115]
−capital risk factor, 21bd	0.542**	−0.202	0.168
	(0.259) [115]	(0.211) [70]	(0.150) [120]
−dealer return, 21bd	0.478*	−0.162	0.121
	(0.248) [121]	(0.228) [88]	(0.155) [131]
Annual issuance / GDP	−0.637	0.476*	−0.325
	(0.549) [124]	(0.283) [76]	(0.404) [137]
Issuance / auction day / GDP	−0.299	0.072	−0.137
	(0.353) [133]	(0.286) [75]	(0.249) [126]
Openness $(A + L)/GDP$	−0.177	0.193	−0.043
	(0.388) [104]	(0.292) [53]	(0.198) [117]

Notes. Each cell reports $\ell \times ROW \times M$ from the specification of Table 3, one moderator M per row, estimated on advanced economies, emerging markets or all issuers; the HUB slope is not interacted with M. Kleibergen–Paap F statistics in brackets. Moderators are standardised within the estimation group; supply scales remain fixed globally. Panels A–D use regional competing supply, Panel E global competing supply (excluding the United States). Monthly within-issuer issuance/GDP is the main-table issuance moderator.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A23: Same-region and other-region competing supply, jointly instrumented

	All 24	Advanced	Emerging	Asia-Pacific	EMEA	Americas
$\ell \times ROW^{\,same\ region}$	2.245***	2.902***	1.072	2.363***	2.813	2.849
	(0.546)	(0.699)	(0.941)	(0.830)	(1.742)	(3.532)
$\ell \times ROW^{\,other\ regions}$	1.003**	1.161*	0.350	0.942	1.299**	−0.374
	(0.394)	(0.652)	(0.459)	(1.694)	(0.533)	(0.599)
difference, same − other	1.241**	1.742***	0.723	1.421	1.514	3.223
	(0.487)	(0.616)	(0.812)	(1.273)	(1.409)	(3.745)
$ROW^{\,same\ region}$	0.257	0.338	−0.015	0.298	0.011	−3.274
	(0.267)	(0.351)	(0.402)	(0.394)	(0.755)	(2.967)
$ROW^{\,other\ regions}$	−0.300	−0.233	−0.281	−1.091	−0.265	−0.215
	(0.237)	(0.337)	(0.307)	(0.944)	(0.272)	(0.433)
Countries	24	13	11	10	10	4
Kleibergen–Paap F	121.4	116.0	73.5	37.9	15.6	38.4
Observations	11,180	6,701	4,479	4,953	4,337	1,890

Notes. Same-region and other-region supply enter jointly with matching rollover instruments for both levels and both domestic-size interactions. The components sum to global ex-US supply. Both use the global total's within-country standard deviation; same minus other therefore compares equal-sized supply shocks, using the joint covariance. Marginal comparisons in the companion figure estimate one block at a time.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A24: Capacity moderators with the HUB slope freed

	Δ_{21} log VIX	−HKM risk factor, 21bd	$1\{ROW \text{ high}\}$	Issuance / GDP within issuer
Panel A. Breadth not interacted with M				
ROW	0.236	0.240	0.550	0.197
	(0.150)	(0.150)	(0.471)	(0.146)
$\ell \times ROW$	1.295***	1.026***		1.142***
	(0.319)	(0.289)		(0.327)
$ROW \times M$	−0.058	0.099	−0.576	0.328*
	(0.196)	(0.184)	(0.550)	(0.188)
$\ell \times ROW \times M$	0.441**	0.521**	1.899***	0.724**
	(0.200)	(0.227)	(0.582)	(0.324)
HUB	−0.153	−0.157	−0.148	−0.205
	(0.142)	(0.146)	(0.141)	(0.138)
$\ell \times HUB$	−1.302***	−1.063***	−1.244***	−1.232***
	(0.332)	(0.298)	(0.315)	(0.324)
Kleibergen–Paap F	124	127	49	130
Observations	6,701	6,307	6,701	6,672
Panel B. Freeing the HUB slope				
ROW	0.229	0.237	0.543	0.189
	(0.151)	(0.151)	(0.501)	(0.147)
$\ell \times ROW$	1.286***	1.029***		1.134***
	(0.320)	(0.292)		(0.327)
$ROW \times M$	−0.210	−0.000	−0.585	0.395*
	(0.216)	(0.217)	(0.630)	(0.219)
$\ell \times ROW \times M$	0.431*	0.557*	1.731***	0.896**
	(0.224)	(0.285)	(0.618)	(0.370)
HUB	−0.141	−0.150	−0.169	−0.196
	(0.145)	(0.146)	(0.199)	(0.138)
$\ell \times HUB$	−1.284***	−1.073***	−1.463***	−1.234***
	(0.332)	(0.298)	(0.480)	(0.324)
$HUB \times M$	0.265*	0.179	0.050	−0.111
	(0.160)	(0.159)	(0.277)	(0.138)
$\ell \times HUB \times M$	0.010	−0.075	0.507	−0.283
	(0.291)	(0.310)	(0.576)	(0.311)
Kleibergen–Paap F	102	9	53	106
Observations	6,701	6,307	6,701	6,672
Country $\times M$	Yes	Yes	Yes	Yes

Notes. Moderator specifications retain the continuous US and HUB blocks. Free HUB adds $HUB \times M$ and $\ell \times HUB \times M$. ROW products have matching rollover instruments and country-specific moderator loadings are included. Samples are indicated in the table.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

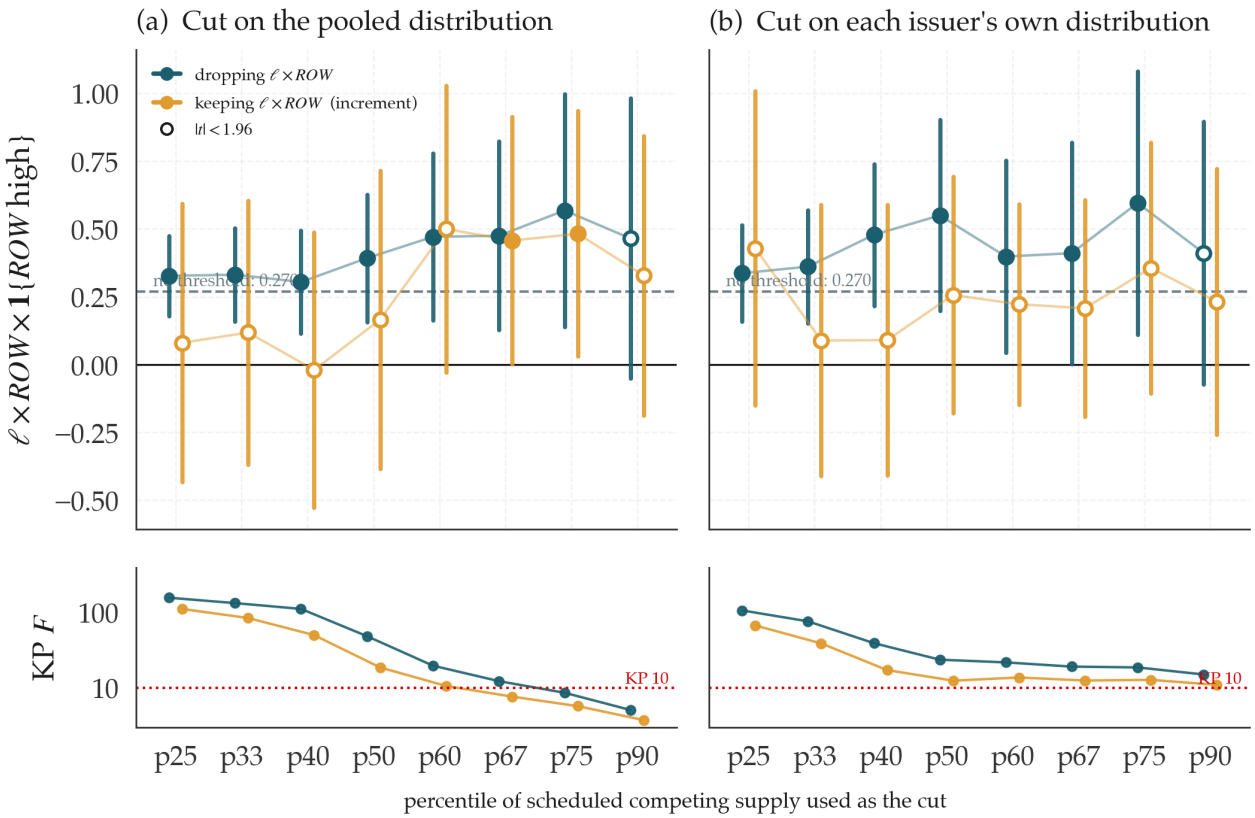
Table A25: A threshold in competing supply: where the cut is put

	$p25$	$p33$	$p40$	$p50$	$p60$	$p67$	$p75$	$p90$
Share of days above the cut	0.79	0.69	0.62	0.51	0.41	0.34	0.26	0.11
Panel A. Keeping $\ell \times ROW$								
$\ell \times ROW$	1.224	1.047	1.577	1.094	−0.145	0.105	0.548	0.940***
	(1.227)	(1.157)	(1.181)	(1.136)	(1.040)	(0.800)	(0.579)	(0.357)
$\ell \times ROW \times \mathbf{1}$	0.389	0.573	−0.096	0.802	2.420*	2.213**	2.336**	1.590
	(1.266)	(1.203)	(1.251)	(1.359)	(1.306)	(1.125)	(1.118)	(1.273)
$ROW \times \mathbf{1}$	−1.496***	−1.643***	−1.169**	−0.715	−0.379	−0.292	0.053	−0.336
	(0.518)	(0.491)	(0.529)	(0.566)	(0.528)	(0.466)	(0.430)	(0.479)
$\ell \times \mathbf{1}$	−0.665	−0.211	−0.363	−0.243	0.557	0.220	−0.616	−0.420
	(1.264)	(1.194)	(1.165)	(1.030)	(0.911)	(0.839)	(0.934)	(1.554)
ROW	1.614***	1.860***	1.184**	0.682	0.421	0.428	−0.006	0.310
	(0.493)	(0.463)	(0.460)	(0.481)	(0.407)	(0.323)	(0.287)	(0.190)
Kleibergen–Paap F	113	85	50	19	11	8	6	4
Observations	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701
Panel B. Dropping $\ell \times ROW$								
$\ell \times ROW \times \mathbf{1}$	1.585***	1.604***	1.474***	1.899***	2.279***	2.299***	2.751***	2.250*
	(0.365)	(0.427)	(0.467)	(0.582)	(0.759)	(0.860)	(1.061)	(1.275)
$ROW \times \mathbf{1}$	−1.381***	−1.510***	−0.949*	−0.576	−0.391	−0.282	0.114	−0.234
	(0.524)	(0.491)	(0.532)	(0.550)	(0.516)	(0.458)	(0.426)	(0.474)
$\ell \times \mathbf{1}$	0.202	0.513	0.735	0.573	0.449	0.298	−0.269	−0.093
	(0.626)	(0.574)	(0.524)	(0.489)	(0.532)	(0.633)	(0.822)	(1.484)
ROW	1.497***	1.725***	0.965**	0.550	0.433	0.419	−0.065	0.216
	(0.499)	(0.466)	(0.473)	(0.471)	(0.400)	(0.319)	(0.289)	(0.187)
Kleibergen–Paap F	159	135	113	49	20	12	9	5
Observations	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701

Notes. Cut-offs and whether the plain ROW interaction is retained vary as labelled; the preferred cut uses predetermined rollover need. Baseline HUB and continuous US controls are retained.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.



Notes: Table A25 and its version with within-country cut-offs drawn; advanced economies. Each marker is the coefficient on $\ell \times ROW \times \mathbf{1}\{ROW \text{ high}\}$ from a separate regression in which the indicator is switched on above the stated percentile of the need-based competing-supply distribution, with its 95% confidence interval; hollow markers are estimates with $|t| < 1.96$. The teal series drops the plain $\ell \times ROW$, so it is the domestic-size slope on high-supply days with the remaining days constrained to zero; the orange series keeps it, so it is the increment over those days. The share of days above the cut runs from 0.79 at the twenty-fifth percentile to 0.11 at the ninetieth. The dashed line is the single-slope estimate with no threshold at all, which is what a threshold specification has to beat. The lower strip is the Kleibergen–Paap statistic on a log scale.

Two things the table makes easy to miss. The teal series drifts up as the cut is raised, but the intervals fan out with it, and the upward drift is partly mechanical: a higher cut constrains a larger share of days to a zero slope. The first stage falls by a factor of roughly thirty-five across the grid and crosses ten around the sixty-seventh percentile on the pooled cut, so the right-hand columns are weak-instrument estimates. The orange interval covers zero at every cut in both panels.

Figure A20: The high-supply threshold across cut-offs

D.6 What the issuance moderator measures

The issuance moderator in column (4) of Table 3 is the previous calendar year's eligible issuance per active issuance month, divided by GDP and demeaned within issuer. Crowding out requires a balance sheet shared with other issuers; dedicated domestic demand (domestic pension funds, insurers and banks) is not shared. What matters is therefore the part of a programme that standing domestic demand was not built to absorb. Domestic absorptive capacity is a slow-moving stock, so the issuer's own average is the relevant benchmark and the deviation from it is the informative variation. Table A26 supports this reading. In advanced economies, the between-issuer part of the annual measure

is uninformative (−0.944, standard error 1.110), while the within-issuer part is 0.664 (0.311), and it is unchanged when both enter jointly. Dividing issuance by the number of active months adds no separate concentration channel beyond the level of issuance. The sub-period tables (Tables A27 and A28) state the main caveat: the within-issuer interaction is carried by 2008–2012 (1.981 against 0.146 in 2013–2025 for the main-table measure) and is not significant outside that window.

Table A26: The issuance moderator: between issuers, within issuers, level and concentration

	Advanced	$+ br. \times M$	All	$+ br. \times M$
Levels, pooled z (the ladder as previously reported)	0.534	1.454*	0.519	1.228**
	(0.731)	(0.785)	(0.543)	(0.580)
between issuers only	−0.944	−0.025	−0.552	0.237
	(1.110)	(1.169)	(0.854)	(0.892)
within issuer only	0.664**	0.845**	0.499**	0.527**
	(0.311)	(0.357)	(0.216)	(0.261)
Both entered jointly: between issuers	−0.671	0.287	−0.504	0.318
	(1.120)	(1.177)	(0.859)	(0.898)
within issuer	0.675**	0.801**	0.498**	0.498*
	(0.312)	(0.342)	(0.219)	(0.260)
Level and concentration jointly: log(issuance / GDP)	0.639	1.609***	0.543*	1.196***
	(0.402)	(0.506)	(0.323)	(0.381)
− log(months with issuance)	0.285	0.489	−0.094	0.115
	(0.402)	(0.500)	(0.381)	(0.433)
The same, both taken within issuer: log(issuance / GDP)	0.719**	0.945***	0.554**	0.553**
	(0.297)	(0.347)	(0.220)	(0.261)
− log(months with issuance)	0.330	0.323	0.083	−0.041
	(0.330)	(0.399)	(0.281)	(0.314)
Observations	6,672	6,672	11,116	11,116

Notes. Each moderator cell reports $\ell \times ROW \times M$; Free HUB also includes $HUB \times M$ and $\ell \times HUB \times M$. Moderator standardisation uses the estimation group; supply scales remain fixed globally. Monthly within-issuer issuance/GDP is the main-table issuance moderator. Brackets report joint KP statistics where shown.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A27: The issuance moderator across sub-periods

	Full sample	Ex 2008–2012	2008–2012	2013–2025
Panel A. Baseline specification (as in the main table)				
Monthly, pooled z	0.581	−0.354	1.513	−0.159
	(0.728)	(0.872)	(1.469)	(0.927)
	[127]	[105]	[40]	[91]
Monthly, within issuer (main table)	0.724**	0.122	1.981**	0.146
	(0.324)	(0.304)	(0.928)	(0.309)
	[130]	[121]	[70]	[105]
Annual, pooled z	0.534	−0.385	1.010	−0.181
	(0.731)	(0.881)	(1.430)	(0.918)
	[123]	[101]	[39]	[90]
Annual, within issuer	0.664**	0.108	1.649*	0.137
	(0.311)	(0.298)	(0.860)	(0.310)
	[135]	[124]	[70]	[109]
Log annual, pooled z	0.593*	−0.044	0.916	0.122
	(0.329)	(0.385)	(0.778)	(0.408)
	[123]	[86]	[49]	[40]
Log annual, within issuer	0.629***	0.042	1.355**	0.156
	(0.239)	(0.245)	(0.625)	(0.251)
	[109]	[111]	[65]	[90]
Panel B. Freeing the HUB slope, + $HUB \times M$				
Monthly, pooled z	1.495*	0.664	1.460	0.854
	(0.783)	(0.915)	(1.534)	(0.973)
	[110]	[94]	[41]	[81]
Monthly, within issuer (main table)	0.896**	0.492	1.730*	0.562
	(0.370)	(0.378)	(0.930)	(0.391)
	[106]	[102]	[23]	[83]
Annual, pooled z	1.454*	0.663	0.946	0.857
	(0.785)	(0.921)	(1.508)	(0.962)
	[110]	[91]	[41]	[80]
Annual, within issuer	0.845**	0.479	1.385	0.549
	(0.357)	(0.379)	(0.862)	(0.397)
	[111]	[106]	[28]	[87]
Log annual, pooled z	1.451***	1.053**	1.140	1.237**
	(0.415)	(0.491)	(0.860)	(0.530)
	[48]	[33]	[15]	[23]
Log annual, within issuer	0.825***	0.296	1.602**	0.288
	(0.271)	(0.299)	(0.628)	(0.346)
	[61]	[69]	[10]	[42]
Observations	6,672	5,262	1,410	5,069

Notes. Each moderator cell reports $\ell \times ROW \times M$; Free HUB also includes $HUB \times M$ and $\ell \times HUB \times M$. Moderator standardisation uses the estimation group; supply scales remain fixed globally. Monthly within-issuer issuance/GDP is the main-table issuance moderator. Brackets report joint KP statistics where shown.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A28: The issuance moderator across sub-periods, pooled

	Full sample	Ex 2008–2012	2008–2012	2013–2025
Panel A. Baseline specification (as in the main table)				
Monthly, pooled z	0.549	−0.470	2.899**	−0.168
	(0.539)	(0.608)	(1.204)	(0.673)
	[164]	[144]	[18]	[118]
Monthly, within issuer (main table)	0.531**	−0.112	2.098***	−0.009
	(0.226)	(0.201)	(0.621)	(0.215)
	[153]	[128]	[13]	[84]
Annual, pooled z	0.519	−0.466	2.396**	−0.173
	(0.543)	(0.621)	(1.147)	(0.676)
	[163]	[143]	[19]	[121]
Annual, within issuer	0.499**	−0.111	1.794***	−0.017
	(0.216)	(0.197)	(0.573)	(0.216)
	[166]	[145]	[13]	[92]
Log annual, pooled z	0.625**	−0.172	1.451**	0.036
	(0.269)	(0.330)	(0.566)	(0.358)
	[122]	[76]	[34]	[54]
Log annual, within issuer	0.560***	−0.200	1.573***	−0.072
	(0.177)	(0.197)	(0.445)	(0.219)
	[133]	[83]	[44]	[47]
Panel B. Freeing the HUB slope, + $HUB \times M$				
Monthly, pooled z	1.260**	0.321	2.786**	0.623
	(0.578)	(0.643)	(1.260)	(0.708)
	[153]	[136]	[17]	[112]
Monthly, within issuer (main table)	0.528**	−0.065	1.874***	0.111
	(0.267)	(0.247)	(0.658)	(0.262)
	[96]	[68]	[11]	[45]
Annual, pooled z	1.228**	0.332	2.280*	0.627
	(0.580)	(0.657)	(1.220)	(0.711)
	[155]	[135]	[18]	[114]
Annual, within issuer	0.527**	−0.021	1.522**	0.159
	(0.261)	(0.249)	(0.616)	(0.269)
	[105]	[74]	[11]	[48]
Log annual, pooled z	1.100***	0.370	1.459**	0.594
	(0.326)	(0.405)	(0.612)	(0.434)
	[68]	[59]	[31]	[44]
Log annual, within issuer	0.588***	−0.225	1.613***	−0.154
	(0.214)	(0.241)	(0.459)	(0.274)
	[67]	[36]	[18]	[22]
Observations	11,116	9,053	2,063	8,738

Notes. Each moderator cell reports $\ell \times ROW \times M$; Free HUB also includes $HUB \times M$ and $\ell \times HUB \times M$. Moderator standardisation uses the estimation group; supply scales remain fixed globally. Monthly within-issuer issuance/GDP is the main-table issuance moderator. Brackets report joint KP statistics where shown.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.7 Competing supply within and across maturity buckets

The baseline measure of competing supply adds up every partner auction above three years, so a thirty-year auction is credited with competing five-year supply. If the relevant marginal buyer is a duration bucket rather than the sovereign complex as a whole, that is measurement error. Table A29 splits competing supply into the part issued in the domestic auction's own maturity bucket — $(3, 7]$, $(7, 15]$ or $(15, \infty]$ years, assigned from the accepted-weighted average maturity of the domestic country-day — and the part issued in the other two. Both parts are instrumented by the corresponding rollover-need aggregates. The allocation calendar deliberately remains the country's full eligible auction calendar rather than the bucket's: a treasury pre-funds a maturing long bond out of whatever it sells that quarter, and restricting the calendar to same-bucket auctions would impose a funding rule the data do not support and would make the instrument a function of the partition.

Panel A enters one aggregate at a time, which is the identified comparison. For advanced economies the domestic-bucket estimate is 0.647 against 0.404 for undifferentiated supply and 0.321 for supply in other buckets; same-bucket supply is also the smaller quantity, 2.8 against 5.1 billion dollars a day on average, so the difference per dollar issued is larger still. Panel B enters both jointly. It is reported for completeness only: the two rollover-need instruments cannot separate the two aggregates, with a Kleibergen–Paap statistic between 3 and 5, and nothing in it should be read.

Table A29: Competing supply in the same maturity bucket and in other buckets

	AE	EM	All 24
Panel A. One competing-supply aggregate at a time			
all > 3y	1.885***	0.517	1.399***
	(0.588)	(0.498)	(0.383)
same maturity bucket	3.374**	−0.591	1.634*
	(1.453)	(1.059)	(0.892)
other maturity buckets	1.590**	1.130*	1.518***
	(0.764)	(0.680)	(0.499)
Kleibergen–Paap F (all / same / other)	244 / 29 / 110	144 / 27 / 97	238 / 50 / 131
Panel B. Both aggregates jointly, joint first-stage diagnostic below			
same maturity bucket	1.996	−1.544	0.725
	(2.317)	(1.669)	(1.252)
other maturity buckets	1.171	1.681	1.262*
	(1.245)	(1.164)	(0.767)
Kleibergen–Paap F	2.8	2.7	3.6
$\ell \times HUB$	−2.133***	−0.602	−1.454***
	(0.585)	(0.415)	(0.357)
Observations	6,701	4,479	11,180

Notes. Global ex-US supply is split into the domestic auction's maturity bucket and other buckets: (3,7], (7,15] and above 15 years. The first block enters one aggregate at a time; the second enters both jointly with their matching rollover instruments. The allocation calendar remains each partner's full eligible auction calendar. Joint first-stage strength is reported explicitly. The baseline HUB and continuous US blocks are retained.
The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.8 Hub presence: alternative measures, inference and the United States

Table A30: Split concurrent supply in emerging economies

	Split ROW (1) EM	Split ROW + connectedness (2) EM
$\ell \times ROW_{same}$	0.968	0.983
	(0.935)	(0.804)
$\ell \times ROW_{other}$	0.411	0.463
	(0.452)	(0.354)
$\ell \times HUB$	−0.456	
	(0.404)	
$\ell \times P_{con}$		−1.429**
		(0.610)
$\ell \times P_{rest}$		0.307
		(0.345)
$\ell \times US$	0.257	0.309
	(0.228)	(0.226)
Kleibergen–Paap rk Wald F	72.4	120.8
Observations	4,396	4,396
Test: $\ell\times$	ROW: same/other	P: con/rest
p-value	0.482	0.015

Notes. Emerging-economy counterparts of Split ROW and Split ROW + HUB in the main table. Both columns use the identical dealer-data sample (4,396 observations). Same-region and other-region ROW enter jointly in levels and domestic-size interactions, instrumented by matching rollover need and scaled by the full-panel within-country SD of the global total. Column 2 replaces HUB by the unweighted auction presence of connected partners (*con*, dealer-network centrality above the median of the domestic issuer's partners) and the rest (*rest*), with one common SD, as in the main table. All other controls, fixed effects, country domestic-size slopes, windows and country definitions match the main table. The final two rows test equality of the indicated domestic-size interaction coefficients, using the joint covariance. Driscoll–Kraay SEs (bandwidth 20) in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A31: HUB presence: counts, GDP weights and any-hub indicator

	Count (baseline) Regional	Count (baseline) Global	GDP-weighted Regional	GDP-weighted Global	Any hub Regional	Any hub Global
ROW	0.218*	−0.084	0.216*	−0.185	0.174	−0.068
	(0.124)	(0.221)	(0.127)	(0.275)	(0.114)	(0.156)
$\ell \times ROW$	0.945***	1.399***	0.910***	1.580***	0.717***	0.584**
	(0.263)	(0.383)	(0.274)	(0.499)	(0.232)	(0.237)
HUB	−0.223**	−0.056	−0.192*	0.067	−0.198**	−0.106
	(0.108)	(0.175)	(0.111)	(0.220)	(0.098)	(0.115)
$\ell \times HUB$	−0.807***	−1.413***	−0.712***	−1.521***	−0.583***	−0.663***
	(0.212)	(0.349)	(0.219)	(0.450)	(0.185)	(0.213)
US	−0.051	−0.112	−0.060	−0.139	−0.059	−0.109
	(0.083)	(0.100)	(0.083)	(0.105)	(0.083)	(0.092)
$\ell \times US$	0.187	0.361**	0.144	0.332*	0.149	0.178
	(0.153)	(0.178)	(0.151)	(0.185)	(0.153)	(0.161)
Kleibergen–Paap rk Wald F	416.3	237.9	395.7	160.9	490.2	445.6
Observations	11,180	11,180	11,180	11,180	11,180	11,180

Notes. 2SLS. Count, the baseline HUB measure, is the number of other hub countries issuing. GDP-weighted weights each hub's presence by its real-time GDP. Any hub is the indicator that at least one other hub issues on a day, averaged over the centred three-day window. Each alternative uses its own within-country standard deviation. The club is fixed at DEU, FRA, GBR, ITA and JPN.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A32: Same-day ROW and HUB robustness

	ROW/HUB: c3/d0 Regional	ROW/HUB: c3/d0 Global	ROW/HUB: d0/c3 Regional	ROW/HUB: d0/c3 Global	ROW/HUB: d0/d0 Regional	ROW/HUB: d0/d0 Global
ROW	0.143	−0.074	0.115	−0.256**	0.184	−0.385**
	(0.113)	(0.137)	(0.098)	(0.106)	(0.114)	(0.181)
$\ell \times ROW$	0.553**	0.377*	0.411**	0.162	0.582***	0.544*
	(0.219)	(0.213)	(0.190)	(0.168)	(0.217)	(0.295)
HUB	−0.141	−0.103	−0.126	−0.017	−0.196*	0.141
	(0.089)	(0.094)	(0.099)	(0.105)	(0.103)	(0.161)
$\ell \times HUB$	−0.419***	−0.474***	−0.489***	−0.474**	−0.556***	−0.710**
	(0.158)	(0.178)	(0.175)	(0.185)	(0.181)	(0.287)
US	−0.001	−0.044	−0.021	−0.061	−0.010	−0.083
	(0.081)	(0.085)	(0.078)	(0.078)	(0.077)	(0.078)
$\ell \times US$	0.014	0.014	−0.010	−0.003	0.004	0.050
	(0.152)	(0.157)	(0.147)	(0.148)	(0.151)	(0.159)
Kleibergen–Paap rk Wald F	572.6	685.3	304.4	1193.0	251.9	574.2
Observations	11,180	11,180	11,180	11,180	11,180	11,180

Notes. 2SLS. The three column pairs replace HUB timing alone, ROW timing alone, and both with the auction-day measure d0. The ROW instrument always matches the ROW window. The US block remains d0 throughout. The c3/c3 reference is Table 1.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A33: Randomisation inference for HUB and dealer connectedness

	Three-day window		Same day	
Panel A. Club permutation: $\ell \times HUB$				
	Regional	Global	Regional	Global
$\ell \times HUB$ (actual club)	−0.807	−1.413	−0.556	−0.710
	(0.212)	(0.349)	(0.181)	(0.287)
RI p: clubs of non-hub issuers	< 0.001	< 0.001	0.003	0.012
RI p: all five-country clubs	0.061	0.039	0.028	0.051
RI p: region-matched clubs	0.129	0.089	0.094	0.148
Non-hub clubs with $\lvert t \rvert > 1.96$	31%	29%	9%	8%
Clubs: non-hub / all / region-matched	26,334 / 80,730 / 7,150			
Panel B. Dealer-list permutation: $\ell \times P_{con} - \ell \times P_{rest}$				
	All	AE	All	AE
Connected − rest (actual dealer lists)	−2.079	−2.123	−1.212	−0.585
	(0.578)	(0.956)	(0.416)	(0.781)
RI p, one-sided	0.007	0.052	0.046	0.345
RI p, two-sided	0.013	0.171	0.049	0.598
Placebos with $\lvert t \rvert > 1.96$	22%	23%	20%	16%
Permutations	2,000			

Notes. Panel A re-estimates the baseline 2SLS (regional or global ROW) with HUB rebuilt from every five-country club of the non-U.S. partners, enumerated exactly, with the same construction and units as the baseline. The RI p-value is the share of reference clubs whose $\ell \times HUB$ t-statistic is at or below the actual one. Region-matched clubs have four EMEA members and one Asia-Pacific member, as the actual club. Panel B relabels the dealer lists across issuers with one persistent permutation and recomputes partner centrality, the per-issuer median split and the Split ROW + connectedness model of Table 2; partners without dealer data stay in the rest. Same day: ROW and HUB or presence measured on the auction day.

The HUB club, continuous US block, global supply scales and control definitions are as in Table 1, except for the stated changes.

Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A34: The United States as an ordinary supplier

	Baseline		U.S. in ROW and HUB		U.S. in ROW and HUB and U.S. outcomes	
	(1) Regional	(2) Global	(3) Regional	(4) Global	(5) Regional	(6) Global
Panel A. Per SD of each column's own supply measure						
ROW	0.218*	−0.084	0.021	0.002	0.016	0.002
	(0.124)	(0.221)	(0.084)	(0.151)	(0.080)	(0.142)
$\ell \times ROW$	0.945***	1.399***	0.380**	0.561*	0.345**	0.623**
	(0.263)	(0.383)	(0.157)	(0.306)	(0.148)	(0.292)
HUB	−0.223**	−0.056	−0.172*	−0.168	−0.150	−0.147
	(0.108)	(0.175)	(0.103)	(0.144)	(0.097)	(0.134)
$\ell \times HUB$	−0.807***	−1.413***	−0.515***	−0.759***	−0.463***	−0.763***
	(0.212)	(0.349)	(0.190)	(0.277)	(0.176)	(0.258)
US	−0.051	−0.112	–	–	–	–
	(0.083)	(0.100)				
$\ell \times US$	0.187	0.361**	–	–	–	–
	(0.153)	(0.178)				
Panel B. Per SD of the baseline supply measure						
ROW			0.009	0.001	0.007	0.001
			(0.038)	(0.055)	(0.038)	(0.054)
$\ell \times ROW$			0.171**	0.205*	0.162**	0.237**
			(0.071)	(0.112)	(0.070)	(0.111)
HUB			−0.130*	−0.128	−0.115	−0.113
			(0.078)	(0.109)	(0.074)	(0.103)
$\ell \times HUB$			−0.390***	−0.575***	−0.355***	−0.586***
			(0.144)	(0.210)	(0.135)	(0.198)
U.S. in ROW and HUB	No	No	Yes	Yes	Yes	Yes
U.S. auctions in sample	No	No	No	No	Yes	Yes
Kleibergen–Paap rk Wald F	416.3	237.9	495.0	206.7	549.1	227.6
Observations	11,180	11,180	11,180	11,180	12,287	12,287

Notes. 2SLS. Columns (1)–(2) are Table 1: the United States is excluded from ROW, its rollover need and HUB, and enters through the separate offered-amount block *US*. Columns (3)–(6) drop that block and treat the United States as an ordinary supplier: its issuance enters regional ROW (Americas) and global ROW, its rollover need enters the matching instruments, and HUB adds the United States to DEU, FRA, GBR, ITA and JPN, excluding the domestic country. Columns (3)–(4) keep the 24-country outcome sample; columns (5)–(6) add 1,107 U.S. auction-day observations as outcomes. Panel A standardises supply by the within-country SD of each column's own measure. Panel B divides supply in columns (3)–(6) by the within-country SD of the corresponding baseline measure, so every column is per the same dollar (ROW) or hub-presence (HUB) shock; the U.S.-inclusive SD relative to the baseline is 2.22 (regional ROW), 2.73 (global ROW) and 1.32 (HUB) in columns (3)–(4), and 2.12, 2.63 and 1.30 in columns (5)–(6). Rescaling leaves t-statistics and first-stage F unchanged.
Controls, fixed effects and domestic-size slopes are as in Table 1.
Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.9 Issuer resizing and the printed auction yield

The baseline holds the announced auction amount fixed. In several countries the issuer can change the competitive allotment after seeing the bids, so the printed yield can partly reflect the issuer's response to demand. A top-up priced at the auction result, such as non-competitive bids or post-auction options, cannot move the printed yield; only a change in the competitive or original allocation can. Table A35 classifies each country by its auction rules and defines yield-relevant resizing r, the log of the yield-relevant accepted amount over the announced amount.

Three checks follow. Table A36 estimates the baseline separately on the countries whose issuer does not resize the sale that sets the printed yield. Table A37 uses r as the outcome of the baseline regression in the resizing countries. Table A38 corrects each resized bond line along its own accepted bids, $y - \kappa(1 - e^{-r})$, where κ is the line's slope of the printed yield in the quantity sold, keeping only days whose resized lines report their own bid yields (88% of auction days). The regional interaction is 0.214 on these days and 0.211 after the correction, against 0.195 on all days. Figure A21 builds the sample up step by step: the countries whose issuer does not resize; then the days whose resized lines carry their own slope; then every remaining day, with the slope of a comparable country of the same income group and auction format, of the lowest and the highest country of that group in the same year, and ten times the highest. Figure A22 shows that the tail is similar within an income group and auction format, which motivates these donors. Figure A23 shows how far resizing moves the printed yield. Table A39 uses the slope itself as the outcome.

Table A35: Which resizing can move the printed auction yield

	Issuer may change competitive sale	Top-ups at the auction price	Printed yield	Resizing measure r	Days $\lvert r\rvert > 0.5\%$	$\varkappa$ median (bp/log pt)	$\varkappa$ from own bids
AUS	no	none	average	0 (ordinary regime)	–	0.3	97%
BRA	yes, quantity set after bids	2nd round at original price	average	comp./offered	29%	0.8	94%
CAN	no	non-comp. carved out of offer	average	0 (ordinary regime)	–	0.4	100%
CHL	yes, issuer cutoff	none	cutoff	accepted/offered	27%	7.9	0% (←MEX)
CZE	yes, quantity may change	later tranche at avg. price	average	comp./offered	90%	1.5	99%
DEU	yes, retention	non-comp. in auction at avg. price	average	allotted/gross issuance	100%	0.4	0% (←GBR)
FRA	yes, split within range	next-day non-comp.	average	Σ comp./segment max	35%	0.4	0% (←GBR)
GBR	no	post-auction option	average	0 (ordinary regime)	–	0.3	99%
HUN	yes, quantity set after bids	post-auction top-up (separate rows)	average	accepted/announced	85%	1.9	94%
IDN	yes, indicative total	later fixed-yield sale	average	Σ accepted/daily total	84%	2.0	98%
IND	yes, greenshoe	retail non-comp. (carved out)	cutoff	accepted/notified	17%	6.1	0% (←MEX)
ITA	yes, range	supplementary placement	cutoff	accepted/offered	22%	7.1	0% (←TWN)
JPN	no	non-price auctions I, II	average	0 (ordinary regime)	–	0.4	89% (←cell)
KOR	yes, cut when yields high	options I, II at highest yield	average	comp./plan	31%	0.2	0% (←AUS)
MEX	no	dealer option	cutoff	0 (ordinary regime)	–	6.2	100%
MYS	allowed	none	average	accepted/offered	0%	1.4	100%
NOR	no	none	cutoff	0 (ordinary regime)	–	12.7	0% (←cell)
NZL	allowed, line reallocation	none	average	accepted/offered (line)	5%	0.9	94%
POL	yes, minister sets cutoff	non-comp.; same-day sales	cutoff	Σ accepted/daily total	58%	6.2	16% (←MEX)
SGP	no; MAS may vary own take	non-comp. pre-close	cutoff	0 (ordinary regime)	–	18.0	100%
SWE	no; may reject bids	none	average	0 (ordinary regime)	–	0.3	85%
THA	yes, overallotment	greenshoe, PAO at fixed yield	average	(NCB+CB+overallot.)/issue	17%	1.3	98%
TWN	allowed, reserve yield	retail (in total)	cutoff	accepted/offered	5%	7.2	100%
ZAF	no; linkers underallocated	dealer option at clearing yield	cutoff	0 (ordinary regime)	–	4.6	8%

Notes. Rules from each debt management office's official auction documentation and auction results. Top-ups priced at the auction result do not move the printed yield and are not resizing. "0 (ordinary regime)": no routine resizing of the competitive sale in the ordinary procedure (exceptions: SGP's MAS may vary its own subscription; ZAF linkers may be underallocated; SWE may reject expensive bids). FRA: one maximum per auction segment (nominal, linker). POL: includes same-day additional sales since 2019. IND: devolvement on dealers/RBI is not in the accepted amount. $\varkappa$: slope of the printed yield in the quantity sold, from the line's own accepted bids, else the country's own same-format median, else that of a comparable country of the same income group and auction format.

Table A36: Crowding out in auctions with a fixed competitive supply

	(1) All countries	(2) Fixed supply	(3) Issuer may resize	(4) Difference (3)−(2)
Panel A: regional ROW				
ROW	0.218*	0.133	0.271	0.127
	(0.124)	(0.152)	(0.178)	(0.231)
$\ell \times ROW$	0.945***	1.240***	0.786**	−0.526
	(0.263)	(0.464)	(0.334)	(0.580)
HUB	−0.223**	−0.189	−0.182	0.005
	(0.108)	(0.152)	(0.147)	(0.180)
$\ell \times HUB$	−0.807***	−1.297***	−0.448*	0.999**
	(0.212)	(0.397)	(0.234)	(0.433)
Kleibergen–Paap rk Wald F	416.3	269.5	268.6	120.2
Observations	11,180	4,972	6,208	11,180
Countries	24	9	15	24
Panel B: global ROW				
ROW	−0.084	−0.215	−0.053	0.225
	(0.221)	(0.283)	(0.300)	(0.344)
$\ell \times ROW$	1.399***	0.867	1.475***	0.264
	(0.383)	(0.827)	(0.461)	(0.814)
HUB	−0.056	0.013	0.010	−0.066
	(0.175)	(0.235)	(0.238)	(0.274)
$\ell \times HUB$	−1.413***	−1.438**	−1.195***	0.588
	(0.349)	(0.696)	(0.383)	(0.657)
Kleibergen–Paap rk Wald F	237.9	182.8	175.3	92.2
Observations	11,180	4,972	6,208	11,180
Countries	24	9	15	24

Notes. Outcome: auction yield spread (baseline). Fixed supply: the competitive quantity is not resized by the issuer in the ordinary auction procedure (AUS, CAN, GBR, JPN, MEX, NOR, SGP, SWE, ZAF); their non-competitive bids and post-auction options are priced at the auction result, which cannot move the auction yield. Issuer may resize: the remaining 15 countries. Column (4) is the coefficient on the term interacted with the resize indicator in a pooled regression with all four terms interacted (instrumented accordingly). Specification as in Table 1: 2SLS of the outcome on domestic log offered size ℓ (country-specific slopes), *ROW* and $\ell \times ROW$ (instrumented by rollover need and $\ell\times$ rollover need), *HUB*, $\ell \times HUB$, the US block and the baseline controls; country, year-month and weekday fixed effects. Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A37: Does yield-relevant resizing respond to competing supply? Resizing countries

	(1) r no lags	(2) r domestic lags	(3) $r <$ p10 domestic lags	(4) $r >$ p90 domestic lags	(5) $r <$ p5 domestic lags	(6) $r >$ p95 domestic lags
Panel A: regional ROW						
ROW	0.003	0.001	−0.001	0.009	−0.003	−0.002
	(0.003)	(0.003)	(0.006)	(0.006)	(0.004)	(0.004)
$\ell \times ROW$	−0.002	−0.002	0.011	−0.001	0.010	−0.004
	(0.008)	(0.007)	(0.010)	(0.014)	(0.009)	(0.012)
HUB	−0.001	0.001	0.002	−0.007	0.000	0.000
	(0.003)	(0.003)	(0.005)	(0.005)	(0.004)	(0.003)
$\ell \times HUB$	−0.003	−0.001	−0.006	−0.008	−0.006	−0.004
	(0.006)	(0.005)	(0.009)	(0.008)	(0.007)	(0.008)
Kleibergen–Paap rk Wald F	268.6	268.9	268.9	268.9	268.9	268.9
Observations	6,208	6,208	6,208	6,208	6,208	6,208
Panel B: global ROW						
ROW	−0.002	−0.002	0.001	0.006	0.007	−0.003
	(0.006)	(0.005)	(0.010)	(0.010)	(0.009)	(0.007)
$\ell \times ROW$	0.020*	0.009	−0.007	0.021	−0.024	0.007
	(0.010)	(0.010)	(0.018)	(0.017)	(0.015)	(0.013)
HUB	0.002	0.003	0.000	−0.007	−0.006	0.001
	(0.005)	(0.005)	(0.009)	(0.009)	(0.007)	(0.006)
$\ell \times HUB$	−0.018**	−0.009	0.003	−0.024	0.016	−0.011
	(0.009)	(0.008)	(0.016)	(0.015)	(0.012)	(0.012)
Kleibergen–Paap rk Wald F	175.3	177.4	177.4	177.4	177.4	177.4
Observations	6,208	6,208	6,208	6,208	6,208	6,208

Notes. Sample: the 15 countries whose issuer can change the sale that sets the printed yield (BRA, CHL, CZE, DEU, FRA, HUN, IDN, IND, ITA, KOR, MYS, NZL, POL, THA, TWN). r: log of the yield-relevant accepted amount over the announced amount on the day (Table A35). Columns (3)–(6): indicators that r is strictly below the country's own 10th/5th or above its 90th/95th percentile. Domestic lags: r on the previous five auction days of the country and its trailing 20-auction mean. Specification as in Table 1: 2SLS of the outcome on domestic log offered size ℓ (country-specific slopes), *ROW* and $\ell \times ROW$ (instrumented by rollover need and $\ell\times$ rollover need), *HUB*, $\ell \times HUB$, the US block and the baseline controls; country, year-month and weekday fixed effects. Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A38: Correcting the printed yield for issuer resizing with each line's own bid slope

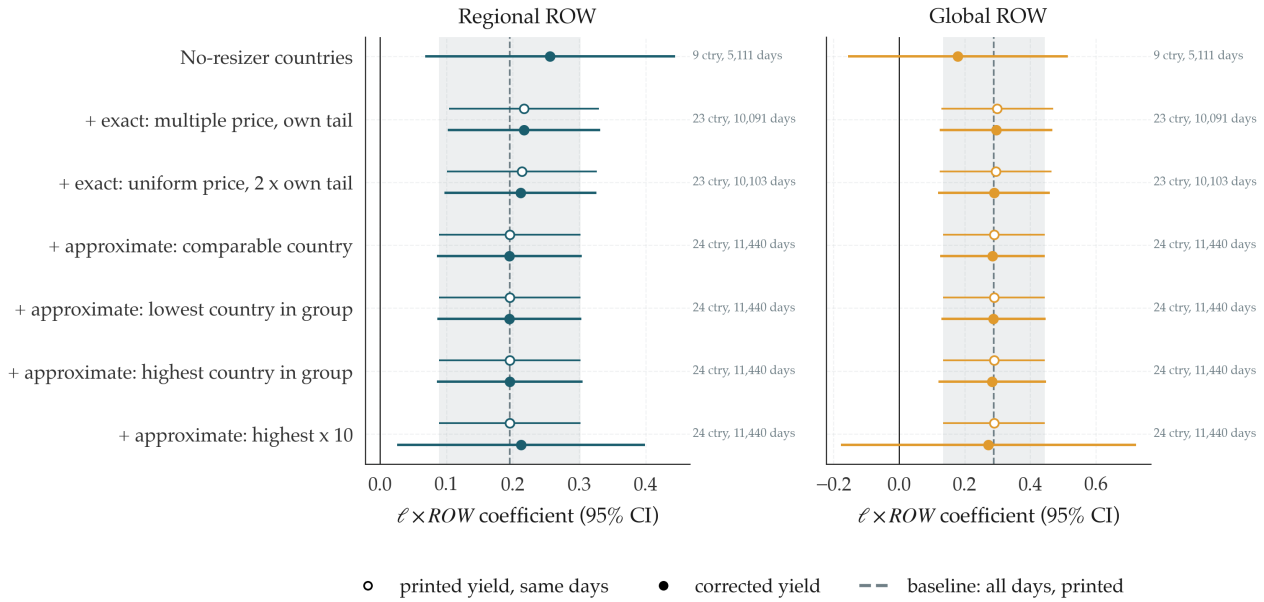
	(1) Printed yield all days	(2) Printed yield correctable days	(3) Corrected yield correctable days
Panel: regional ROW, all countries			
$\ell \times ROW$	0.945^{***}	1.033^{***}	0.211^{***}
	(0.263)	(0.279)	(0.058)
$\ell \times HUB$	-0.807^{***}	-0.869^{***}	-0.180^{***}
	(0.212)	(0.215)	(0.044)
ROW effect at $\ell = \mathrm{sd}(\ell)$ (bp)	0.73^{***}	0.76^{***}	0.74^{***}
	(0.19)	(0.20)	(0.20)
Observations	11,180	9,865	9,865
Panel: global ROW, all countries			
$\ell \times ROW$	1.399^{***}	1.424^{***}	0.289^{***}
	(0.383)	(0.420)	(0.087)
$\ell \times HUB$	-1.413^{***}	-1.464^{***}	-0.300^{***}
	(0.349)	(0.363)	(0.075)
ROW effect at $\ell = \mathrm{sd}(\ell)$ (bp)	0.68^{**}	0.66^{*}	0.64^{*}
	(0.33)	(0.35)	(0.35)
Observations	11,180	9,865	9,865
Panel: regional ROW, resizing countries			
$\ell \times ROW$	0.786^{**}	0.831^{**}	0.167^{**}
	(0.334)	(0.376)	(0.079)
$\ell \times HUB$	-0.448^{*}	-0.437^{*}	-0.091^{*}
	(0.234)	(0.242)	(0.050)
ROW effect at $\ell = \mathrm{sd}(\ell)$ (bp)	0.70^{***}	0.67^{**}	0.63^{**}
	(0.27)	(0.29)	(0.29)
Observations	6,208	4,893	4,893
Panel: global ROW, resizing countries			
$\ell \times ROW$	1.475^{***}	1.369^{***}	0.271^{**}
	(0.461)	(0.528)	(0.111)
$\ell \times HUB$	-1.195^{***}	-1.098^{***}	-0.220^{***}
	(0.383)	(0.409)	(0.085)
ROW effect at $\ell = \mathrm{sd}(\ell)$ (bp)	0.75^{*}	0.58	0.52
	(0.43)	(0.48)	(0.49)
Observations	6,208	4,893	4,893

Notes. Correctable days: every line of the day either needs no correction (the issuer cannot resize the sale that sets the printed yield, or yield-relevant resizing is within 0.5% of the announced amount) or reports its own accepted-bid yields. Resized lines without their own bid yields are not corrected by assumption: their days are dropped. (2) is the printed yield on exactly these days. (3) replaces each resized line's printed yield by $y - \varkappa\,(1 - e^{-r})$, the change along that line's own accepted bids had the issuer sold exactly the announced amount; it is exact if the accepted bids are linear in the quantity sold, and first-order otherwise. Multiple price: $\varkappa$ is the highest minus the average accepted yield, the exact first-order slope of the average yield; uniform price: twice the cutoff minus the average accepted bid yield (a linear bid schedule). Yields in the harmonised semiannual convention of the outcome. The correction then averages the lines of the day as in the baseline outcome and divides by the same MAD scale. r: yield-relevant resizing (Table A35). Dropping resized days without bid yields selects on resizing; compare (1) and (2). Specification as in Table 1: 2SLS of the outcome on domestic log offered size ℓ (country-specific slopes), *ROW* and $\ell \times ROW$ (instrumented by rollover need and $\ell\times$ rollover need), *HUB*, $\ell \times HUB$, the US block and the baseline controls; country, year-month and weekday fixed effects. Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A39: The concession versus the within-auction bid slope

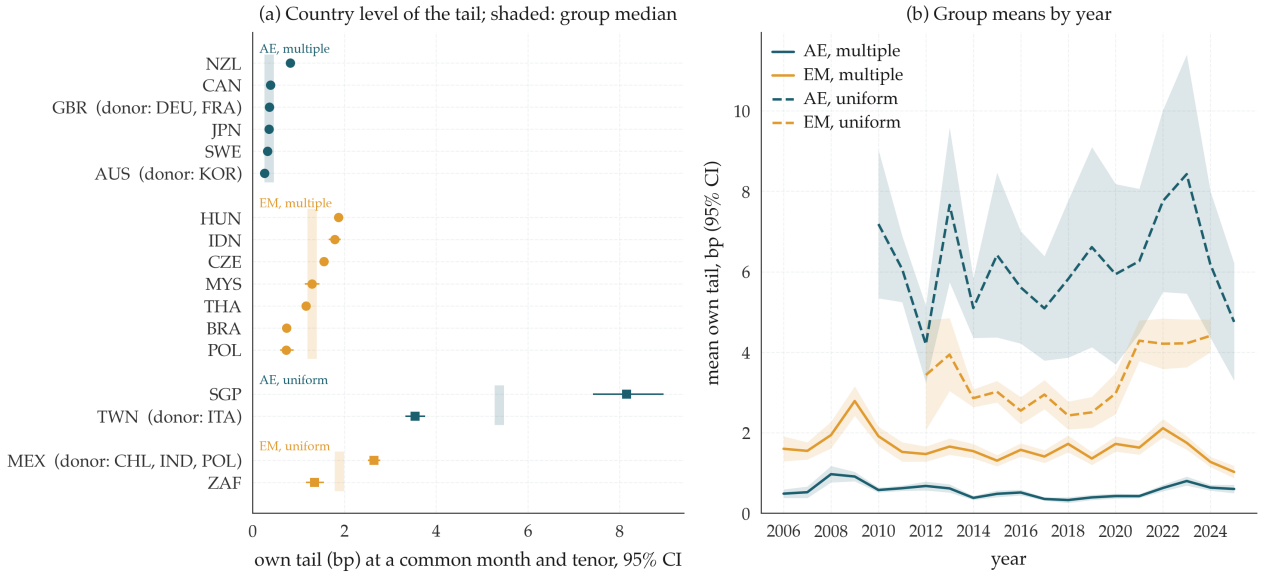
	(1) Concession same days	(2) κ/MAD	(3) κ/MAD domestic lags	(4) log κ
Panel A: regional ROW				
ROW	0.209	−0.008	−0.012	0.009
	(0.150)	(0.012)	(0.013)	(0.013)
$\ell \times ROW$	0.706**	−0.011	−0.014	0.055**
	(0.303)	(0.015)	(0.018)	(0.027)
HUB	−0.136	0.003	0.004	−0.001
	(0.122)	(0.011)	(0.011)	(0.012)
$\ell \times HUB$	−0.528***	−0.000	−0.001	−0.023
	(0.185)	(0.011)	(0.013)	(0.022)
Kleibergen–Paap rk Wald F	295.8	295.8	268.2	295.8
Observations	7,421	7,421	6,415	7,421
Countries	17	17	17	17
Panel B: global ROW				
ROW	−0.072	−0.004	−0.011	0.011
	(0.272)	(0.020)	(0.020)	(0.023)
$\ell \times ROW$	1.170***	−0.018	−0.024	0.038
	(0.433)	(0.022)	(0.025)	(0.042)
HUB	0.009	0.002	0.006	−0.004
	(0.205)	(0.019)	(0.020)	(0.019)
$\ell \times HUB$	−1.091***	0.009	0.011	−0.028
	(0.328)	(0.021)	(0.023)	(0.037)
Kleibergen–Paap rk Wald F	146.1	146.1	139.5	146.1
Observations	7,421	7,421	6,415	7,421
Countries	17	17	17	17

Notes. Auction days whose lines report their own accepted-bid yields. (1): the baseline outcome, the auction yield concession over the MAD scale, on these days. (2)–(4): the day's average slope κ of the printed yield in the quantity sold (multiple price: highest minus average accepted yield; uniform price: twice the cutoff minus the average accepted bid yield; harmonised semiannual convention), bp per log point, divided by the same MAD scale, or in logs. Domestic lags: the outcome on the previous five auction days and its trailing 20-auction mean. Specification as in Table 1: 2SLS of the outcome on domestic log offered size ℓ (country-specific slopes), *ROW* and $\ell \times ROW$ (instrumented by rollover need and $\ell\times$ rollover need), *HUB*, $\ell \times HUB$, the US block and the baseline controls; country, year-month and weekday fixed effects. Driscoll–Kraay standard errors (bandwidth 20) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. On the countries whose issuer does not resize and which report bid yields (AUS, CAN, GBR, JPN, MEX, SGP, SWE, ZAF), the regional $\ell \times ROW$ coefficient is −0.039 (0.034) for κ/MAD and 0.045 (0.048) for log κ: there, where resizing cannot move the accepted range, the slope does not respond significantly.



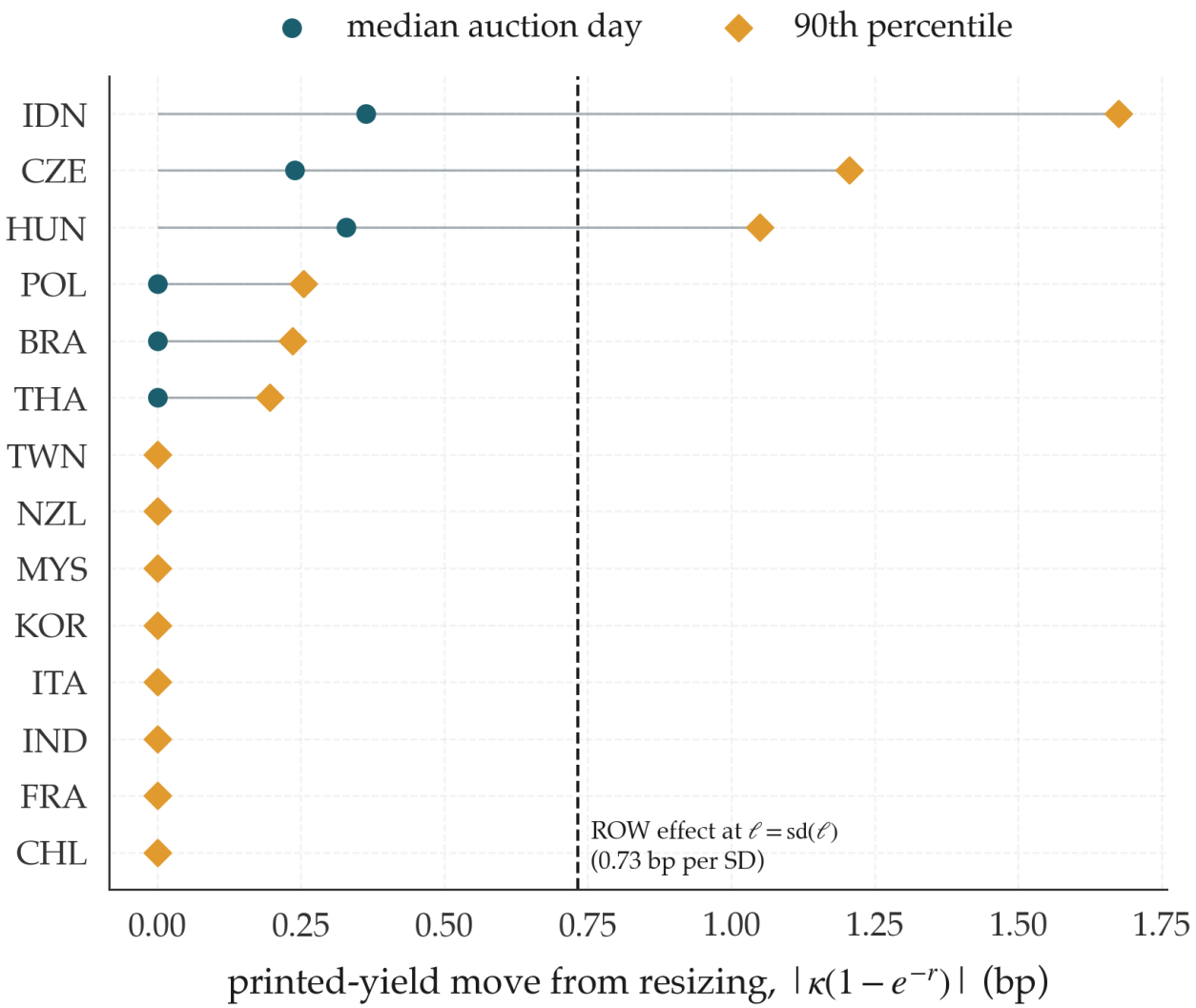
Notes. $\ell \times ROW$ coefficients with 95% confidence intervals; regional (left) and global (right) *ROW*. Rows add auction days step by step: the countries whose issuer does not resize the sale that sets the printed yield; days whose resized lines report their own accepted-bid yields, corrected with that slope, first multiple price, then uniform price; and all remaining days, whose resized lines take the slope of a comparable country of the same income group (AE/EM) and auction format (FRA, DEU from GBR; KOR from AUS; ITA from TWN; CHL, IND and POL's uniform-price lines from MEX; a country's own same-format lines first), the lowest or the highest country slope of that group and format in the same year, or ten times the highest. Slope $\varkappa$ per log point: multiple price, the highest minus the average accepted yield; uniform price, twice the cutoff minus the average accepted bid yield; harmonised yields. Correction $\varkappa(1 - e^{-r})$. Hollow: the printed yield on the same days. Dashed line and band: the printed yield on all days.

Figure A21: Crowding out with the printed yield corrected for issuer resizing



Notes. Own tail of each auction line: the highest minus the average accepted yield, harmonised yields, bp. (a) Country level at a common month and tenor: the log tail is regressed on year-month and tenor-bucket fixed effects without country effects; dots are the country means of the residual (one observation per auction day), transformed back to bp, with 95% confidence intervals; shaded: the median country of each income group and auction format. Donor labels: the countries without own bid yields whose resized lines take that country's slope. (b) Group means by year with 95% confidence intervals. Country explains 51% of the residual variance, income group × auction format 39%.

Figure A22: Within-auction bid tails by country, income group and auction format



Notes. Absolute change in the day's printed yield, $|\kappa(1-e^{-r})|$ averaged over the day's lines, on the days used in Table A38, with each line's own slope. The dashed line is the *ROW* effect at $\ell = \mathrm{sd}(\ell)$ for a one-standard-deviation shock (Table 1).

Figure A23: How far yield-relevant resizing moves the printed yield

E Additional Results for Section 5

Figure A24 plots the marginal effect of each day characteristic on the concession as a function of domestic size, the object that equation (11) sums. Figure A25 compares each issuer's observed calendar in 2021–2025 with 400 random calendars, together with the best and worst calendars and the best calendars under the three restrictions of Section 5.1.

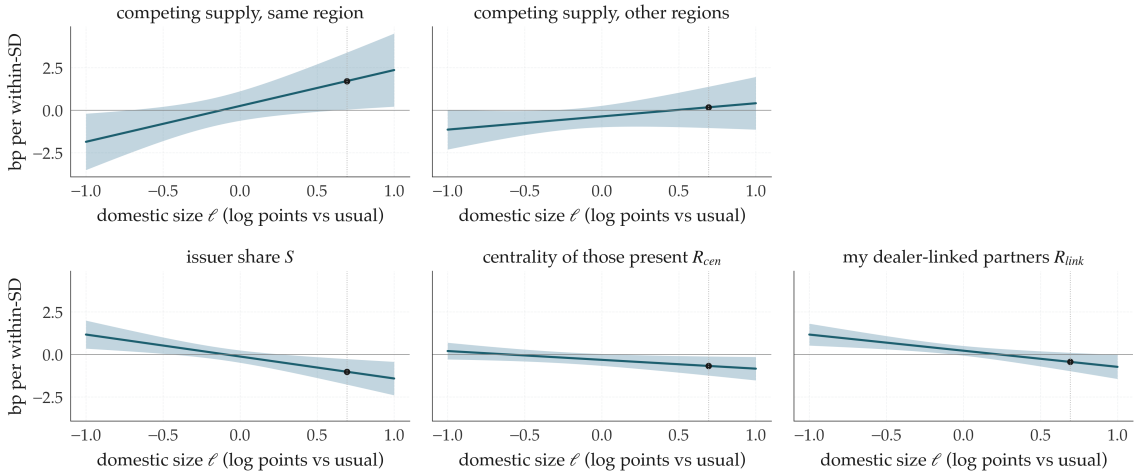


Figure A24: Marginal effects of day characteristics by auction size

Notes: $m(\beta_k + \gamma_k \ell)$ for each priced day characteristic of Table 2, column (8) (R^{GDP} and the coverage counts are held at their country-year mean and not shown), in basis points per within-country standard deviation, at the median scale $m = 4.08$ bp. Shaded: pointwise delta-method 95% confidence bands. The dot marks $\ell = \log 2$, an auction twice the issuer's usual size.

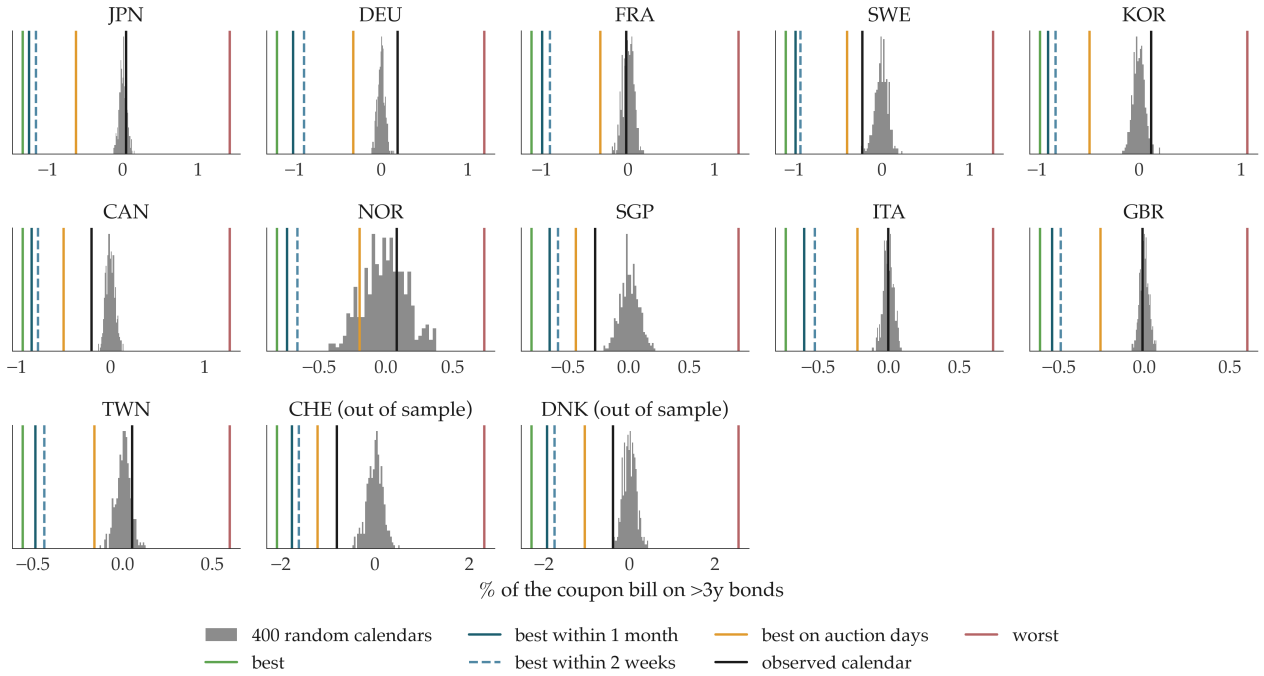


Figure A25: Observed, random and optimal calendars, 2021–2025

Notes: Annual cost of each calendar relative to the average random calendar, as a share of the coupon bill on bonds with more than three years to maturity. Histogram: 400 calendars in which each auction falls on a random business day of its year, at most one auction per day. Lines: observed calendar; best and worst calendar over all business days; best calendar with moves of at most one month or two weeks; best re-ordering of the issuer's own auction days. Costs from equation (11) including the intermediary-stress term at the realised He et al. (2017) factor. Switzerland and Denmark are out of sample.

Table A40: Data Sources by Country

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
AE			
AUS	Australian Office of Financial Management (AOFM) aofm.gov.au/data-hub	AOFM; same portal	Syndicated bonds included in AOFM Treasury Bonds issuance file. Inflation-linked (Treasury Indexed Bonds) index series: aofm.gov.au/securities/treasury-indexed-bonds. Non-competitive (retail) allotments: closed 2012, no separate data.
CAN	Bank of Canada, GoC Auction Results bankofcanada.ca/markets/government-securities-auctions	Bank of Canada, Outstanding T-Bills & Bonds bankofcanada.ca/markets/\protect.\kern\fontdimen3\font.\kern\fontdimen3\font.\kern\fontdimen3\font/goc-t-bills-bonds-outstanding	Inflation index (Real Return Bonds): Statistics Canada CPI series. Foreign-currency bonds issued exclusively to fund official reserves; not included in domestic portfolio. Green bonds issued via syndication. Buybacks and switches: not yet incorporated.
CHE	Swiss Federal Finance Administration (EFV) efv.admin.ch/en/data-publications; pre-2011: Cavaleri et al. (2025),	EFV, *Bilanz* time series efv.admin.ch/de/zeitreihen	No foreign-currency debt, no inflation-linked bonds, no syndication, no floating-rate bonds. EFV dashboard for granular debt breakdown: data.finance.admin.ch/superset/dashboard/20.
DEU	Deutsche Finanzagentur deutsche-finanzagentur.de	Deutsche Finanzagentur, Tradeable Securities; same portal	Retention mechanism: a portion of each auction is withheld and sold later on the secondary market; `total_amount_issued` used to account for this. Inflation-linked Federal Securities: deutsche-finanzagentur.de/en/federal-securities/types-of-federal-securities/inflation-linked-federal-securities.

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Table A40 continued…

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
DNK	Danmarks Nationalbank, Government Debt nationalbanken.dk/en/government-debt	Statistics Denmark, series DNSOSB: statbank.dk; Nationalbank statbank (domestic + foreign fixed-rate debt)	Buybacks and taps: nationalbanken.dk/en/government-debt/trading-and-data/issuance-and-buybacks. Bond list with maturity dates: nationalbanken.dk/en/government-debt/trading-and-data/list-of-danish-government-bonds. Exact maturity dates for pre-2015 bonds retrieved from Refinitiv. Foreign-currency debt used as currency reserves only.
FRA	Agence France Trésor (AFT) aft.gouv.fr/en/principaux-chiffres-oat	AFT Negotiable Debt Statistics; INSEE series 001711531	Inflation-linked OATi (French CPI index): aft.gouv.fr/fr/oati-presentation. Inflation-linked OAT€i (euro-area HICP): FRED series CP0000EZ19M086NEST. No floating-rate bonds identified.
GBR	UK Debt Management Office (DMO) dmo.gov.uk/data; reports D1A, D2.1A, D2.2D, D2.1E, D10A	DMO, Gilts in Issue (annual vintages downloaded per year)	Exact maturity dates (pre-2015) and ISINs matched via annual *Gilts in Issue* reports; remaining unmatched bonds verified on Refinitiv. Gilt Tenders (outright sales, Dutch auction) included. Switch auctions and non-competitive *stock* observations noted separately.
JPN	Ministry of Finance Japan (MoF) mof.go.jp/english/policy/jgbs/auction/past_auction_results; Financing Bills (FB) 2002–2009 and T-Bills Jan–Apr 2009: NDL Web Archive warp.da.ndl.go.jp/info:ndljp/pid/1022127/www.mof.go.jp/english/bonds/fb/fb_resul.htm	MoF, Government Bond Balances mof.go.jp/english/policy/jgbs/reference/gbb; BOJ Statistics (FM05) stat-search.boj.or.jp	CPI (inflation-linked JGBi): Refinitiv; cross-checked with FRED series CPALCY01JPM661N. 15-year floating-rate bonds: mof.go.jp/english/policy/jgbs/topics/bond/15year_floating (not yet incorporated). Note: bidding data 2002–Oct. 2005 excluded due to unit scaling inconsistency in PDF sources. No external sovereign bonds.

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Table A40 continued…

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
NOR	Norges Bank, Government Debt Statistics norges-bank.no/en/topics/Government-debt/statistics	Norges Bank; same portal (bonds and bills outstanding files)	Buyback auctions and direct request-for-quote from primary dealers (repurchase of bonds with <1-year residual maturity): norges-bank.no/en/topics/Government-debt/Secondary-market. Government own-stock changes (change_in_own_stock) excluded. No inflation-linked or floating-rate central government bonds.
NZL	NZ Debt Management (NZDM) debtmanagement.treasury.govt.nz; Nominal bonds & T-Bills history sheets	RBNZ, NZ Debt Securities Statistics rbnz.govt.nz/statistics/series/new-zealand-debt-securities; NZDM month-end files (bonds & bills)	Syndications (including re-openings / taps): debtmanagement.treasury.govt.nz/resource/government-bonds-syndication. No non-competitive bids post-auction. Foreign-currency issuance: no date-level data available.
SGP	Monetary Authority of Singapore (MAS) eservices.mas.gov.sg/statistics/fdanet/BondTreasuryBillsCMTBsAuctions.aspx	MAS, Outstanding SGS Bonds mas.gov.sg/bonds-and-bills/outstanding-sgs; Savings Bonds outstanding: eservices.mas.gov.sg/statistics/fdanet/AmountOutstanding.aspx	Syndicated SGS: eservices.mas.gov.sg/statistics/fdanet/SyndicationData.aspx. Savings Bonds (retail, direct allotment): eservices.mas.gov.sg/statistics/fdanet/AllotmentResult.aspx. Note: competitive and non-competitive bid amounts not separately disclosed in public data. No foreign-currency sovereign debt. Net government debt near zero: proceeds invested via GIC/Temasek.
SWE	Swedish National Debt Office (Riksgälden) riksgalden.se (Auction Results portal; Bloomberg auction system)	Riksbank, Securities Statistics riksbank.se/en-gb/statistics/securities-statistics; SCB Database statistikdatabasen.scb.se	Switch auctions: Riksgälden same portal (separate *sold/bought* view). Foreign-currency debt (≈5% of total): issued via syndication; no historical date-level data (confirmed by Riksgälden correspondence). Green bonds: issued via syndication; no data available. Note: floating-rate exposure managed via interest-rate swaps, not separate floating bonds.

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Table A40 continued…

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
BRA	Secretaria do Tesouro Nacional (STN) tesourotransparente.gov.br/ckan/dataset/ds013; Portal de Leilões do Tesouro portal-leiloes.tesouro.gov.br	Tesouro Transparente, Federal Public Debt Stock tesourotransparente.gov.br/ckan/dataset/estoque-da-divida-publica-federal; BCB series: bcb.gov.br	Tesouro Direto (direct/retail sales): tesourotransparente.gov.br/ckan/dataset/vendas-do-tesouro-direto. Tesouro Direto redemptions: tesourotransparente.gov.br/ckan/dataset/resgates-do-tesouro-direto. NTN-B exchange auctions (*Troca_NTNB*): not yet incorporated (≈USD 10bn over 7 years). External/syndicated summary: tesourotransparente.gov.br/temas/divida-publica-federal/estatisticas-e-relatorios-da-divida-publica-federal. LFT floating (Selic-indexed face value): BCB bond characteristics document. Note: direct issuance excluded due to computational scale; central bank holdings added to competitive + non-competitive totals.
CHL	Ministry of Finance Chile (Hacienda) hacienda.cl/english/work-areas/international-finance/public-debt-office/statistics/historical-treasury-bond-auction-results; 2022–2025 (Spanish portal): hacienda.cl/areas-de-trabajo/finanzas-internacionales/oficina-de-la-deuda-publica/estadisticas/resultados-licitaciones-2025-consolidado	Hacienda, Treasury Bonds Outstanding Amount: hacienda.cl/english/work-areas/international-finance/public-debt-office/statistics/treasury-bonds-outstanding-amount; Central Bank of Chile: bcentral.cl (si3.bcentral.cl series)	Bond financial characteristics (coupon, maturity): hacienda.cl/english/work-areas/international-finance/public-debt-office/statistics/financial-characteristics-local-bonds. Bookbuilding / SOMA syndication: no historical date-level data available (identified from press releases only). External (global) bonds: partially observed via "*" entries in auction data.

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Table A40 continued…

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
CZE	Czech Ministry of Finance (MoF) mfcr.cz	Czech National Bank (CNB); MoF, Annual Government Debt Report mfcr.cz/assets/attachments/\protect.\kern\fontdimen3\font.\kern\fontdimen3\font.\kern\fontdimen3\font/The-Czech-Republic-Government-Debt-Management-Annual-Report-for-2024.pdf	Treasury securities by maturity (ISIN-level): mfcr.cz/en/fiscal-policy/state-debt/debt-statistic/by-maturity. CPI index for 3 inflation-linked bonds. Note: MoF occasionally bids in its own auctions and sells later from portfolio; these amounts do not appear in competitive/non-competitive totals and are excluded.
HUN	Government Debt Management Agency (ÁKK) akk.hu/statistics/historical-data	ÁKK, Amount Outstanding of Government Securities akk.hu/statistics/public-debt-finance/amount-outstanding-government-securities; ÁKK Central Government Gross Debt: akk.hu/statistics/public-debt-finance/central-government-gross-debt	External (foreign-currency) bonds: akk.hu/content/path=characteristicseign-currency-bonds. Euribor (floating benchmark): ECB Data Portal, series FM.M.U2.EUR.RT.MM.EURIBOR3MD_.HSTA. Non-competitive (post-auction) sales: akk.hu/statistics/auction-results/non-competitive-sales. Note: switches and direct issuance move amounts from competitive line; no coupon-rate data in raw files (to be supplemented from Refinitiv).
IDN	DJPPR, Summary of Issuance Results djppr.kemenkeu.go.id/en/summaryofissuanceresults; 2012 data from separate worksheet	DJPPR, Outstanding Government Securities djppr.kemenkeu.go.id/en/outstandingofgovernmentsecurities	Non-competitive (Lelang/Auction GSO) bids submitted and settled day after competitive auction. Government Islamic Securities (Sukuk): same DJPPR portal. Floating-rate instruments (VR, SBR, ST, SWR, FRS): floor rates apply; coupon details to be added. China issued first CNY-denominated tranche Oct. 2025 (not yet in dataset).

Continued on next page

Table A40 continued…

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
IND	Reserve Bank of India (RBI) Data Portal data.rbi.org.in; Path: Publications → Time Series → Public Debt → Internal Debt (Marketable) → Dated Securities	RBI Data Portal (central government market loans, T-bills); MoF, *Status Paper on Government Debt* (annual, ISIN-level appendix): rbi.org.in/scripts/bs_viewcontent.aspx?Id=1956	State Development Loans (SDL/SGS): RBI Data Portal. Floating Rate Bonds: 182-day T-bill benchmark (post-2020 series) and 364-day T-bill benchmark (pre-2017 series) from RBI auction results. CPI index: RBI Data Portal, Real Sector – Prices & Wages. Note: no external foreign-currency sovereign bonds; external debt is multilateral/bilateral loans only.
ITA	Banca d'Italia, Auction Results bancaditalia.it/compiti/operazioni-mef/risultati-aste	MEF, Outstanding Debt by ISIN × Issuance Date dt.mef.gov.it/en/debito_pubblico/dati_statistici	Syndicated bonds (domestic): dt.mef.gov.it/it/debito_pubblico/emissioni_titoli_di_stato_interni/risultati_aste. External (global) bonds: dt.mef.gov.it/it/debito_pubblico/emissioni_sui_mercati_internazionali/il_programma_global_bond/archivio. Bond universe (for identifying non-auction ISINs): UPB fiscal dashboard en.upbilancio.it/dashboard-titoli-di-stato. Floating benchmark (CCT/CCTEU): Euribor 6-month. Inflation index (BTPI): euro-area HICP ex-tobacco. Note: auctions cover ≈2/3 of total debt; non-auction ISINs assumed syndicated and added from MEF outstanding data to reach ≈70% coverage.
KOR	Ministry of Economy & Finance (MOEF), KTB Auctions ktb.moef.go.kr/eng/aggYl.do (web-scraped)	MOEF, KTB Trading & Volume ktb.moef.go.kr/eng/avDyTrVol.do	Option I (retail non-competitive, ≤20% of offered amount) and Option II (PD add-on post-auction at average price): both reported in MOEF data. External (USD-denominated) bonds: disclosed in PDF format only; not incorporated. No inflation-linked KTBs issued. Coupon/interest data: to be supplemented from Refinitiv. Note: dataset covers ≈87% of central government debt; T-bill auctions not observed.

Continued on next page

Table A40 continued…

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
MEX	Secretaría de Hacienda (SHCP) finanzaspublicas.hacienda.gob.mx/es/Finanzas_Publicas/Ingles; auction dates extracted from quarterly PDF calendars via GPT; Banco de México (Banxico)	Banco de México banxico.org.mx (Sector 7, CA138)	Direct issuance: Banxico, Sector 22, CF377 banxico.org.mx/SieInternet. UDI inflation index: Banxico, Sector 8, CP150. Syndicated placement: Banxico portal (data only from 2022; excluded). Individual bidding micro-data: received directly from Banxico. Bloomberg auction dates used to cross-check circulation dates.
MYS	Bank Negara Malaysia (BNM) financialmarkets.bnm.gov.my/auction-result (download: Auction Results, select all)	BNM, Summary of Government Bond Issuances & Redemptions financialmarkets.bnm.gov.my/summary-of-government-bonds-issuance-and-redemption	Three sources combined: BNM auction result download; BNM overall bond list (for ISIN/maturity); BNM broken data extract for auction dates (cross-merged on settlement date). Note: good coverage only from 2016 onward. No inflation-linked bonds.
POL	Polish Ministry of Finance gov.pl/web/finance/t-bills-and-t-bonds	Polish MoF, Historical Data gov.pl/web/finance/Historical-data	Switch auctions (AZ and others, critical for maturity transformation): gov.pl/web/finance. Buyback auctions (UM, AO, PP, OB types): same portal; material from 2014. Inflation indexation coefficients: gov.pl/web/finance/indexation-coefficients1. External (international) bonds: gov.pl/web/finance/international-bonds. Note: switch operations (AZ) are large and essential; excluding buybacks produces significant stock mismatch.
THA	Bank of Thailand (BOT) bot.or.th/en/our-services/bond-and-debt-securities-services; data available from 2022 only	Public Debt Management Office (PDMO) pdmo.go.th/en/public-debt/debt-domestic-external?ft=monthly	Post-Auction Option (PAO): additional allotment to primary dealers at weighted-average auction yield. Greenshoe option: additional over-allotment included in grand total. FPO Statistical Database (potential earlier data): fpo.go.th/main/Statistic-Database.aspx. No inflation-linked bonds identified. External debt small (≈0.8% of total).

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Table A40 continued…

ISO	Auction Data Source	Outstanding Debt Source	Other Sources (Syndicated / External / Direct / Supplementary)
TUR	Central Bank of Turkey (TCMB) tcmb.gov.tr (Treasury Auction Results, Switch Auctions, Buyback Auctions)	Turkish Treasury & Finance Ministry (HMB) en.hmb.gov.tr/public-finance; Domestic Debt Stock by Instrument (xlsx) and List of Securities (xlsx)	External (global) bonds: HMB external borrowing statistics ("bond issues" section). Switch operations: HMB public finance portal. Post-auction sales (primary dealer right at average price). Floating benchmark: TLREF and T-bill yield series. Note: USD-denominated bonds in TCMB data are domestic auctions in foreign currency; global bonds issued abroad are separate. Lease certificates (gold, FX): excluded. Private placement CPI bonds and TLREF bonds not in auction data (residual gap).
TWN	Government Open Data Platform data.gov.tw/en/datasets/7234 (bonds), data.gov.tw/en/datasets/7235 (T-bills)	Government Open Data Platform data.gov.tw/en/datasets/9465 (bonds), data.gov.tw/en/datasets/9471 (T-bills)	Issuance data (outstanding issuance file): data.gov.tw/en/datasets/9465. Settlement conventions confirmed via DGPA work calendars: dgpa.gov.tw/en/index?mid=138 (T-bills: T+1; bonds: T+3). No inflation-linked or floating-rate government bonds. No foreign-currency sovereign bonds.
USA	U.S. Treasury FiscalData fiscaldata.treasury.gov/datasets/treasury-securities-auctions-data	U.S. Treasury FiscalData, Schedules of Federal Debt fiscaldata.treasury.gov/datasets/schedules-federal-debt	Buybacks: fiscaldata.treasury.gov/datasets/treasury-securities-buybacks. CPI index (TIPS inflation-linked): FRED series CPIAUCNS (BLS CPI-U, not seasonally adjusted). Floating-rate notes (FRNs): Refinitiv. No external foreign-currency sovereign bonds. Note: indirect bidders (central banks, asset managers via primary dealers) identifiable in auction micro-data.
ZAF	National Treasury South Africa investor.treasury.gov.za (Historical Results: Fixed-rate, Floating-rate, Inflation-linked, Switch, T-Bill auctions); Web Archive used for access: web.archive.org	South African Reserve Bank (SARB) resbank.co.za/en/home/what-we-do/statistics/releases/economic-and-financial-data-for-s[illegible]a.xlsm	Exact maturity dates: Treasury Monthly Revenue Statements treasury.gov.za/comm_media/press/monthly. Switch auctions: National Treasury same portal. Floating-rate notes (FRN): 3-month JIBAR benchmark. Inflation-linked bonds: revalued using reference CPI. Note: bonds R186, R2044, R2048, I2050 have three separate maturity tranches; allocated proportionally by issuance amount.

Table A41: Countries Considered but Excluded from Dataset

ISO	Reason for Exclusion
CHN	Auction data publicly available since 1996 but individual bidding micro-data (bids submitted, bid-to-cover ratios) not publicly disclosed. Excluded due to absence of competitive bidding statistics.
COL	No auction-level bid data identified. The non-competitive tranche is unusually large (≈80% of primary auction) with a 9-day exercise window, making construction of a consistent daily inflow/outflow series infeasible.
EGY	Observed data limited to yearly aggregates without individual auction date resolution. Large-scale debt restructuring episodes complicate the rollover series. Substantial external debt not observed at auction level.
ESP	Historical auction-level data with exact expiration dates requires scraping of individual auction pages at `tesoro.es/en/deuda-publica/subastas/resultados-subastas-anteriores`. Not incorporated in current version.
GRC	Auction micro-data not identified in public sources. Heavy reliance on syndicated issuance — particularly post-2010 — and official-sector programmes (ESM/EFSF) limits the coverage of market auction data.
ISR	Machine-readable auction data with auction dates available only from 2022 via `data.gov.il`. Earlier data requires manual matching to Bloomberg issuance records. Time series too short for panel estimation.
MMR	No variation in local issuance amounts across observations (constant values throughout the sample). Substantial data gaps further preclude use.
VNM	Data availability under investigation. Not incorporated in current version.