# Loanly Governments*

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**Abstract**

This paper studies the funding structure of governments, examining financing beyond traditional sovereign bond markets. We collect a novel dataset on government liabilities by instrument for a sample of 33 advanced economies and document that beyond the much-studied role of bond-based borrowing, about 15% of government debt consists of loans. We further show that when bond yields rise, governments reduce bond issuance but simultaneously expand loan-based borrowing, implying that total government debt supply need not be upward sloping in bond prices. To study these linkages, we propose and implement a novel high-frequency identification strategy based on surprise changes in bond yields surrounding changes in sovereign credit ratings. Lastly, we focus on the governments' creditors, applying an "unveiling" methodology. These unveiled data show a sizable share of loans are financed by the foreign sector, but the funds are channeled through the domestic banking sector, raising financial stability concerns.

*Keywords: Government debt, Sovereign bond markets, Loans, Credit ratings*

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## 1. Introduction

Sovereigns use government debt to temporarily finance public expenses, cope with macroeconomic crises, and smooth taxes over time (e.g., Barro, 1979; Romer and Romer, 2019; Broner et al., 2022). To raise the needed funds, advanced economies typically resort to sovereign bonds, which are the key object of interest in the large literature on government debt (e.g., Meyer et al., 2022; Mitchener and Trebesch, 2023). When the funding costs of bond financing increases, conventional wisdom predicts less *bond* borrowing, all else equal. However, this does not necessarily imply that *total* government debt declines, if governments are able to resort to alternative financing sources beyond traditional bond markets. But, do they?

Yes! We find sovereign financing via *loans* instead of bonds is prevalent in many advanced economies. This typically neglected government debt instrument matters. As sovereign bond prices decline and yields increase, we find reduced bond borrowing, consistent with a conventional, upward sloping, government debt supply schedule. However, loan financing simultaneously *increases* strongly so that overall government debt supply is not necessarily upward sloping in bond prices. An analysis only of bond debt cannot detect this crucial feature of loan-bond substitution. In addition, we show that these effects are more pronounced for yield increases than for yield decreases, highlighting an important non-linearity. We establish causality of our findings based on a high-frequency identification strategy commonly applied to monetary policy (e.g., Nakamura and Steinsson, 2018a), leveraging asset price adjustments surrounding changes in sovereign credit ratings. These plausibly exogenous surprise changes in yields shift the demand for government debt. Finally, we focus on the governments' creditors using an unveiling methodology following Mian et al. (2017). The unveiled data show a sizable share of loans being financed by the foreign sector, with the funds channeled through the domestic banking sector. This raises financial stability concerns, and we indeed find an increase of financial distress following these dynamics.

We make three main contributions. First and foremost, we show that loan financing matters, particularly for estimating governments' funding choices in response to yield changes. Second, we propose a novel identification strategy that allows estimating the causal effect of yield changes in a large panel of advanced economies. Third, we provide novel unveiled data for the same set of countries, which reveal the ultimate creditors of foreign debt, distinguishing between loans and bonds. We expect both the unveiled government debt data and our high-frequency instrument to be useful for answering many further research questions.[1]

[1]For example, one may use our high-frequency surprises to estimate the effect of yield changes on other asset prices

For our analysis, we compile granular government debt data from the OECD financial accounts for an unbalanced panel of 33 advanced economies at quarterly frequency between 1960 and 2024, with most countries entering the sample in the 1980s and 1990s.[2] We start by documenting that loan financing is prevalent in all countries in our sample. Typically, the stock of outstanding loans is above 10 percent of GDP. This is partly accounted for by the central government and partly by lower levels, e.g., states or municipalities. Strikingly, in many cases, the share of loan financing increases around financial crises. These observations motivate us to investigate how governments' funding choices depend on the cost of their main debt instrument: Sovereign bonds.

Sovereign bond yields, however, summarize investors' beliefs about the macroeconomic and fiscal situation of a given country, raising reverse causality concerns. To address such concerns, we propose a novel high-frequency identification strategy, similar to those previously applied to, e.g., monetary policy (Kuttner, 2001; Bernanke and Kuttner, 2005; Nakamura and Steinsson, 2018a). The main identification idea is that high-frequency bond yield changes surrounding credit rating change announcements by rating agencies can be used as a source of variation that is plausibly unrelated to macroeconomic fundamentals. The underlying premise is that all relevant macroeconomic and financial information has been available before the announcement and, therefore, has already been priced in prior to the rating change.[3]

To operationalize this idea, we construct a novel daily sovereign credit rating index, which summarizes the credit ratings of the four leading agencies. Using this index, we provide empirical support for our identification idea via event studies of daily bond yields around changes in government credit ratings. These estimates show no pre-trends, but a sharp shift in the yield level after rating change events. Additionally, the event study estimates provide two further insights. First, we find considerably stronger effects for credit rating changes that increase bond yields. Second, the effects are larger and more significant when the rating change and the yield change agree, i.e., when focusing on yield increases due to rating downgrades and yield decreases due to upgrades. We refer to these as the conventional cases.

Motivated by this evidence, we leverage changes in bond yields on days with credit rating change events as our identifying variation. Specifically, we compute four separate surprise series covering positive and negative yield changes combined with either credit rating upgrades or

and conventional macroeconomic aggregates as often done for monetary policy (e.g., Bauer and Swanson, 2023b).

[2]These data have been collected by Diebold and Richter (2021) and further extended in Castells-Jauregui et al. (2024).

[3]Rating changes still matter because, e.g., they may coordinate expectations and institutional investors can often hold certain assets only if they are rated sufficiently well. As a result, investors may re-balance their portfolios after credit rating changes primarily due to the rating change.

downgrades. Lastly, we provide instrument diagnostics and find that past macroeconomic data do not meaningfully predict our surprises, at least when focusing on the two conventional cases.

Given these high-frequency surprises, we move to our main analysis studying the relation between bond yields and sovereign funding choices. Our key outcomes are the one-year change in the ratio of outstanding government loans to bonds, the loan-bond ratio, as well as the issuance of loans and bonds over a one-year period. We start our investigation with a simple OLS regression of these outcomes on quarterly sovereign bond yield changes, regardless of sovereign credit rating changes. This simple specification reveals that positive yield changes are associated with an increase in the loan-bond ratio and the issuance of new loans, whereas bond issuance declines. Conversely, the effects of yield decreases display similar signs, but the magnitudes are considerably muted. We obtain similar results when focusing on yield changes that occur in quarters with credit rating changes only, while setting all other yield changes to zero.

To establish causality, we instrument the quarterly yield changes with our high-frequency yield surprises. In the first stage, the two surprise series corresponding to the above-mentioned conventional cases pass the weak instrument test from Montiel-Olea and Pflueger (2013) at the 1% significance level, whereas the remaining two series do not. As a result, we focus on the two strong surprises and instrument yield increases and decreases separately. Focusing on the two conventional cases can be interpreted as a sign restriction similar to the one employed in monetary policy by Jarociński and Karadi (2020). In our case, this sign restriction imposes that positive yield changes must be due to rating downgrades and negative yield changes due to upgrades.

We proceed to the second stage, estimating the dynamic effects using instrumental variable local projections (Jordà, 2005). Focusing on positive yield changes, we find that the effects on the bond yield are very persistent for about 6 quarters and revert slowly to zero afterwards. The loan-bond ratio increases considerably and plateaus at a higher level after 14 quarters. The increase in this ratio is driven by a sizable increase in loan issuance amounting to more than 3 percent of GDP at the peak response after around 3.5 years. This is very well mirrored by a similarly sized decrease in bond issuance. As a result, total government debt does not change significantly. All of the above-discussed effects are highly statistically significant, with the discussed exception of total government debt. For yield decreases, we find broadly comparable dynamics in terms of direction. In contrast to yield increases, however, the responses of the loan-bond ratio and bond issuance are not statistically significant. Loan issuance does respond significantly, but with a considerably lower magnitude.

In summary, since our instrument likely captures a surprise shift in the demand for sovereign debt, we can interpret the results as identifying a supply curve. Specifically, we find that the government bond supply curve is upward sloping in bond prices, while this is not necessarily true for total debt, given by the joint supply of loans and bonds. Importantly, we note that we carefully control for foreign assistance programs so that these effects plausibly capture funding from the private sector. Finally, comparing our instrumental variable approach with simple OLS, we find that OLS estimates deliver similarly signed coefficients but display a considerable downward bias across outcomes.

As a last step in our analysis, we focus on the creditors of government debt and implications for financial stability. Such an analysis requires counterparty data. However, counterparty data is unavailable for the majority of observations in our sample.[4] Therefore, we apply the "unveiling" methodology introduced by Mian et al. (2020) and further developed by Diebold and Richter (2021) to allocate loans and bonds to creditors, providing us with an estimate of the latent counterparty data. This methodology builds on a proportionality assumption, which we carefully validate with those observations for which the counterparty data is available.

After having validated the results of our unveiling, we estimate the effects of yield changes on the holdings of sovereign debt by other sectors of the economy. In general, these effects are less precisely estimated, possibly because our unveiling methodology introduces measurement error in the left-hand side variable of the regression. However, focusing on yield increases, we still find a statistically significant increase in government loan holdings by the domestic financial sector. Furthermore, we find a significant decrease of government bond holdings by the foreign sector. Yet, the foreign sector does not significantly expand its government loan positions. For yield decreases, in contrast, we find no meaningful effects.

We further apply the "unveiling" methodology to allocate the corporate sector asset holdings to the sectors that ultimately own the corporate sector, as in Mian et al. (2020). Using these ultimate creditor holdings as outcomes in the instrumental variable regressions, we find that the foreign sector significantly increases its loan holdings. A comparison with the above results for direct counterparties indicates that the foreign sector funds these government loans indirectly via the domestic financial sector. The reallocation from bonds to loan holdings on the asset side of other sectors' balance sheets may raise financial stability concerns, as a highly liquid asset is replaced with a less liquid one. Additionally, the foreign funds that ultimately finance these loans may be

[4] And might, especially in the case of government loans, be confidential.

more prone to flight risk (Forbes and Warnock, 2012; Broner et al., 2013).[5]

Finally, we provide corroborative evidence for the validity of these financial stability concerns. Specifically, we study changes in the Romer and Romer (2017) financial distress index conditional on changes in the government's loan-bond ratio, finding it to be considerably elevated. When we break down the change in government liabilities by counterparty, we find that an increase in the loan-bond ratio of government liabilities held by the foreign sector (i.e., the foreign sector's assets) is followed by the largest and most significant increase in financial distress. These effects are strongest when we account for the indirect holdings of government debt by the foreign sector via the domestic banking sector.

**Related literature.** We contribute to three strands of the literature. The first strand of literature empirically investigates general trends in government finances; see Mitchener and Trebesch (2023) for an overview. Recent advances in data availability allow for the analysis of government debt in developing countries at the instrument level (e.g., Mihalyi and Trebesch, 2022). Further, a few papers have focused on development loans, most notably with the rise of China as an international creditor (Horn et al., 2021; Gelpern et al., 2023). However, little research exists for advanced economies because this literature generally focuses on bonds (e.g., Meyer et al., 2022) or considers government liabilities as a whole. Beyond bonds, Fang et al. (2025) study total government debt, including loans, but do not discriminate between instruments. Relative to these papers, we are the first to demonstrate the relative importance of loans and provide novel estimates on how loan and bond financing respond to yield changes.

Second, we contribute to the broad macroeconomic literature on the identification of causal effects; see Ramey (2016) or Nakamura and Steinsson (2018b) for an overview. Related are papers that apply the high-frequency identification approach in various contexts. This approach is most often applied to monetary policy (e.g., Kuttner, 2001; Bernanke and Kuttner, 2005; Nakamura and Steinsson, 2018a) and has been refined recently to better account for potential confounders (Miranda-Agrippino and Ricco, 2021; Bauer and Swanson, 2023a,b). Beyond monetary policy, this approach has been applied to OPEC oil quota announcements (Känzig, 2021; Degasperi, 2023) and European carbon pricing events (Känzig, 2023). Further, and closely related is Phillot (2025), who identify US Treasury supply shocks. Relative to these papers, we compile yield surprises that plausibly capture demand shocks to sovereign debt leveraging sovereign credit rating announcements.

[5]This may be especially relevant when highly volatile foreign capital is used to finance increasingly illiquid domestic assets (Calvo, 1998; Diebold and Richter, 2021), suggesting that the two mentioned channels may amplify each other.

More generally, we further relate to the surprisingly sparse literature on sovereign credit ratings, which focuses, e.g., on home bias (Fuchs and Gehring, 2017), rating quality and competition (Becker and Milbourn, 2011), and implications for firm borrowing (Almeida et al., 2017). A comprehensive survey is provided by Panizza et al. (2009).

Third, we contribute to the literature examining financial stability through the lens of balance sheet risk of financial intermediaries. A large body of research has studied the provision of safe assets by sovereigns, which are often used by financial institutions for risk management or as collateral (Greenwood et al., 2015; Krishnamurthy and Vissing-Jorgensen, 2015). Several papers have documented a prolonged increase in demand for these assets, driven by a "savings glut" among agents with excess capital (Bernanke, 2005; Summers, 2014; Mian et al., 2020). However, this growing demand has not been matched by a corresponding increase in the supply of safe assets, which has remained relatively stable (Gorton et al., 2012; Castells-Jauregui et al., 2024), leading to a secular decline in interest rates for safe assets. We contribute to this literature by showing that yield increases due to credit rating downgrades persistently affect yields, inducing a reduction in the issuance of liquid assets (bonds) and an increase in the issuance of less liquid assets (loans). The simultaneous substitution from more to less liquid assets on the balance sheets of financial intermediaries is followed by heightened financial distress. This effect is especially pronounced when less liquid assets on financial intermediaries' balance sheets are increasingly financed by more volatile foreign capital. These findings also relate to Jordà et al. (2016), who show that the banking sector is more vulnerable to adverse financial shocks when the sovereign's borrowing capacity is constrained.

## 2. Sovereign debt in loans and bonds

We begin by motivating our analysis of loans and bonds by documenting trends in the liability structure of governments for our sample of advanced economies. We find that a substantial portion of government debt consists of loans, and that loan financing often increases around periods of financial distress.

**Data.** Our main data on government debt are the OECD financial accounts. It contains the issuance, as well as the existing stock of government debt by credit instrument, i.e., loans and bonds. For the regression analyses in subsequent sections, we further supplement our main data with various conventional macroeconomic series, including ten-year sovereign bond yields, CPI inflation,

and real GDP, as well as the financial distress index from Romer and Romer (2017). Overall, we have an unbalanced panel of 33 advanced economies covering the period from 1960 to 2024, with most countries entering the sample in the 1980s and 1990s. Furthermore, we use high-frequency data on government bond yields and sovereign credit ratings, which we introduce along with the identification strategy.

**Descriptive evidence.** Figure 1 shows the development of government liabilities relative to GDP, decomposed by financing instrument for a selected set of countries between 1980 and 2024. The top row displays the United States, Japan, and an average of all other sample countries. The bottom row depicts selected European countries. The corresponding charts for all other countries in our sample are provided in Figure A1.1 in the Appendix.

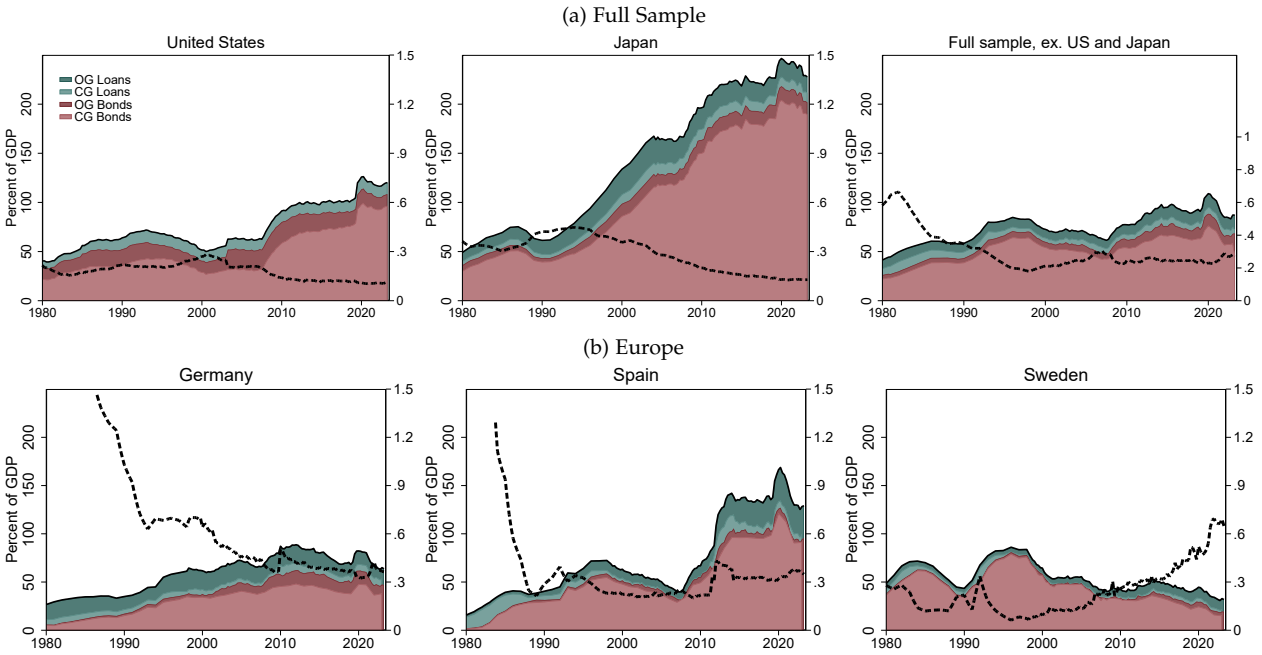
The panels show the stock of outstanding bond liabilities in red (the two lower areas) and outstanding loan liabilities in green (the two upper areas). These data are at the level of the general government, which includes the central government and lower levels, e.g., states or municipalities. However, we also offer a breakdown between the central government (CG) and the remaining other levels of the government (OG). The central government's liabilities are always indicated by the lighter-colored areas (the lower ones), whereas the remaining OG liabilities are the darker-colored areas (the upper ones). The dotted black line additionally shows the general government's loans divided by bonds, the loan-bond ratio, on a secondary vertical axis on the right.

For the United States, government liabilities consist mostly of bonds throughout the entire sample. Yet, even the United States has a stable share of loan financing of around 10 percent of GDP, which is exclusively at the central government level. In Japan, loans account for more than 25 percent of GDP, split between the central government and lower-level entities. Focusing on all remaining sample countries in the top-right panel of Figure 1, we obtain an intermediate case, with the typical share of loans out of GDP being around 15 percent in most periods.

Focusing on the loan-bond ratio, we can see a secular decline in this ratio since the 2000s in the US, the 1990s in Japan, and during the 1980s for the remaining sample countries. The general trend away from loan financing, particularly during the early part of our sample, is consistent with the global development of government bond markets (Baker et al., 2021; OECD Global Debt Report, 2024) and with structural reforms that enabled governments to shift from relationship-based financing to market-based funding (De Broeck et al., 1998).

Moving to the selected European countries in the second row of Figure 1, we cap the loan-bond

**Figure 1:** *Government loans and bonds by country*




*Notes:* This figure shows the stock of government debt relative to GDP, broken down by financing instrument, between 1980 and 2024 for selected countries. Panel (a) displays series for the United States, Japan, and a sample average excluding the United States and Japan. Panel (b) presents series for Germany, Spain, and Sweden. Across panels, government bond liabilities are shown in red (bottom area), liabilities in the form of loans in green. Lighter areas represent the portion of the respective instrument issued by the central government (CG), and the darker areas summarize the remaining other levels of the government (OG). The black line indicates the total amount of government liabilities relative to GDP. The dotted black line shows the loan-bond ratio on a secondary vertical axis on the right.

ratio at 1.5 to ensure the visibility of fluctuations at lower levels in the later part of the sample. For Germany and Spain, there is a pronounced decline in the loan-bond ratio during the initial decades of the sample. This trend is mostly driven by an increasing amount of bond debt, while loan debt relative to GDP remained relatively stable. Additionally, in both countries, we observe an increase in loans relative to bonds during the Euro Crisis, as indicated by the uptick in the loan-bond ratio. This uptick is stronger and more persistent in Spain, which was directly affected by the crisis. In the bottom-right panel, we show that loans are generally less important in Sweden. However, the figure shows a marked spike in the loan-bond ratio during the Scandinavian Financial Crisis in the early 1990s. There is also a considerable upward trend in this ratio beginning in the 2000s. This increase in the loan-bond ratio is highly persistent, driven mostly by a declining amount of central government bonds, and continues until the end of our sample in 2024.

Overall, we find non-negligible loan financing that is prevalent across both space and time. Interestingly, loan financing often increases relatively during periods of financial turmoil. This motivates us to study the relationship between governments' financing costs, measured by bond yields, and debt, measured separately via loans and bonds, in the following sections.

## 3. Identification strategy

In this section, we first construct an index of sovereign credit ratings. Our identification approach builds on this index and leverages high-frequency changes in government bond yields around sovereign credit rating changes. We document the absence of pre-trends in yields and confirm that our high-frequency surprises are orthogonal with respect to various macroeconomic variables. This justifies the use of these surprises as potential instrument for sovereign bond yield changes.

### 3.1. Sovereign credit ratings

**A credit rating index.** We collect the majority of sovereign credit ratings from World Government Bonds Credit Ratings (2024), and, in the case of missing entries, supplement it using Trading Economics (2024) and the websites of Fitchs (2024); Moodys (2024); Standard and Poors (2024); DBRS (2024).[6] A commonality among the rating schemes of all four agencies is that they offer the same number of distinct rating categories.[7] This similarity offers a natural way of aggregating all four ratings into a compound rating index, since all ratings can be ranked on a numerical scale from 0 to 32. Figure A1.2 in the Appendix exemplifies this for the United States, showing its ratings and the different scales of the four agencies as of November 2024.

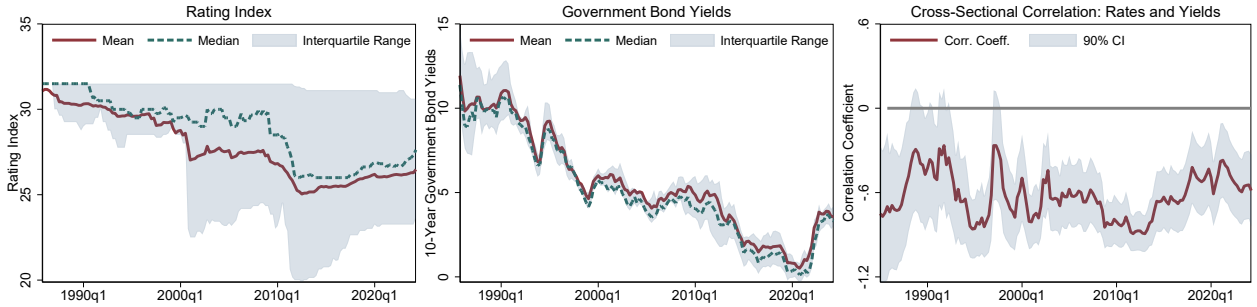
To obtain a composite rating index, we map the ratings on a numerical scale for each rating agency. Ratings for governments in default are coded as 0. The lowest non-default rating is coded as 1, which, e.g., in the case of S&P corresponds to "C" with a negative outlook. It increases to 1.5 for a stable outlook and to 2, for "C" with a positive outlook. Afterwards, each rating step has three potential sub-steps: negative, stable, and positive outlook. Each improvement sub-step increases our rating variable by 0.5. This implies that the top rating is coded as 32.[8] The other rating agencies use comparable scales, as illustrated in Figure A1.2. Employing this rating-coding approach, we obtain a daily rating time series for each country. Given these data, we compute our sovereign credit index as the average across all four rating agencies.

[6]We include these rating agencies as the only ones classified as External Credit Assessment Institutions (ECAI) by the EBA (European Banking Authority, 2018), coinciding with them having the largest market shares of all rating agencies.

[7]Labels may differ across agencies to, e.g., reflect different corporate styles. Yet, the individual labels are remarkably close: For example, the current (end of May 2025) US rating of S&P, Moody's, and Fitch is the second best rating on their individual rating scales and the labels are "AA+", "Aa1", and "AA+", respectively.

[8]The different rating steps for, e.g., S&P are: C, CC, CCC-, CCC, CCC+, B-, B, B+, BB-, BB, BB+, BBB-, BBB, BBB+, A-, A, A+, AA-, AA, AA+ and AAA. Figure A1.2 illustrates this for S&P and the rating steps of the other agencies.

**Figure 2:** *Government credit ratings and government bond yields*




*Notes:* This figure shows quarterly government credit ratings and government bond yields between 1985 and 2024 for our unbalanced sample of advanced economies. The left panel displays the sample average and median of our credit rating index in red (solid line) and green (dotted line), respectively. Shaded areas represent the interquartile range. The middle panel presents the same three statistics, mean, median, and interquartile range, for ten-year government bond yields for the same set of observations. The right panel displays the cross-sectional correlation coefficient between yields and ratings, and the shaded area indicates the 90% confidence set.

**Descriptive evidence.** We provide descriptive evidence comparing our rating index with ten-year constant maturity government bond yields. For this analysis, we aggregate the rating index to quarterly frequency by taking end-of-quarter values, matching the aggregation of the bond yields.

The left panel of Figure 2 displays the mean, median, and interquartile range of our quarterly rating index between 1985 and 2024. The figure shows a secular downward trend in sovereign credit ratings that holds for both, the median and average rating. This decline is partly driven by the inclusion of additional countries with lower credit scores and partly by downgrades within the existing sample, especially around and after the 2001 and 2007 financial crisis periods. Notably, these credit rating changes are concentrated among countries in the lowest quartile of the rating index, as the upper bound of the interquartile range (the third quartile) remains relatively stable throughout the sample.

The middle panel displays the average ten-year government bond yield for the same set of observations (i.e., where both ratings and yields are available). Despite notable fluctuations over the business cycle, these yields exhibit a similar long-term downward trend. This secular trend in bond yields aligns well with a large literature documenting long-term declines in interest rates (Holston et al., 2017; Rogoff et al., 2024), particularly for safe assets (Caballero et al., 2017; Del Negro et al., 2019).

The observed positive co-movement between average credit ratings and average bond yields may reflect other macroeconomic trends that drive down bond yields, regardless of credit ratings. For example, this can be due to increased supply of funds, often referred to as savings glut (Bernanke, 2005; Summers, 2014; Mian et al., 2020). To take out such confounding trends, we compute the cross-sectional correlation between bond yields and credit ratings at each point in time. The results are displayed in the right panel, suggesting that ratings and yields are inversely correlated, as one

would expect.

## 3.2. Yield change surprises

**Identification approach.** The main identification idea is that high-frequency bond yield changes surrounding credit rating change events can be used as a source of variation that is plausibly unrelated to macroeconomic fundamentals.[9] The underlying premise is that all relevant macroeconomic and financial information has been available before the rating change and, therefore, has already been priced in prior to the rating change. This plausibly rules our reverse causality, i.e., that we are capturing the effects of macroeconomic and financial conditions on the bond yield.[10] However, one may wonder why rating changes should still move markets if all information is already incorporated in asset prices. We argue rating changes still matter because, e.g., they may coordinate expectations and institutional investors can often hold certain assets only if they are rated sufficiently well. As a result, investors may re-balance their portfolios after credit rating changes primarily due to the rating change. Thus, bond yield changes surrounding credit rating events in a sufficiently tight window plausibly reflect a surprise shift in the demand for sovereign bonds that we aim to measure.

**Credit rating change events.** We define a credit rating change event indicator as

$$RatingChange_{i,\tau} = \begin{cases} 1 & \text{if } \Delta RatingIndex_{i,\tau} \neq 0 \\ 0 & \text{else,} \end{cases} \tag{1}$$

where $RatingIndex_{i,\tau}$ denotes our credit rating index for country $i$ at daily date $\tau$, and $\Delta$ indicates the change relative to $\tau - 1$. We exclude weekends since no yield data is available, so that $\tau$ refers to workdays. When credit rating changes occur on Saturday or Sunday, we re-code these event to the following Monday.

Occasionally, credit rating changes are a direct endogenous response to preceding debt policy events, such as sovereign debt restructurings, bailouts or similar interventions by international organizations. Such events typically have much larger effects on government bond yields than

[9] This identification idea has been originally proposed to study monetary policy (e.g., Kuttner, 2001; Bernanke and Kuttner, 2005; Gürkaynak et al., 2005). Recently, it has also been applied to, e.g., OPEC oil supply (Känzig, 2021; Degasperi, 2023), European carbon pricing (Känzig, 2023), and US treasury auctions (Phillot, 2025).

[10] We view it as implausible that rating agencies possess private information unavailable to other market participant, e.g., investment banks or hedge funds. Therefore, we expect that information effects as discussed for monetary policy (e.g., Nakamura and Steinsson, 2018a) and OPEC oil supply shocks (e.g., Degasperi, 2023) are likely no concern.

rating changes not surrounded by debt policy events. Therefore, following a narrative approach, we manually check all credit rating change events with extraordinary large changes in bond yields.[11] Whenever we detect a relevant debt policy event, we exclude all rating changes which occur within 90 days before or after it, i.e., $RatingChange_{i,\tau+s} = 0$ for all $s \in [-90, 90]$. Through this procedure, we reduce the total number of credit rating change events from XX to XX. While our narrative approach necessitates some judgment, we find that our results are robust to simply excluding all candidate events with extraordinary large yield changes.

**High-frequency yield data** Ideally, one would like to use prices of contracts regarding future government bonds, which directly capture expectation revision (e.g., Bernanke and Kuttner, 2005; Gürkaynak et al., 2005). However, this is infeasible since such futures are not available for our large cross-section of countries going back to the 1980s.[12] Instead, we operationalize our high-frequency identification approach using daily ten-year constant maturity government bond yields. With these data, we can measure bond yield adjustments in a small event window around rating change events. Importantly, the bond yield changes are still adequate to construct an instrumental variable as long as they correlate with the underlying fundamental shock that realizes at credit rating change events.

**Daily event studies.** Before constructing the high-frequency bond yield surprise, we estimate event studies to better understand the credit rating change events under consideration. These event studies allow us to assess the behavior of ten-year government bond yields on the days surrounding credit rating change events. Specifically, we can assess potential pre-trends in bond yields and understand how long it takes until markets have fully responded, without taking a stance on how we measure the high-frequency surprise eventually. Formally, we estimate regressions

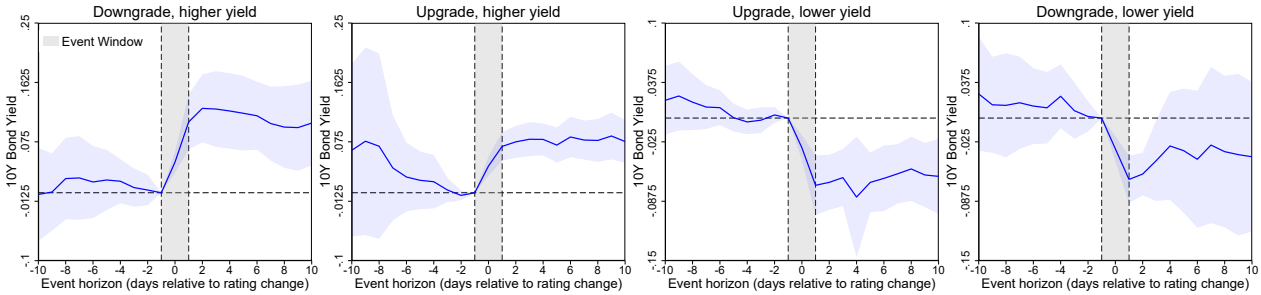
$$Y_{i,\tau+h} - Y_{i,\tau-1} = \alpha_i^h + \beta^h \; RatingChange_{i,\tau} + u_t^h, \tag{2}$$

for $h \in [-10, 10]$, where $Y_{i,\tau}$ is the daily ten-year bond yield at the closing value, $\alpha_i^h$ is a country fixed effect, $RatingChange_{i,\tau} \in \{0, 1\}$ is the credit rating change indicator defined above, and $u_t^h$ is an error term.

We run this regression on four different sub-samples, distinguishing between the following cases: (i) a positive rating change on a downgrade event, (ii) a positive rating change on an upgrade event, (iii) a negative rating change on an upgrade event, and (iv) a negative rating change on

[11] Specifically, we define extraordinary large yield changes as those surprises, which exceed to be described.
[12] The same data limitation applies to intraday yield data, which are not available consistently across space and time.

**Figure 3:** *Event study of daily yields around credit rating change events*




*Notes:* This figure presents daily event study regression results based on Equation 2, as specified in the text. The dependent variable is the daily bond yield and the OLS estimates are provided by the solid blue line. The two left panels consider yield increases around credit rating downgrades and upgrades, whereas the two right panels show the same for yield decreases. We estimate a parsimonious specification without controls, only including country fixed effects. The shaded ares are confidence bands at the 95 percent level, based on standard errors clustered by country and time.

a downgrade event.[13] Cases (i) and (iii) are the conventional cases where the yield responds as expected, i.e., an unanticipated downgrade signals lower creditworthiness driving up yields, and vice versa for upgrades. In contrast, case (ii) and (iv) are more puzzling events because the sign of the rating change and the yield change do not align well.

We report the event study estimates for these four cases in Figure 3. The solid line shows the point estimates given by $\beta^h$ and the blue shaded area indicates 95% confidence bands, based on standard errors being clustered at the country and time level. Focusing on all four cases jointly, we highlight two key findings. First, there are no statistically significant pre-trends visible, suggesting that our rating events are unanticipated. Second, the change in the yield seems to plateau one day after the credit rating change event. This suggests to capture the entire yield surprise, a two day event window is needed, which we have also visualized as gray shaded area.

Focusing on the differences across the four cases, there are two noteworthy observations. First, downgrade events that are followed by a yield increase display no pre-trend whatsoever. In contrast, upgrades followed by yield increases display a substantial pre-trend relative to the estimated post-event effects, albeit the pre-trend not being statistically significant. Second, upgrades that are followed by lower yields deliver a statistically significant effect over the entire ten-day window, whereas downgrades followed by lower yield display largely insignificant effects. Both findings suggest that the conventional cases (downgrades with higher yields and upgrades with lower yield) have more appealing empirical properties for the use as an instrumental variable for bond yields at business cycle frequency. Because of this evidence, we consider separate high-frequency surprises for all four cases below.

[13] To split the sample, we use the two day change of the yields between $\tau + 1$ and $\tau - 1$ anticipating our subsequent event window choice. However, our event study estimates are not sensitive to this choice.

**Event window choice.** When constructing high-frequency surprises, the choice of the event window is critical. A smaller window reduces the risk that confounding events being inadvertently captured in the surprise variable, the so-called background noise (Nakamura and Steinsson, 2018a). A larger event window helps to measure the effect of the rating change more comprehensively if market participants need more time to process the news and respond with their trading behavior. In addition, many rating changes are announced in the evening after markets have closed to avoid undue market turmoil. Balancing these considerations, we have opted for a two-day event window, since our event study results suggest a two-day window to be appropriate. Given this, we formally define a yield change surprise $YCS_{i,\tau}$ for country $i$ on day $\tau$ as

$$YCS_{i,\tau} = (Y_{i,\tau+1} - Y_{i,\tau-1}) \times RatingChange_{i,\tau} \tag{3}$$

where $RatingChange_{i,\tau}$ is the rating change event indicator defined above.[14]

**High-frequency yield change surprises.** The presented event study evidence suggests that it is potentially important to distinguish between four types of rating change events. In addition, obtaining separate series for each case may also be useful to allow for non-linearities. Therefore, we first define two additional high-frequency yield change surprises

$$YCS^{\mathcal{H}}_{i,\tau} = YCS_{i,\tau} \times \mathbb{1}\{YCS_{i,\tau} > 0\} \quad \text{and} \quad YCS^{\mathcal{L}}_{i,\tau} = YCS_{i,\tau} \times \mathbb{1}\{YCS_{i,\tau} < 0\}, \tag{4}$$

to distinguish between positive and negative yield surprises and, subsequently,

$$YCS^{\mathcal{HD}}_{i,\tau} = YCS^{\mathcal{H}}_{i,\tau} \times \mathbb{1}\{\Delta RatingIndex_{i,\tau} < 0\} \text{ and } YCS^{\mathcal{LD}}_{i,\tau} = YCS^{\mathcal{L}}_{i,\tau} \times \mathbb{1}\{\Delta RatingIndex_{i,\tau} < 0\} \tag{5}$$

$$YCS^{\mathcal{HU}}_{i,\tau} = YCS^{\mathcal{H}}_{i,\tau} \times \mathbb{1}\{\Delta RatingIndex_{i,\tau} > 0\} \text{ and } YCS^{\mathcal{LU}}_{i,\tau} = YCS^{\mathcal{L}}_{i,\tau} \times \mathbb{1}\{\Delta RatingIndex_{i,\tau} > 0\}, \tag{6}$$

to distinguish also between credit rating downgrades and upgrades, capturing all four above-mentioned cases. As a last step, we aggregate the individual surprises time series from daily to quarterly frequency by summing up all surprises that occur within a quarter.

In Table 1, we provide summary statistics for all quarterly surprise series that we have compiled. The last columns indicates the number of countries for which we have at least one surprise, suggesting that we capture surprises in most of the OECD countries in our sample. In total, we

[14] As explained above, credit rating changes on Saturdays or Sundays are re-coded to the following Monday. Thus, the surprise would be given by the yields on the following Tuesday minus that of the preceding Friday.

**Table 1:** *Summary statistics for quarterly yield change surprises*

| | Mean | Median | Std. Dev. | Min | Max | Obs | Countries |
|---|---|---|---|---|---|---|---|
| $YCS_{i,t}$ | 0.010 | 0.002 | 0.179 | -1.460 | 1.409 | 455 | 27 |
| $YCS^{\mathcal{H}}_{i,t}$ | 0.107 | 0.050 | 0.203 | 0.001 | 1.656 | 248 | 25 |
| $YCS^{\mathcal{L}}_{i,t}$ | -0.082 | -0.046 | 0.155 | -1.463 | -0.001 | 264 | 26 |
| $YCS^{\mathcal{HD}}_{i,t}$ | 0.140 | 0.057 | 0.244 | 0.001 | 1.656 | 125 | 21 |
| $YCS^{\mathcal{HU}}_{i,t}$ | 0.070 | 0.046 | 0.122 | 0.002 | 1.235 | 126 | 24 |
| $YCS^{\mathcal{LU}}_{i,t}$ | -0.079 | -0.050 | 0.147 | -1.463 | -0.001 | 165 | 23 |
| $YCS^{\mathcal{LD}}_{i,t}$ | -0.084 | -0.042 | 0.164 | -1.440 | -0.001 | 104 | 20 |

*Notes:* This table presents summary statistics for all constructed yield change surprise time series, as described in the text. The series are aggregated to quarterly frequency by summing up all surprises within a quarter. The last column indicates the number of countries for which we have at least one non-zero surprise in the sample.

have 455 surprises of which 248 are positive and 264 are negative surprises.[15] Relative to high-frequency monetary policy surprises, we have comparatively large magnitudes with the standard deviation ranging between 0.15 and 0.20 percentage points and the largest surprises being around 1.5 percentage points. This suggests that our surprise series capture meaningful variation in bond yields that may be used to identify the effects of yield changes on macroeconomic outcomes.

**Predictability of high-frequency surprises.** For monetary policy, an influential literature documents that high-frequency surprises can be predicted by past macroeconomic data (Cieslak, 2018; Miranda-Agrippino and Ricco, 2021; Bauer and Swanson, 2023a,b). Therefore, we investigate whether lagged macroeconomic indicators predict our surprises. To this end, we estimate the following quarterly regression

$$YCS^{k}_{i,t} = \alpha^{k}_{i} + \beta^{k} X_{i,t-1} + v^{k}_{t}, \tag{7}$$

where $k$ indexes the surprise series, $\alpha^{k}_{i}$ is a country fixed effect, and $X_{i,t-1}$ contains a lag of the left-hand side variable, real GDP growth, CPI inflation, total government debt (including social security and pensions), government bond debt, government loan debt, and the ten-year government bond yield at end-of-quarter values. The three government debt variables are stocks and always expressed relative to GDP. Importantly, all regressors realize before the credit rating change.

In principle, it would be desirable to use more recent macroeconomic predictors known just before a credit rating change, for example surprises from macroeconomic data releases prior to a rating change (see, e.g., Känzig, 2023). However, such data is not available for many of our countries

[15] Note that the observations from rows two and three need not sum up row one due to aggregation, i.e., we can have positive and negative surprises in the same quarter.

and periods. Moreover, we note that if more recent variables could predict the rating change, it may also lead to visible pre-trends in our event study specifications, which we do not find.

The regression results are in Table 2 for the four most granular cases. Columns (1) and (2) focus on positive surprises ($\mathcal{H}$igher yields). In column (1), the positive surprises arise from credit rating $\mathcal{D}$owngrades. For this surprise series, we find that there is no statistically significant predictability at the 5% level. For positive surprises due to credit rating $\mathcal{U}$pgrades, we however, find a statistically significant auto-regressive coefficient, although with a negative sign. We obtain a similar result for negative surprises ($\mathcal{L}$ower yields) due to credit rating $\mathcal{U}$pgrade in column (3). Lastly, column (4) shows that lagged stocks of government debt have some statistically significant effects, although with small coefficients.

We draw two main conclusions. First, downgrade surprises that raise yields are our most promising candidate for a valid instrument with high instrument relevance. This series is not predictable and the corresponding event study displays no pre-trends, suggesting instrument validity. The event study also displays the strongest effect on daily yields, suggesting that this may be a strong instrument for quarterly bond yields. Second, upgrade surprises that lower yields may also be a reasonable instrument, consistent with the event study results. While the auto-regressive coefficient is significant, we find that the coefficient is negative suggesting that these surprises are not persistent. However, we may also investigate the two other surprise series in our subsequent analysis. To address remaining predictability concerns, we always include lagged macroeconomic controls in our specifications and show that our results also hold when using the residualized surprises from Equation 7, i.e., when we use $\hat{v}_t^k$, the OLS residual.

## 4. Bond yields and governments' funding structures

In this section, we study the relation between government bond yields and government debt in loans and bonds. Our general finding is that an increase in government bond yields implies an increase in funding via loans and a smaller decrease in financing via bonds so that government debt as whole tends to expand. This suggests the bond supply curve of governments is upward sloping in bond prices, whereas total government debt supply is not necessarily. As an additional result, we find a decrease in bond yields has more muted effects, suggesting relevant sign-dependencies.

We establish the results in three ways. First, we document these relations unconditionally for all bond yield changes in our sample. Second, we condition on quarters with sovereign credit rating changes as an intermediate step. Finally, we instrument yield changes using our high-frequency

**Table 2:** *Predictive regressions for high-frequency yield change surprises*

| | $YCS^{\mathcal{HD}}_{i,t}$ | $YCS^{\mathcal{HU}}_{i,t}$ | $YCS^{\mathcal{LU}}_{i,t}$ | $YCS^{\mathcal{LD}}_{i,t}$ |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $LHS\ Var_{i,t-1}$ | 0.109 | -0.054*** | -0.076*** | -0.036 |
| | (0.070) | (0.017) | (0.021) | (0.085) |
| $GDP\ Growth_{i,t-1}$ | -0.001* | 0.000** | 0.000 | 0.001 |
| | (0.001) | (0.000) | (0.000) | (0.001) |
| $Inflation_{i,t-1}$ | -0.002 | -0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| $Gov.\ Long\ Yield_{i,t-1}$ | 0.004 | 0.001 | -0.002 | -0.003 |
| | (0.003) | (0.001) | (0.002) | (0.002) |
| $Total\ Gov.\ Debt_{i,t-1}$ | 0.001 | 0.000 | -0.000 | -0.001** |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| $Gov.\ Loans_{i,t-1}$ | -0.001 | 0.000 | -0.000 | 0.001** |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| $Gov.\ Bonds_{i,t-1}$ | -0.001 | -0.000 | 0.000 | 0.001* |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| $R^2$ | 0.101 | 0.066 | 0.081 | 0.073 |
| Country FE | ✓ | ✓ | ✓ | ✓ |
| Observations | 3085 | 3085 | 3085 | 3085 |

*Notes:* This table presents quarterly regression results based on Equation 7, as specified in the text. The dependent variables are the quarterly yield change surprise time series. Columns (1) and (2) use positive yield surprises from rating downgrades and upgrades, respectively. Columns (3) and (4) use negative yield surprises from upgrades and downgrades, respectively. All regressors are described in the text, and we include country fixed effects. Standard errors are in parenthesis and clustered by country and year, and *,**,*** indicates significance at the 0.1, 0.05, 0.01 levels, respectively.

yield surprises to establish causality.

## 4.1. Linking bond yields to governments' funding structure

**All yield changes.** We start our analysis by documenting the relation between bond yield changes and financing via loans and bonds. To this end, we run the following regression

$$z_{i,t+4} = \alpha_i + \alpha_t + \beta\, \Delta Y^k_{i,t} + \gamma\, X^{Macro}_{i,t-1} + \nu_{i,t+4}, \tag{8}$$

where $\nu_{i,t+4}$ is an error term, $\alpha_i$ and $\alpha_t$ are country and time fixed effects, and $\Delta Y^k_{i,t}$ is the quarter-on-quarter change of the ten-year government bond yield. The superscript $k \in \{\Delta > 0, \Delta < 0\}$ denotes if we consider only yield increases or decreases. The left-hand side variable, $z_{i,t+4}$, is the change between $t-1$ and $t+4$ of the loan-bond ratio, i.e., government loans divided by bonds, both measured as stock variables. Alternatively, $z_{i,t+4}$ is the sum of newly issued loans between $t$ and $t+4$, and similarly for newly issued bonds.[16] These flow variables are always expressed relative to

[16]Studying newly issued bonds instead of stocks is advantageous because issuance is free of valuation effects and, thus, better captures governments active funding decisions.

**Table 3:** *Relation between yield changes and government funding choices*

| | $\Delta_5$ Loan-Bond ratio$_{i,t+4}$ | | $\Sigma_{j=0}^{4}$ Loan Issuance$_{i,t+j}$ | | $\Sigma_{j=0}^{4}$ Bond Issuance$_{i,t+j}$ | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\Delta Y_{i,t}$ | 0.020** | | 0.515*** | | -0.268** | |
| | (0.009) | | (0.119) | | (0.111) | |
| $\Delta Y_{i,t}^{\Delta>0}$ | | 0.031*** | | 0.837*** | | -0.345 |
| | | (0.010) | | (0.226) | | (0.226) |
| $\Delta Y_{i,t}^{\Delta<0}$ | | 0.008 | | 0.188** | | -0.190 |
| | | (0.007) | | (0.090) | | (0.120) |
| $R^2$ | 0.049 | 0.051 | 0.293 | 0.307 | 0.056 | 0.056 |
| Country FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 3540 | 3540 | 3540 | 3540 | 3540 | 3540 |

*Notes:* This table presents quarterly regression results based on Equation 8, as specified in the text. The dependent variables are the change in the loan-bond ratio between $t-1$ and $t+4$ in columns (1) and (2), the cumulative issuance of new government loans relative to GDP from $t$ to $t+4$ in columns (3) and (4), and the cumulative new issuance of government bond liabilities relative to GDP over the same period in columns (5) and (6). $\Delta Y_{i,t}$, $\Delta Y_{i,t}^{\Delta>0}$, and $\Delta Y_{i,t}^{\Delta<0}$ refer to the quarter-on-quarter change in ten-year government bond yields as well as the same change conditioning on positive changes and negative changes, respectively. Controls include a quarterly lag of real GDP growth, CPI inflation, the ten-year government bond yield, the rating index, and total government debt. All specifications additionally include country and time fixed effects. Standard errors are in parenthesis and clustered by country and year, and *,**,*** indicates significance at the 0.1, 0.05, 0.01 levels, respectively.

nominal GDP and, all government debt variables are at the level of the general government in the national accounts.[17] The vector of macroeconomic control variables, $X_{i,t-1}^{Macro}$, includes a lag of real GDP growth, CPI inflation, the bond yield, the rating index, and total government debt.

In Table 3, we provide the estimation results. Here and throughout all regressions in section 4, we present standard errors in parentheses that are clustered at the country and time level. In columns (1), (3), and (5), we show that a one percentage point increase in bond yields is associated with an increase in the loan-bond ratio of 0.08. This is particularly driven by loan issuance which increases by 2.1 percent of GDP over the one year horizon under consideration. In contrast, bond issuance is reduced by 1.1 percent of GDP, suggesting that overall government debt might increase. All of these estimates are statistically significant at the 1% or 5% level. In the remaining columns, we repeat the estimation but allow for sign-dependence between bond yield increases and bond yield decreases. This reveals that the above discussed effects are primarily driven by yield increases, whereas the estimated effects for yield decreases are more muted.

We caution to interpret the above findings as structural relation, let alone as an estimate of the slope of the governments' debt supply schedules. For such an interpretation, one requires a plausibly exogenous shifter in the demand for government debt. Thus, we next turn to credit rating change events.

[17] We provide additional estimates using the central government in the sensitivity analysis..

**Credit rating change events.** We argue that high-frequency changes in yields around sovereign credit rating change events deliver plausibly exogenous shifts in the demand for government debt. Thus, as an intermediate step, we condition on credit rating change events and re-estimate the link between government bond yields and government debt. Formally, we estimate

$$z_{i,t+4} = \alpha_i + \alpha_t + \beta\, \Delta Y^k_{i,t} + \gamma\, X^{Macro}_{i,t-1} + \delta\, X^{FAP}_{i,t+4} + \tilde{v}_{i,t+h}, \tag{9}$$

where all elements are defined analogously to Equation 8, with two exceptions. First, we focus on credit rating change events so that superscript $k$ indicates the sign of the bond yield change ($\Delta \gtrless 0$), and $\mathcal{U}$ and $\mathcal{D}$ indicate rating upgrade and downgrade events, respectively. When no rating change occurs, the regressors assume a zero value. The other exception is that we may also control for foreign assistance programs by international organizations. We do this to focus on government financing from the private sector. Specifically, vector $X^{FAP}_{i,t+4}$ contains the change between $t-1$ and $t+4$ of six distinct series that measure the stock of received foreign aid.[18] The series measure the stock of funding from the International Monetary Fund (IMF), the European Stability Mechanism (ESM), the European Financial Stability Facility (EFSF), the European Balance of Payments Facility, the European Financial Stabilisation Mechanism (EFSM), and the European instrument for temporary Support to mitigate Unemployment Risks in an Emergency (SURE). However, we start the analysis by excluding the foreign assistance program controls and subsequently introduce them to highlight their effects on our coefficients of interest.

We present the results in Table 4 that discriminate between positive and negative yield changes in columns (1), (4), and (7). Consistent with the unconditional results, we find an increase in the loan-bond issue driven by a sizable increase in loan issuance and a smaller reduction in bond issuance, all effects being statistically significant at the 1% or 5% level. While the signs have not changed, we note that the estimated magnitudes are considerably larger when focusing only on credit rating change events. This contrasts with yield increases, for which we find no statistically significant effects.

In columns (2), (5), and (8), we further discriminate between credit rating downgrades and upgrades in addition to yield increases and decreases, covering all four possible combinations. The results show our findings are primarily driven by yield increases in quarter with credit rating downgrades. All corresponding estimates increase further in magnitude and are highly statistically

[18] We define the controls in this way mirror the definition of the left-hand side variable and purge the variation that is only due to foreign assistance programs.

**Table 4:** *Relation between yield changes and government funding choices*

| | $\Delta_5$ Loan-Bond ratio$_{i,t+4}$ | | | $\Sigma_{j=0}^{4}$ Loan Issuance$_{i,t+j}$ | | | $\Sigma_{j=0}^{4}$ Bond Issuance$_{i,t+j}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $\Delta Y_{i,t}^{\Delta>0,\mathcal{D}\vee\mathcal{U}}$ | 0.036*** | | | 0.890*** | | | -0.470** | | |
| | (0.011) | | | (0.247) | | | (0.232) | | |
| $\Delta Y_{i,t}^{\Delta<0,\mathcal{D}\vee\mathcal{U}}$ | 0.003 | | | 0.021 | | | 0.006 | | |
| | (0.007) | | | (0.093) | | | (0.060) | | |
| $\Delta Y_{i,t}^{\Delta>0,\mathcal{D}}$ | | 0.041*** | 0.023*** | | 1.079*** | 0.515*** | | -0.511* | -0.235 |
| | | (0.014) | (0.007) | | (0.319) | (0.160) | | (0.264) | (0.240) |
| $\Delta Y_{i,t}^{\Delta<0,\mathcal{D}}$ | | -0.024* | -0.026 | | -0.422* | -0.120 | | -0.486 | -0.646** |
| | | (0.013) | (0.019) | | (0.234) | (0.258) | | (0.360) | (0.327) |
| $\Delta Y_{i,t}^{\Delta>0,\mathcal{U}}$ | | 0.010 | 0.013 | | -0.108 | 0.076 | | -0.210 | -0.433 |
| | | (0.015) | (0.019) | | (0.123) | (0.148) | | (0.226) | (0.288) |
| $\Delta Y_{i,t}^{\Delta<0,\mathcal{U}}$ | | 0.006 | 0.005 | | 0.064 | 0.062 | | 0.066 | 0.044 |
| | | (0.009) | (0.005) | | (0.115) | (0.047) | | (0.092) | (0.093) |
| $R^2$ | 0.050 | 0.052 | 0.094 | 0.292 | 0.310 | 0.592 | 0.056 | 0.057 | 0.091 |
| Country FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Foreign Assistance | | | ✓ | | | ✓ | | | ✓ |
| Observations | 3540 | 3540 | 3343 | 3540 | 3540 | 3343 | 3540 | 3540 | 3343 |

*Notes:* This table presents quarterly regression results based on Equation 9, as specified in the text. The dependent variables are the change in the loan-bond ratio between $t-1$ and $t+4$ in columns (1) to (3), the cumulative issuance of new government loans relative to GDP from $t$ to $t+4$ in columns (4) to (6), and the cumulative new issuance of government bond liabilities relative to GDP over the same period in columns (7) to (9). $\Delta Y_{i,t}$, $\Delta Y_{i,t}^{\Delta>0}$, and $\Delta Y_{i,t}^{\Delta<0}$ refer to the quarter-on-quarter change in ten-year government bond yields as well as the same change conditioning on positive changes and negative changes, respectively. The additional superscript indicates yield changes due to credit rating downgrades ($\mathcal{D}$) and upgrades ($\mathcal{U}$), setting the regressor to zero when no rating change occurs. Controls include a quarterly lag of real GDP growth, CPI inflation, the ten-year government bond yield, the rating index, and total government debt. All specifications additionally include country and time fixed effects. Foreign assistance controls account for emergency lending from international institutions, as explained in the text. Standard errors are in parenthesis and clustered by country and year, and *,**,*** indicates significance at the 0.1, 0.05, 0.01 levels, respectively.

significant for the loan-bond ratio and loan issuance, but less precisely measured for bond issuance.

Finally, in columns (3), (6), and (9), we re-estimate the same specification but include the controls for foreign assistance programs to focus on debt held by the private sector. We find that all coefficients roughly half, suggesting that foreign assistance plays a meaningful role. However, the remaining coefficients are still sizable in magnitudes and statistically significant at the 1% level for the loan-bond ratio and the issuance of new loans. For newly issued bonds, we find no statistically significant effects, however. Due to this importance of foreign assistance, we include the foreign assistance control vector in all subsequent estimations.

**Summary.** We find a robust link between bond yields and government funding choices that crucially depends on the sign of the yield change. However, the presented OLS estimates may suffer from reverse causality, i.e., we could partly capture the effect of macroeconomic conditions on bond yields. Thus, we next employ the yield change surprises to establish plausibly causal relationships.

## 4.2. Identifying the effect of bond yields on governments' funding structures

**First stage.** To establish causality, we leverage our high-frequency identified yield surprises, which constitute a plausibly exogenous surprise to bond yields, as discussed in section 3. We start this analysis by investigating instrument relevance and estimate the first stage corresponding to Equation 9. We instrument the yield change with the corresponding yield change surprise, $YCS^k_{i,t}$. Specifically, we consider each of the following four cases separately: we distinguish between credit rating upgrades and downgrades as well as positive and negative yield changes. Moreover, we always report two specifications. Either, we only instrument yield changes on corresponding credit rating change events, setting all other yield changes to zero. Alternatively, we instrument all yield changes regardless of whether a rating change event occurs in the same quarter.

In Table 5, we report the coefficients on the instrumental variables for all eight first stages. Focusing on columns (1) and (2) as well as (5) and (6), we find that positive yield surprises due to downgrades and negative yield surprises due to upgrades display large coefficients with the expected sign, which are highly statistically significant. This holds regardless of whether we consider only yield changes on credit rating change events in columns (1) and (5) or all yield changes in columns (2) and (6). These are the conventional cases, where credit rating changes and the yield surprise agree in their sign, i.e., a credit rating downgrade is accompanied by an increase in yields and vice versa for rating upgrades. In the remaining columns, we consider the other cases. The coefficients are considerably smaller, and even display a puzzling sign when not conditioning on credit rating change events. While these findings already suggests that the two conventional cases provide a stronger first stage, we turn to formal weak instrument tests next.

As recommended by Andrews et al. (2019), we use the weak instrument test from Montiel-Olea and Pflueger (2013), which is robust to heteroskedasticity, serial correlation and clustering. This test compares an effective F statistic with a critical value.[19] The reported critical value corresponds to a test of the null hypothesis that the relative weak instrument bias exceeds 5%.[20] We compute the critical value for testing this null at the 1% significance level. Both the critical value and the effective F statistic are included in Table 5. For the conventional cases in columns (1), (2), (5), and (6), we clearly reject the null of weak instruments, whereas we cannot reject the null hypothesis for the remaining cases.

Lastly, we test for weak instruments via the reduced-form of Equation 9, i.e., we replace the

[19] In our "just identified" setting, the effective and Kleibergen-Paap F statistics coincide (Andrews et al., 2019).

[20] This is the critical value for the most conservative null hypothesis that is tabulated in the Stata output of the *weakivtest* command from Montiel-Olea and Pflueger (2013).

**Table 5:** *First stage estimates and weak instrument tests*

| | $\Delta Y_{i,t}^{\Delta>0,\mathcal{D}}$ | $\Delta Y_{i,t}^{\Delta>0}$ | $\Delta Y_{i,t}^{\Delta>0,\mathcal{U}}$ | $\Delta Y_{i,t}^{\Delta>0}$ | $\Delta Y_{i,t}^{\Delta<0,\mathcal{U}}$ | $\Delta Y_{i,t}^{\Delta<0}$ | $\Delta Y_{i,t}^{\Delta<0,\mathcal{D}}$ | $\Delta Y_{i,t}^{\Delta<0}$ |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $YCS_{i,t}^{\mathcal{HD}}$ | 2.094*** | 1.812*** | | | | | | |
| | (0.172) | (0.170) | | | | | | |
| $YCS_{i,t}^{\mathcal{HU}}$ | | | 0.176 | -0.697*** | | | | |
| | | | (0.226) | (0.188) | | | | |
| $YCS_{i,t}^{\mathcal{LU}}$ | | | | | 2.988*** | 2.101*** | | |
| | | | | | (0.157) | (0.183) | | |
| $YCS_{i,t}^{\mathcal{LD}}$ | | | | | | | 0.568*** | -1.239*** |
| | | | | | | | (0.205) | (0.330) |
| Country FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Macro controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Foreign assistance controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Effective F | 141.70 | 109.29 | 0.58 | 13.25 | 346.70 | 125.86 | 7.34 | 13.51 |
| Montiel-Olea & Pflueger (2013) critical value | 46.22 | 46.22 | 46.22 | 46.22 | 46.22 | 46.22 | 46.22 | 46.22 |
| $R^2$ | 0.38 | 0.20 | 0.03 | 0.02 | 0.45 | 0.29 | 0.08 | 0.21 |
| Observations | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 |

*Notes:* This table presents first stage regression results corresponding to Equation 9, as specified in the text. The dependent variables are the quarter-on-quarter change in the ten-year government bond yield, conditioning on positive ($\Delta > 0$) or negative ($\Delta < 0$) yield changes as indicated by the superscript. Columns (1), (3), (5), and (7) further condition on a corresponding credit rating upgrade ($\mathcal{U}$) or downgrade ($\mathcal{D}$) occurring in the same quarter. The regressors are the yield change surprises, and the superscript additionally indicates whether these surprises changes are positive ($\mathcal{H}$igher yields) or negative ($\mathcal{L}$ower yields). Controls include a quarterly lag of real GDP growth, CPI inflation, the ten-year government bond yield, the rating index, and total government debt. All specifications additionally include country and time fixed effects. Foreign assistance controls account for emergency lending from international institutions, as explained in the text. The effective F statistic and the critical value correspond to the Montiel-Olea and Pflueger (2013) weak instrument test at the 1% significance level. An F statistics above the critical value allows rejecting the null of weak instruments. Standard errors are in parenthesis and clustered by country and year, and *,**,*** indicates significance at the 0.1, 0.05, 0.01 levels, respectively.

endogenous variable by the instrument to project directly on the instrumental variable via OLS. Following Chernozhukov and Hansen (2008), the hypothesis test of the reduced-form estimates against the null of a zero coefficient is equivalent to testing whether the instrument has zero relevance. These tests are in Table A3.2 in the Appendix, leading to similar conclusions.

As a result of the above presented tests, we conclude that we have two strong instruments that allow us to estimate the causal effects of government bond yield increases and decreases.

**Second stage.** Given the strong first stage for positive yield surprises from rating downgrades and negative yield surprises from rating upgrade, we use these instruments to estimate the effect of yield changes on government debt variables based on Equation 9.

We present the results in Table 6 and first focus on the effects of yield increases. Over a one-year period after a yield increase by one percentage point, we find an increase in the loan-bond ratio of almost 0.2, an increase in loan issuance between 4.5 and 5.2 percent of GDP, and a decrease in bond issuance between 3.2 and 3.6 percent of GDP. All of these estimates are statistically significant at the 1% level, regardless of whether we instrument all yield increases or only yield increases conditional

**Table 6:** *Effects of yield changes on government funding choices using the high-frequency yield surprise*

| | $\Delta_5$ Loan-Bond ratio$_{i,t+4}$ | | | | $\Sigma_{j=0}^{4}$ Loan Issuance$_{i,t+j}$ | | | | $\Sigma_{j=0}^{4}$ Bond Issuance$_{i,t+j}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| $\Delta Y_{i,t}^{\Delta>0,\mathcal{D}}$ | 0.043*** | | | | 1.114*** | | | | -0.787*** | | | |
| | (0.009) | | | | (0.153) | | | | (0.117) | | | |
| $\Delta Y_{i,t}^{\Delta>0}$ | | 0.049*** | | | | 1.288*** | | | | -0.910*** | | |
| | | (0.011) | | | | (0.197) | | | | (0.121) | | |
| $\Delta Y_{i,t}^{\Delta<0,\mathcal{U}}$ | | | -0.003 | | | | 0.351** | | | | -0.031 | |
| | | | (0.007) | | | | (0.159) | | | | (0.189) | |
| $\Delta Y_{i,t}^{\Delta<0}$ | | | | -0.004 | | | | 0.500** | | | | -0.044 |
| | | | | (0.010) | | | | (0.207) | | | | (0.267) |
| $R^2$ | 0.201 | 0.192 | 0.188 | 0.183 | 0.608 | 0.587 | 0.593 | 0.607 | 0.122 | 0.116 | 0.115 | 0.116 |
| Country FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Macro Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| FAP Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 | 2713 |

*Notes:* This table presents quarterly instrumental variable regression results based on Equation 9, as specified in the text. The dependent variables are the change in the loan-bond ratio between $t-1$ and $t+4$ in columns (1) to (4), the cumulative issuance of new government loans relative to GDP from $t$ to $t+4$ in columns (5) to (8), and the cumulative new issuance of government bond liabilities relative to GDP over the same period in columns (9) to (12). $\Delta Y_{i,t}$, $\Delta Y_{i,t}^{\Delta>0}$, and $\Delta Y_{i,t}^{\Delta<0}$ refer to the quarter-on-quarter change in ten-year government bond yields as well as the same change conditioning on positive changes and negative changes, respectively. The additional superscript indicates yield changes due to credit rating downgrades ($\mathcal{D}$) and upgrades ($\mathcal{U}$), setting the regressor to zero when no rating change occurs. We instrument all positive yield changes with positive yield surprises from downgrades ($YCS_{i,t}^{\mathcal{H}\mathcal{D}}$), and all negative yield changes with negative yield surprises from upgrades ($YCS_{i,t}^{\mathcal{L}\mathcal{U}}$). Controls include a quarterly lag of real GDP growth, CPI inflation, the ten-year government bond yield, the rating index, and total government debt. All specifications additionally include country and time fixed effects. Foreign assistance controls account for emergency lending from international institutions, as explained in the text. Standard errors are in parenthesis and clustered by country and year, and *,**,*** indicates significance at the 0.1, 0.05, 0.01 levels, respectively.

on credit rating events. Since we interpret our surprises as capturing demand shocks, one may interpret our estimated coefficients as slopes of the government debt supply schedules. The results imply a bond supply curve, which is upward sloping in bond prices. However, total government debt supply may not be upward sloping since loan financing expands strongly when bond yields increase.

Moving to yield decreases in Table 6, we find a statistically significant effect on loan issuance. However, the estimated coefficients are less than half of the coefficients for yield increases. Furthermore, the loan-bond ratio and the issuance of new bonds display only insignificant effects. This suggests an economically meaningful sign-dependence of yield changes.[21] While increases in yields lead to an increase in loan financing, we find that equally-sized decreases in yields only partly reverse this effect. Similarly, we find no evidence that yield decreases reverse the effect on bond issuance or the loan-bond ratio.

[21] Often, it can be challenging to disentangle sign- and size-dependencies (Caravello and Martinez-Bruera, 2024). In our case, however, we note that the distribution of positive and negative yield change surprises is comparable so that we can plausibly attribute the detected non-linearity to sign-dependencies.

**Dynamic effects.** The above presented estimates focus on a one year period after a yield change. However, changes in government yields are likely to be persistent. Therefore, we estimate a dynamic version of Equation 9 where we only change the left-hand side from $z_{t+4}$ to $z_{t+h}$, for $h = 0, ..., 20$. That is, we consider the $h$-period ahead change of the ten-year government bond yield and the loan-bond ratio, and the cumulative issuance of loans and bonds between $t$ and $t + h$. We keep the right-hand side of the regression fixed and use the instrumental variables as before. Moreover, we focus on the more general case of yield changes without conditioning on rating change events.[22]

The resulting dynamic responses are presented in Figure 4. We show the IV estimates and the corresponding OLS estimates for comparison. The shaded area and the dashed lines indicate 95% confidence bands based on standard errors clustered at the country and time level. The left column indicates the responses to yield increases and the right column indicates responses to yield decreases, although the coefficients have to be interpreted identically since we did not multiply the yield decrease effects by minus one.[23] Moreover, all responses are normalized to correspond to an impact change in the bond yield equal to 0.25 percentage points, which roughly corresponds to a standard deviation in the yield change surprise series.

Both yield increases and decreases are persistent keeping the yield elevated for the first six quarters. Over this time horizon, the overall impact is broadly comparable, albeit somewhat stronger for yield increases. From six quarters onward, we find that yield increases remain persistent, whereas yields after decreases quickly revert to zero. While there are some differences between both types of yield changes, we view them as only being moderately important.

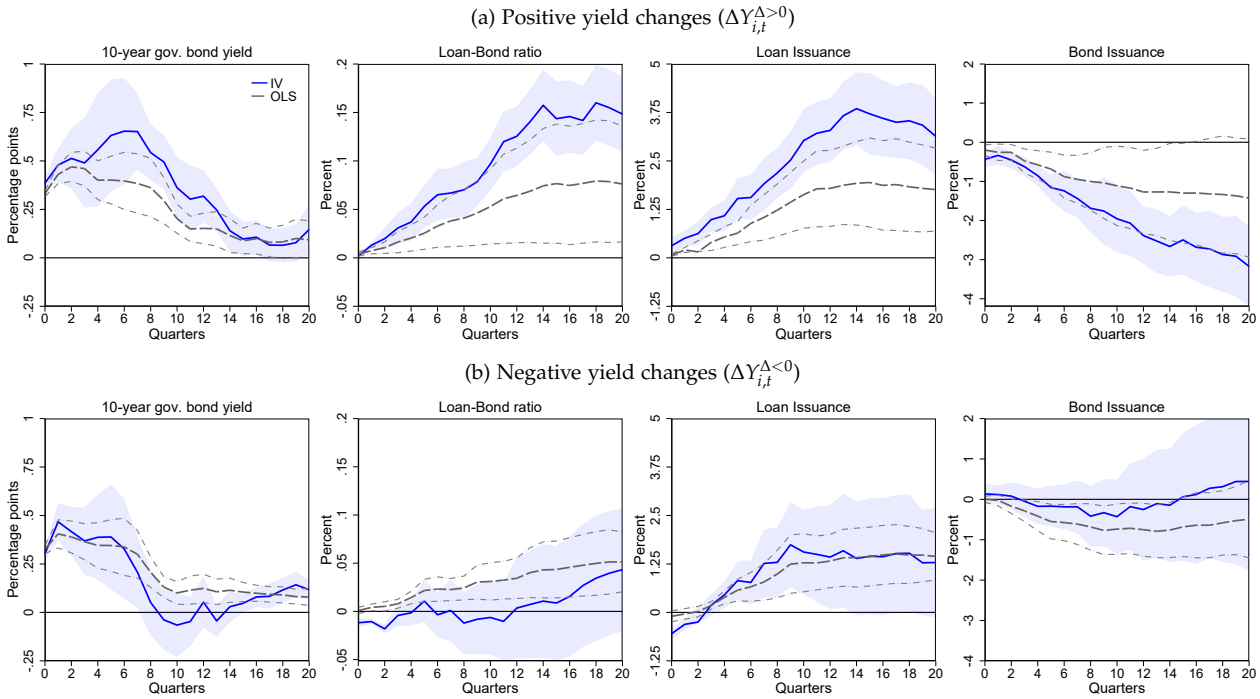
This contrasts with all other variables for which we find strong and highly significant effects only for yield increases. In response to a yield increase, the loan-bond ratio consistently increases until it levels off at 0.1 after 14 quarters, with these estimates being highly statistically significant. This is partly driven by an equally significant increase in loan issuance, which plateaus after 10 quarters at around 2.1% of GDP. We find the opposite effect on bond issuance which levels off after 14 quarters. Over this 14-quarter horizon, cumulative bond issuance has been 1.9% lower due to the yield increase.

In contrast, the coefficients for yield decreases are mostly insignificant for the loan-bond ratio and the issuance of new bonds. Only for loan issuance, we find statistically significant coefficients with the same sign as for yield increases. However, the magnitudes are considerably smaller.

[22] When using the time series that set quarterly yield changes to zero in quarters with no corresponding rating change event, we obtain similar results and present them in Figure A3.5 in the Appendix.

[23] Specifically, this means that the estimated responses for yield increases and decreases should look identical in the absence of sign-dependencies.

**Figure 4:** *Dynamic effects of yield changes on government funding choices using the high-frequency yield surprise*




*Notes:* This figure presents quarterly instrumental variable regression results based on Equation 9, as specified in the text. The dependent variables are the change in the ten-year government bond yield and the loan-bond ratio between $t-1$ and $t+h$ in the left panels, and the cumulative issuance of new government loans and bonds relative to GDP from $t$ to $t+h$ in the right panels. The top row focuses on positive yield changes and the bottom row focuses on negative yield changes. We instrument all positive yield changes with positive yield surprises from downgrades ($YCS_{i,t}^{\mathcal{HD}}$), and all negative yield changes with negative yield surprises from upgrades ($YCS_{i,t}^{\mathcal{LU}}$). Controls include a quarterly lag of real GDP growth, CPI inflation, the ten-year government bond yield, the rating index, and total government debt. All specifications additionally include country and time fixed effects. Foreign assistance controls account for emergency lending from international institutions, as explained in the text. The shaded ares are confidence bands at the 95 percent level, based on standard errors clustered by country and time.

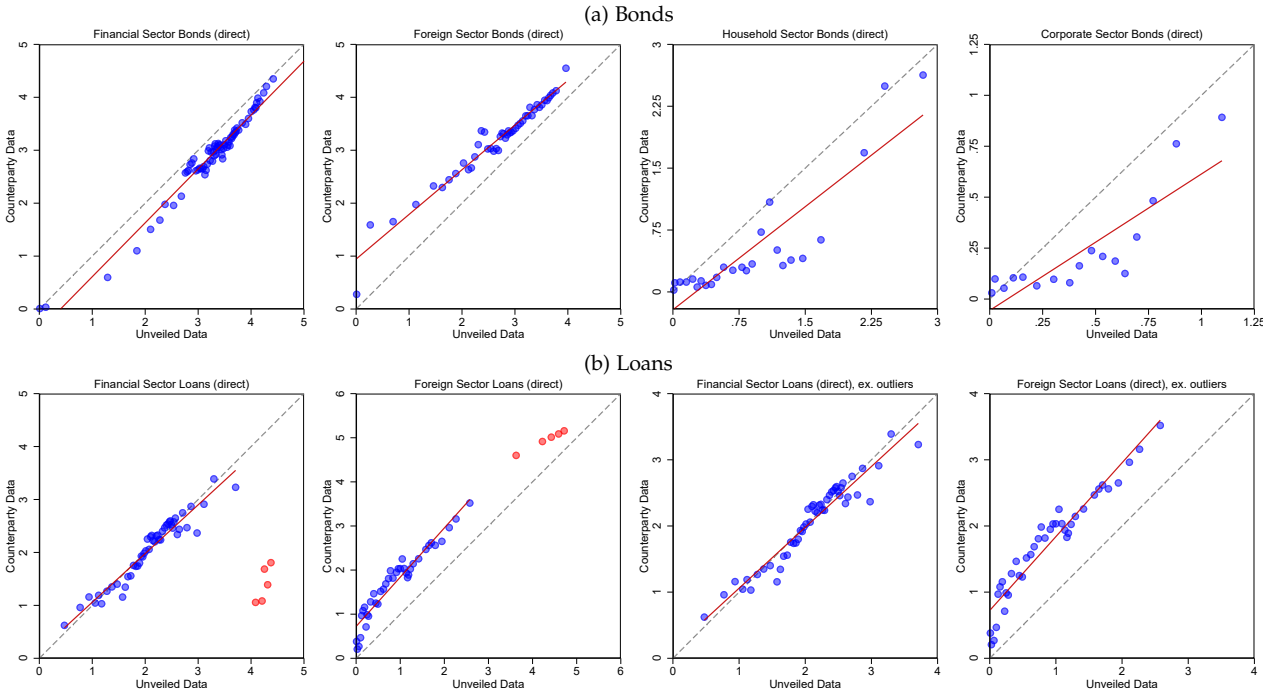
**Summary.** Our overarching result is increases in government bond yields imply increased funding via loans and a smaller decrease in financing via bonds so that government debt as whole tends to expand. This suggests the bond supply curve of governments is upward sloping in bond prices, whereas total government debt supply is not necessarily. As an additional result, we find a decrease in bond yields has more muted effects, suggesting economically meaningfully sign-dependencies.

## 5. Government creditors and financial stability

### 5.1. Unveiling government creditors

**Unveiling methodology.** In this section, we investigate the creditors that provide the funds to the government. Such an analysis requires counterparty data. However, counterparty data is unavailable for the majority of observations in our sample. Therefore, we apply the "unveiling" methodology introduced by Mian et al. (2020) and further developed by Diebold and Richter (2021) to allocate loans and bonds to creditors, providing us with an estimate of the latent counterparty

**Figure 5:** *Unveiling validation*




*Notes:* This figure presents binscatter plots that compare counterparty data from the financial account on the vertical axis with our unveiled data on the horizontal axis, which are an estimate of the counterparty data. We take the natural logarithm of all observations.

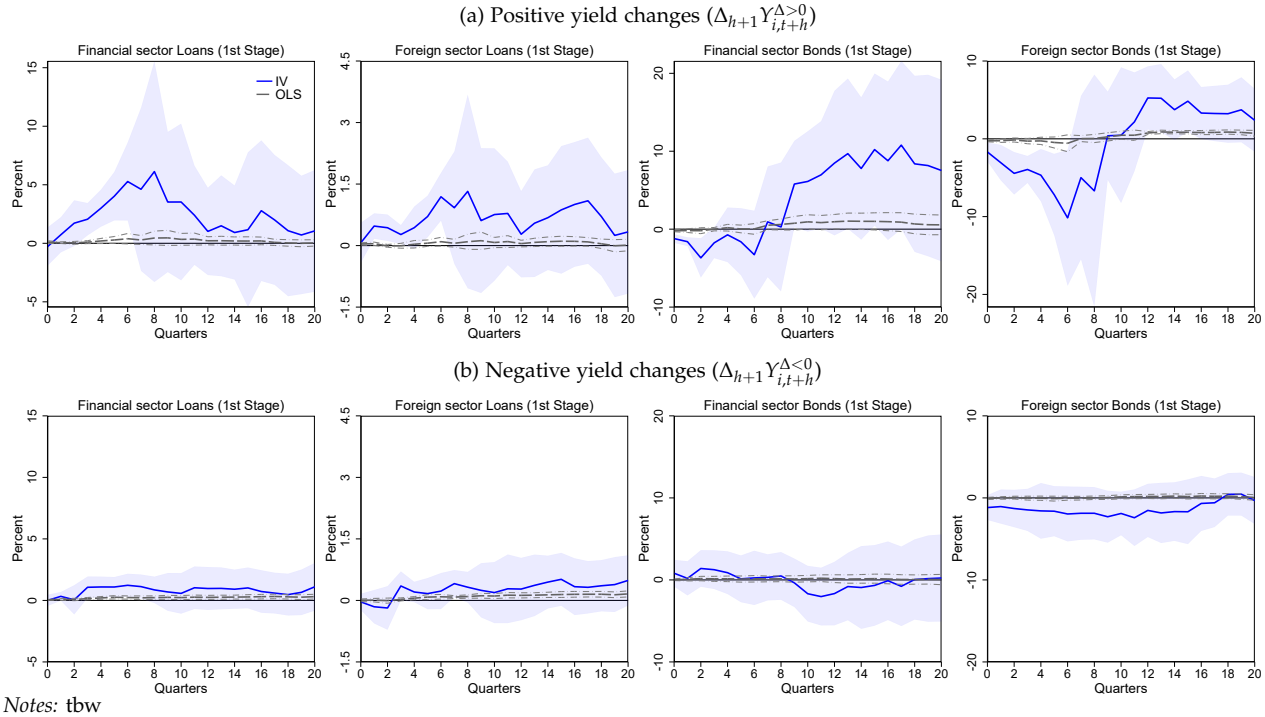
variables, to which we refer as "unveiled" data. This methodology builds on a proportionality assumption, which is described in detail in Diebold and Richter (2021). Thus, we refer the reader to Diebold and Richter (2021) for a detailed description of the method.

we carefully validate our approach by comparing our counterparty estimates with actual counterparty data, when available. This counterparty data covers roughly one-third of our sample. In Figure 5, we provide binscatter plots of the natural logarithm of the counterparty data on the vertical axis and our unveiled data on the horizontal axis. Overall, the unveiling works remarkably well, with very few exceptions. These exceptions pertain to observations with large loan financing, which we highlight as red. These outliers likely reflect financing from international organizations. As a result, we exclude all of these outliers in the subsequent analysis.

**Dynamic effects of first-stage unveiled holdings.** Given this validation, we proceed and use the unveiled data as an additional outcome using our instrumental variable local projection approach.

The results are provide in Figure 6. In general, these effects are less precisely estimated, possibly because our unveiling methodology introduces measurement error in the left-hand side variable of the regression. However, focusing on yield increases, we still find a statistically significant increase in government loan holdings by the domestic financial sector. Furthermore, we find a

**Figure 6:** *Dynamic effects of yield changes on direct holdings using the high-frequency yield surprise*



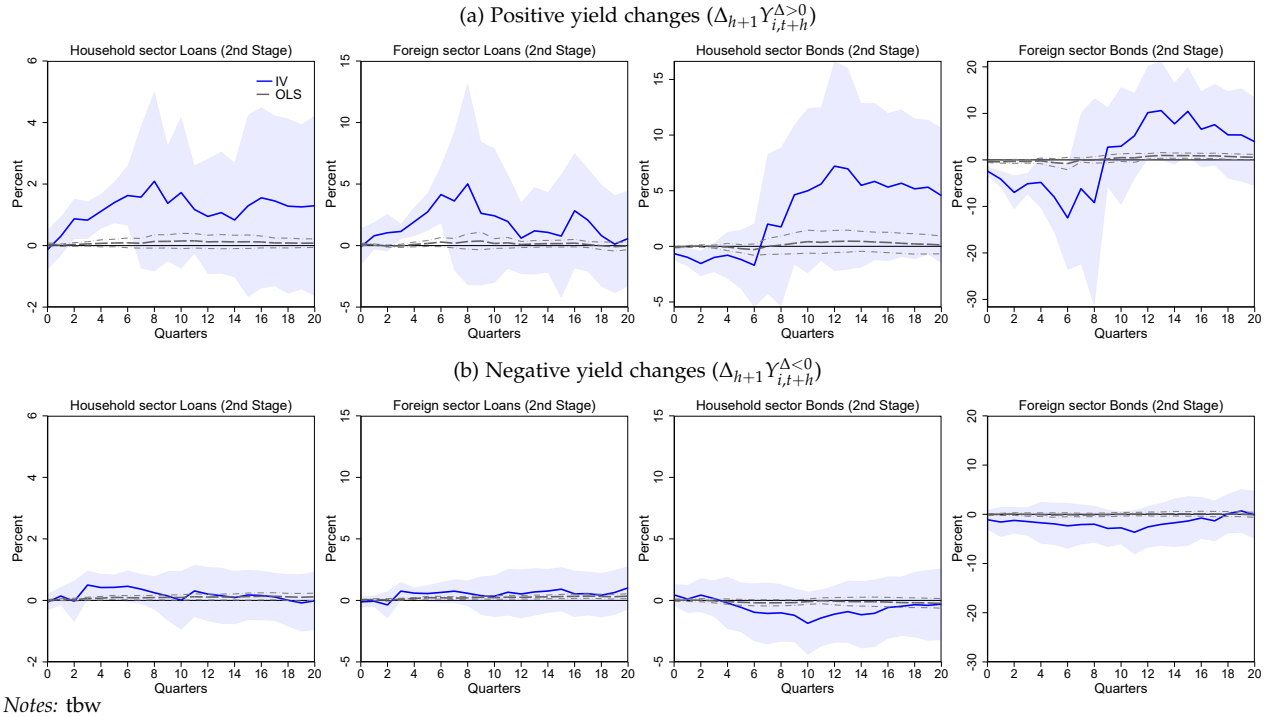

*Notes:* tbw

significant decrease of government bond holdings by the foreign sector. Yet, the foreign sector does not significantly expand its government loan positions. For yield decreases, in contrast, we find no meaningful effects.

**Dynamic effects of second-stage unveiled holdings.** We further apply the "unveiling" methodology to allocate the corporate sector asset holdings to the sectors that ultimately own the corporate sector, as in Mian et al. (2020). In Figure 7, we present impulse responses of these data using our instrumental variable approach. We find that the foreign sector significantly increases its loan holdings. A comparison with the above results for direct counterparties indicates that the foreign sector funds these government loans indirectly via the domestic financial sector. The reallocation from bonds to loan holdings on the asset side of other sectors' balance sheets may raise financial stability concerns, as a highly liquid asset is replaced with a less liquid one. Additionally, the foreign funds that ultimately finance these loans may be more prone to flight risk (Forbes and Warnock, 2012; Broner et al., 2013).[24]

[24]This may be especially relevant when highly volatile foreign capital is used to finance increasingly illiquid domestic assets (Calvo, 1998; Diebold and Richter, 2021), suggesting that the two mentioned channels may amplify each other.

**Figure 7:** *Dynamic effects of yield changes on direct and indirect holdings using the high-frequency yield surprise*




*Notes:* tbw

## 5.2. Financial distress.

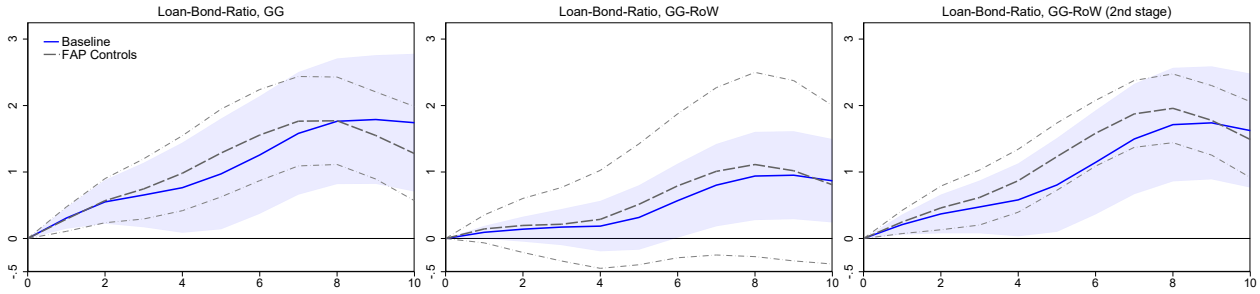
**Econometric specification.** As a final step, we link the previous results of loan-bond substitution to increased instability in the financial sector, using the financial distress index from Romer and Romer (2017).[25] To gauge the relationship between changing loan-bond ratios for different sectors and financial fragility, we run the following sequence of regressions

$$\Delta_h y_{i,t+h} = \alpha_i + \alpha_t + \beta_1 \, \Delta_4 \textit{Loan-bond ratio}_{i,t} + \gamma \, Z_{i,t} + v_{i,t+h}, \tag{10}$$

where the outcome variable $\Delta_h y_{i,t+h}$ refers to changes in the financial distress index between $t$ and $t+h$. On the right hand side $\Delta \textit{Loan-bond ratio}_{i,t}$, refers to our previous outcome variable: the one year change in the loan-bond ratio. In the baseline specification, we use the loan-bond ratio of the general government, but then alternate between different loan-bond ratios for Non-FAP loans, loans of government subsectors and unveiled holdings of government debt. All specifications additionally include two-way fixed effects for country and time and the control vector $Z_{i,t}$. This vector contains four lags of GDP growth, the rating index, the natural logarithm of the price level based on the CPI, as well as 4 lags of dependent variable: the distress index. We additionally control for the level of

[25] Their index ranks financial distress on a range between 0 and 14 on a bi-annual basis, which we linearly interpolate to quarterly frequency.

**Figure 8:** *Loan-bond substitution and financial distress*




*Notes:* This table presents quarterly regression results based on Equation 10, as specified in the text. The dependent variable is the change in the financial distress index, constructed by Romer and Romer (2017), between $t$ and $t+h$. In Panel A, the independent variable is the change in the loan-bond ratio of government liabilities between $t-4$ and $t$. In Panel B, the independent variable is the change in the loan-bond ratio of government liabilities that are directly held by the financial sector, as identified using the unveiling approach described in subsection A2, over the same period. In Panel C, the independent variable is the change in the loan-bond ratio of government liabilities that are directly held by the foreign sector, likewise identified using our unveiling approach, and measured over the same period. Panel D includes the changes in the loan-bond ratio of government liabilities that are directly held by the financial and foreign sectors jointly. Controls include four quarterly lags of GDP growth, the rating index, the natural logarithm of the price level based on the CPI, and the distress index. We also control for the level of the loan-bond ratio and the total level of assets at the sector level in $t-5$, i.e., the period before the change in the loan-bond ratio begins, as well as the change in total assets for the respective sector between $t-4$ and $t$. All specifications additionally include country and time fixed effects. Standard errors are in parenthesis and clustered by country and year, and *,**,*** indicates significance at the 0.1, 0.05, 0.01 levels, respectively.

the loan-bond ratio in the pre-change period in $t-5$, and the change in the total assets or liabilities of the respective sector between $t-4$ and $t$.[26] The idea is to control for overall shifts in the size of the balance sheet to focus only on compositional changes.

**Loan-bond substitution and financial distress.** The estimation results are provided in Figure 8. In the left panel, we find that an increase in the government loan-bond ratio is associated with a statistically significant increase in the Romer and Romer (2017) financial distress index. Relating to the earlier unveiling results we focus on the foreign sector's loan-bond ratio. In the middle panel, we account for direct holdings of the foreign sector. An increase of this loan bond ratio is associated with a delayed increase in financial distress. However, when accounting for indirect holdings via the domestic financial sector, the effects become substantially larger and less delayed, as indicated in the right panel.

Overall, we find that loan-bond substitution by the government and the associated reallocation towards loans on the asset side of other sectors is linked to an increase in financial distress, in particular when volatile funding is channeled into loans via domestic financial intermediaries.

[26]When the loan-bond ratio refers to government liabilities, this means including the level and change in total government liabilities. When the loan-bond ratio refers to the assets of one of the sectors holding government liabilities (e.g., changes in the relative holdings of loans and bonds by the financial or foreign sector), this means including the level and change in the total assets of that sector.

## 6. Conclusion

We demonstrate sovereign financing via *loans* instead of bonds is prevalent in many advanced economies. This typically neglected government debt instrument matters. As sovereign bond prices decline and yields increase, we find reduced bond borrowing, consistent with a conventional, upward sloping, government debt supply schedule. However, loan financing simultaneously *increases* strongly so that overall government debt supply is not necessarily upward sloping in bond prices. An analysis only of bond debt cannot detect this crucial feature of loan-bond substitution. In addition, we show that these effects are more pronounced for yield increases than for yield decreases, highlighting an important non-linearity. We establish causality of our findings based on a high-frequency identification strategy commonly applied to monetary policy (e.g., Nakamura and Steinsson, 2018a), leveraging asset price adjustments surrounding changes in sovereign credit ratings. These plausibly exogenous surprise changes in yields shift the demand for government debt. Finally, we focus on the governments' creditors using an unveiling methodology following Mian et al. (2017). The unveiled data show a sizable share of loans being financed by the foreign sector, with the funds channeled through the domestic banking sector. This raises financial stability concerns, and we indeed find an increase of financial distress following these dynamics.

We make three main contributions. First and foremost, we show that loan financing matters, particularly for estimating governments' funding choices in response to yield changes. Second, we propose a novel identification strategy that allows estimating the causal effect of yield changes in a large panel of advanced economies. Third, we provide novel unveiled data for the same set of countries, which reveal the ultimate creditors of foreign debt, distinguishing between loans and bonds. We expect both the unveiled government debt data and our high-frequency instrument to be useful for answering many further research questions. For example, future research may use our high-frequency surprises to estimate the effect of yield changes on other asset prices and conventional macroeconomic aggregates.

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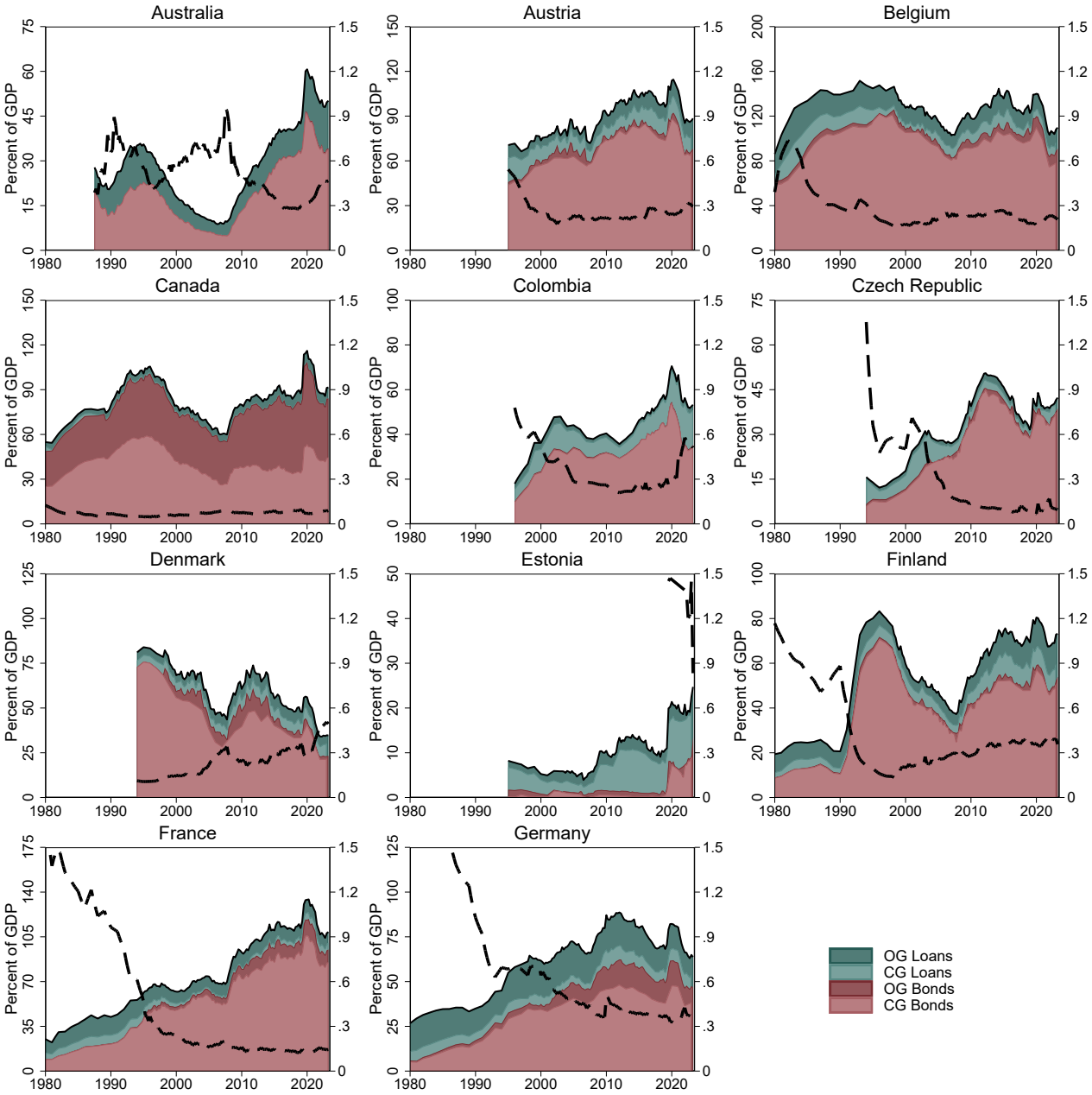
# Appendix

# Loanly Governments

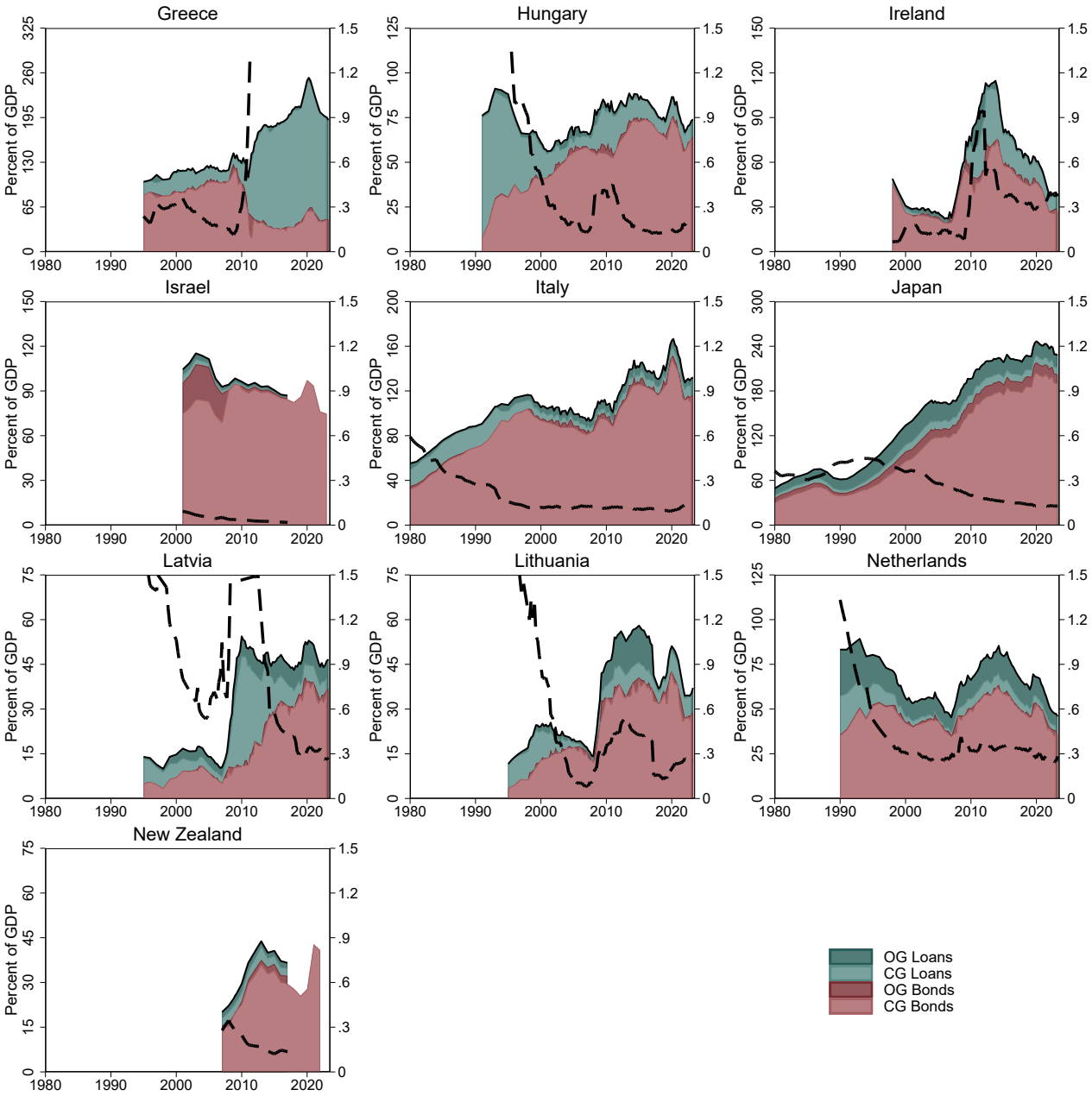
# A. Appendix

## A1. Data

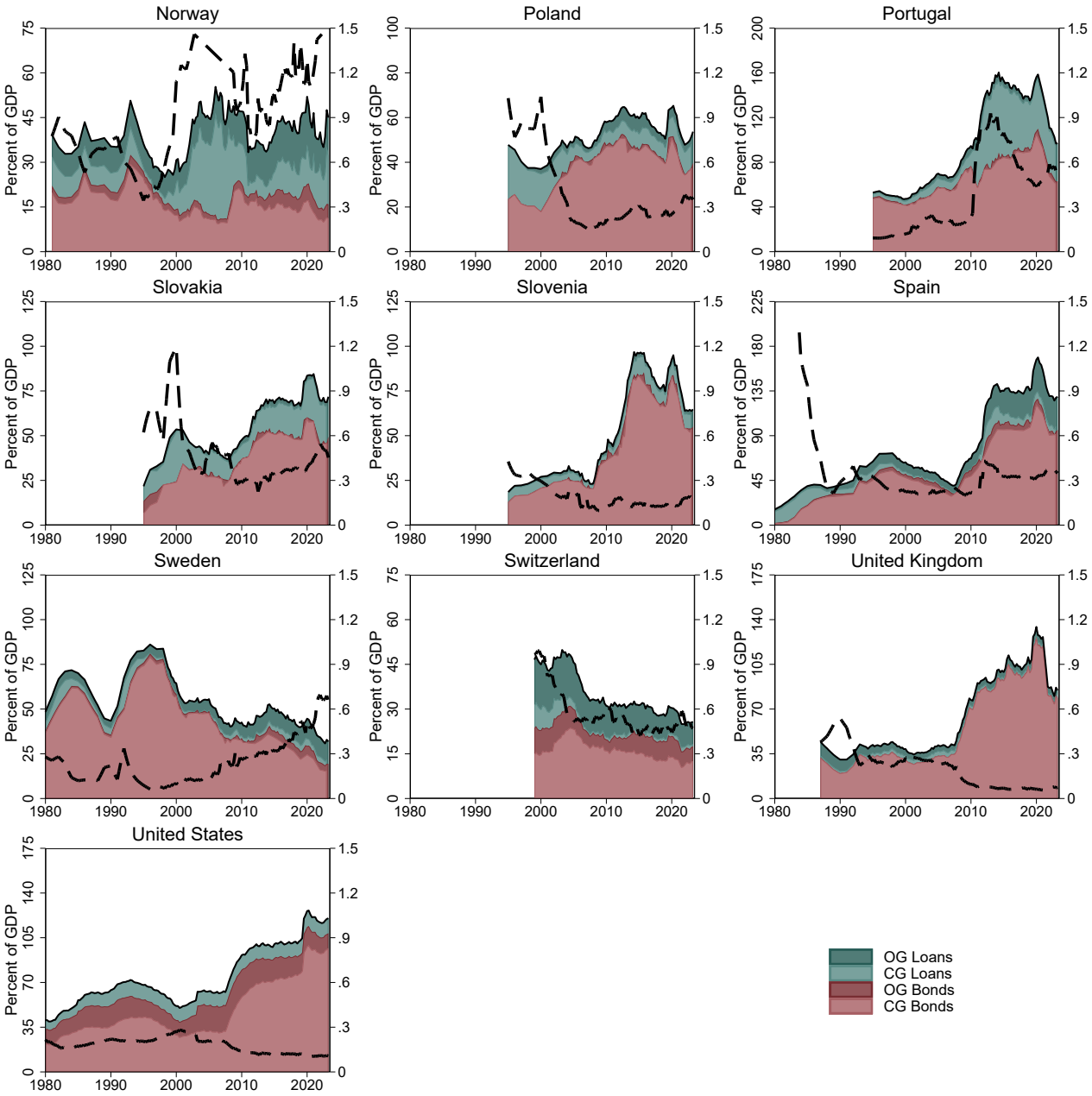
**Figure A1.1:** *Government loans and bonds by country, remaining countries*




*Notes:* This figure shows the stock of government debt relative to GDP, broken down by financing instrument, between 1980 and 2018 for selected countries. Across panels, government bond liabilities are shown in red (bottom area), liabilities in the form of loans in green. Lighter areas represent the portion of the respective instrument issued by the central government. The solid black line indicates the total amount of government liabilities relative to GDP. The dotted black line shows the loan-bond ratio on a secondary vertical axis on the right and capped at a maximum value of one.




*Notes:* Continuation of Figure A1.1, part (2/3).




*Notes:* Continuation of Figure A1.1, part (3/3).

**Figure A1.2:** *Current credit ratings of the United States (November 2024), for different agencies*

| Grade | Description | S&P | Moody's | Fitch | DBRS |
|---|---|---|---|---|---|
| Investment Grade | Prime | AAA | Aaa | AAA | AAA |
| | High Medium Grade | AA+ | Aa1 | AA+ | AA(high) |
| | | AA | Aa2 | AA | AA |
| | | AA- | Aa3 | AA- | AA(low) |
| | Upper Medium Grade | A+ | A1 | A+ | A(high) |
| | | A | A2 | A | A |
| | | A- | A3 | A- | A(low) |
| | Lower Medium Grade | BBB+ | Baa1 | BBB+ | BBB(high) |
| | | BBB | Baa2 | BBB | BBB |
| | | BBB- | Baa3 | BBB- | BBB(low) |
| Speculative Grade | Speculative | BB+ | Ba1 | BB+ | BB(high) |
| | | BB | Ba2 | BB | BB |
| | | BB- | Ba3 | BB- | BB(low) |
| | Highly Speculative | B+ | B1 | B+ | B(high) |
| | | B | B2 | B | B |
| | | B- | B3 | B- | B(low) |
| | Substantial Risk | CCC+ | Caa1 | CCC+ | CCC(high) |
| | | CCC | Caa2 | CCC | CCC |
| | | CCC- | Caa3 | CCC- | CCC(low) |
| | Extremely Speculative | CC | Ca | CC | CC |
| | | C | C | C | C |
| | In Default | RD | / | RD | RD |
| | | SD | / | SD | SD |
| | | D•NR | D•NR | D•NR | D•NR |

*Notes:* This figure shows the rating scale of the top 4 rating agencies, used to construct our composite rating index, as described in section 2. The shown table is a snapshot from the website of World Government Bonds Credit Ratings (2024) and highlights the current credit rating of the United States (as of November 2024) in green. Positive and negative outlooks are represented by red and green dots respectively.

## A2. Unveiling the holders of loans and bonds

**Unveiling approach.** In addition to the stock of government debt by instrument, the OECD's financial accounts also contain the financial balance sheets of all other sectors in the economy (households, non-financial corporations, the financial sector, the government, and the rest of the world). In the financial accounts, assets and liabilities at the instrument level perfectly match each other. This allows us to build on the "unveiling" methodology introduced by Mian et al. (2020) and further developed by Diebold and Richter (2021) to determine the direct and ultimate counterparties holding government debt.

In short, this process involves the proportional allocation of sectoral liabilities to the assets of all other sectors at the instrument level. While bonds, and especially loans, are often held as assets by financial intermediaries, these intermediaries are not the ultimate counterparties providing financing. Instead, intermediaries may finance their assets with, for example, deposits, bonds, equity, etc., on the liability side of their balance sheets. Thus, an intermediary's assets are ultimately financed by the sectors that hold its liabilities as assets on their own balance sheets. Following Mian et al. (2020), we assume that ultimate financing sectors ($u$) can only be domestic households, the government, or the rest of the world ($u \in HH, GG, RoW$). Accordingly, all assets of the financial and non-financial corporate sectors can be allocated to these three ultimate counterparties.

**Unveiling example.** The underlying unveiling approach has been described in detail in Diebold and Richter (2021) and Mian et al. (2020). Thus, we only provide an instructive example to explain the approach in our setting. While the general unveiling approach applies to each individual financial instrument listed in the financial accounts data (deposits, bonds, loans, shares, insurance and pension products, gold and SDRs, derivatives and options, other accounts), our example focuses exclusively on bonds. Further, for simplicity, let us not distinguish between financial and non-financial corporations and suppose there is only a single intermediate sector. When we want to allocate the government's bond liabilities to its financing sectors, the first step is to assign the bonds to direct counterparties. Let us assume there are bonds worth 100 dollars in the government's balance sheet *liabilities*. The balance sheets of the remaining sectors indicate that of all bond *assets* in the entire economy (excluding the government itself), 60%, 30%, and 10% are held by the intermediate sector, the rest of the world (foreign sector), and domestic households, respectively. The first step of the unveiling proportionally allocates the government's bond liabilities to the asset holdings of the other sectors according to these shares.

**Table A2.1:** *Government debt, unveiling stages*

| | *Total* | *Households* | *Foreign Sector* | *Government* | *Financial Sector* | *Corporates* |
|---|---|---|---|---|---|---|
| **Panel A: Bonds** | | | | | | |
| First Stage (Direkt) | 48.92 | 4.17 | 13.24 | 0.00 | 30.19 | 1.32 |
| Second Stage (Direkt+Indirekt) | 48.92 | 20.11 | 24.13 | 4.45 | 0.00 | 0.00 |
| **Panel B: Loans** | | | | | | |
| First Stage (Direkt) | 14.10 | 0.10 | 2.73 | 0.00 | 9.91 | 1.27 |
| Second Stage (Direkt+Indirekt) | 14.10 | 5.42 | 7.18 | 1.78 | 0.00 | 0.00 |

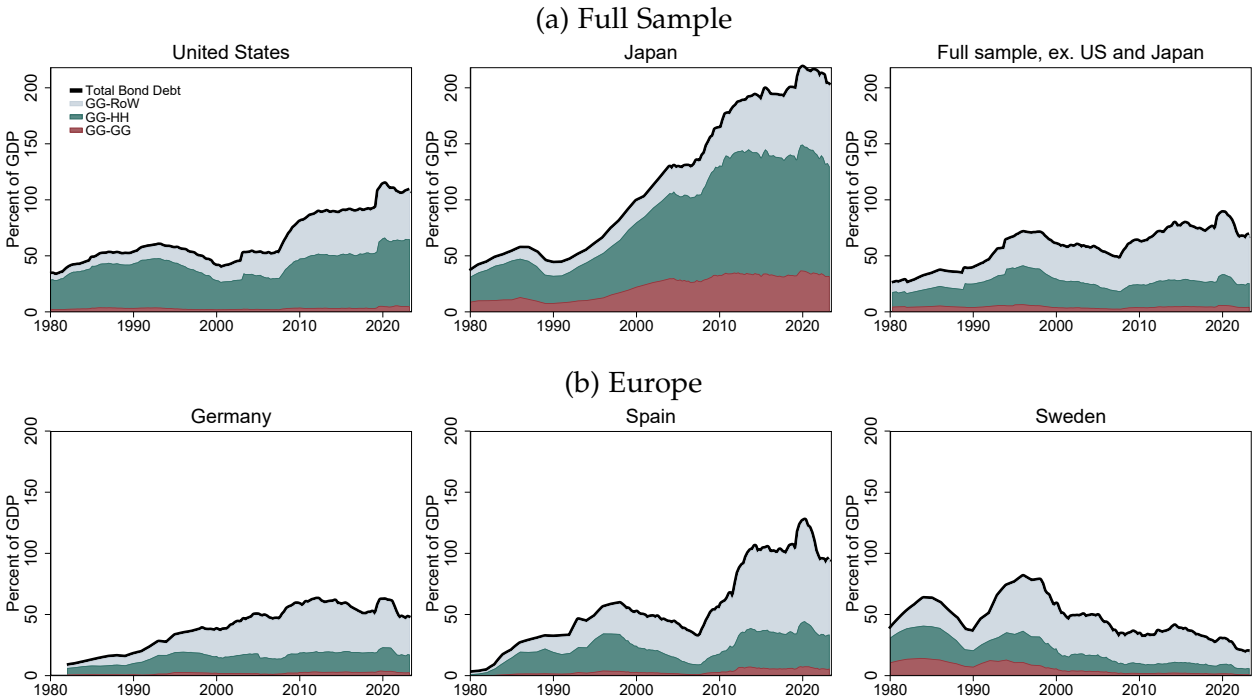
*Notes:* This table shows the average allocation of government liabilities for the two separate stages of the proportional unveiling approach described in subsection A2. Panel A displays the allocation for bonds, and Panel B presents the allocation for loans. In both panels, the first row allocates the entirety of government liabilities (shown for reference in the first column) to households, the foreign sector, the financial sector, and the non-financial corporate sector, thus excluding the government itself. The second row reallocates the direct holdings of the corporate sectors (financial and non-financial) to the three ultimate counterparties: households, the foreign sector, and the government. The figures for the ultimate counterparties in the second row of both panels, thus, represent the total amount of government debt ultimately financed by these sectors, combining both direct and indirect holdings of government debt.

In the second unveiling step, we want to "unveil" the role of the intermediate sector, which is owned by the ultimate counterparties (households, government, rest of the world). Let us assume that the intermediate sector is financing itself exclusively with deposits, while households hold 50% of all deposits in the economy, the foreign sector holds 40%, and the government holds 10%. Again, we can obtain this data from the balance sheets of the ultimate counterparties. Thus, we assign the intermediate sector's deposit liabilities to the ultimate counterparties according to their respective shares in total deposit holdings. Households would now be assumed to hold 40% of the government's bonds, 10% directly, and 30% indirectly via owning 50% of the intermediate sector's liabilities, which in turn holds 60% of the government's bonds. Similarly, the foreign sector would be assumed to hold 54% of the government's bond liabilities, 30% directly, and 24% via holding 40% of the financial sector's 60% bond share. The government, not financing itself directly, would be assumed to have financed itself indirectly with 6% via its share in the financial sector.[27]

**Unveiled government debt over time.** Table A2.1 shows the cross-country average results for both unveiling stages for government bonds and loans in panels A and B, respectively. On average, governments have outstanding bond debt of 48.92% of GDP. According to the first stage of the unveiling, 4.17% is held by households, 13.24% by the rest of the world, 30.19% by financial corporations, and 1.32% by non-financial corporations. In the second stage of the unveiling, the direct holdings of financial and non-financial corporations are re-allocated to the three ultimate counterparties. In turn, the counterparties' holdings consist of the sum of their direct and indirect

[27] An example of the government financing itself might be via (partially) government-owned banks or other corporations that are government-owned.

**Figure A2.3:** *Unveiled Government Bonds by country*

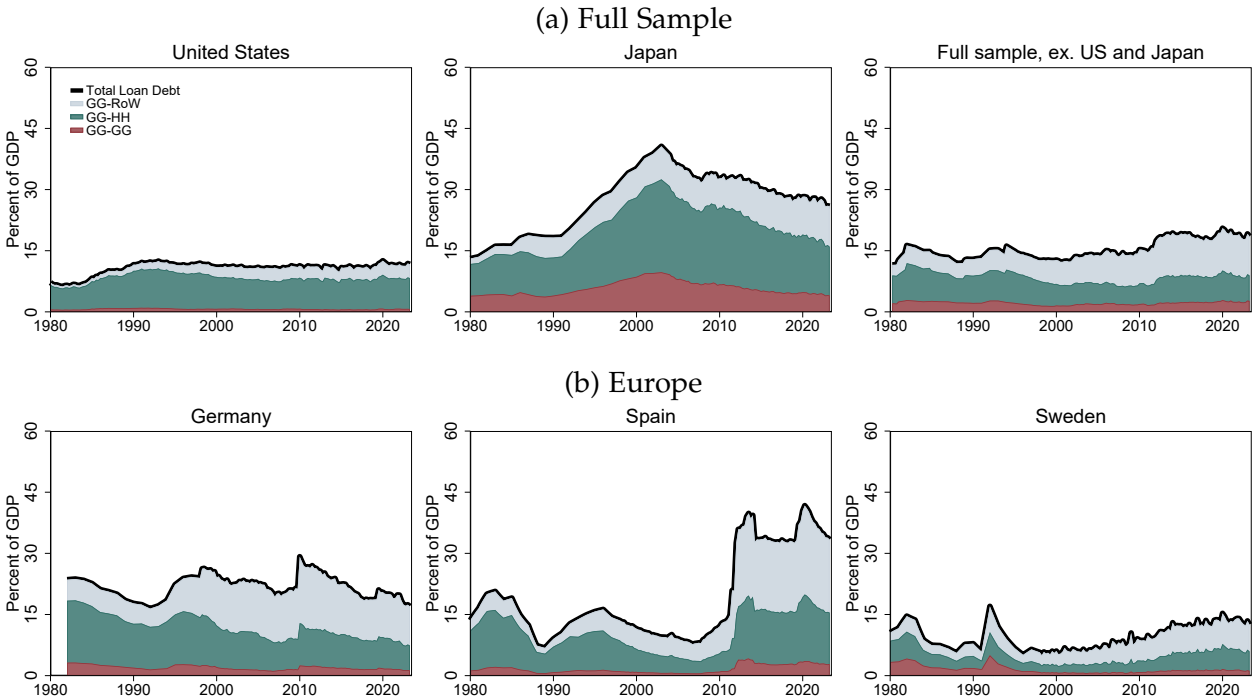



*Notes:* This figure shows the stock of government bond debt relative to GDP, broken down by ultimate financing counterparty, between 1980 and 2018 for selected countries. Panel (a) displays series for the United States, Japan, and a sample average excluding the United States and Japan. Panel (b) presents series for Germany, Spain, and Sweden. Across panels, government bond liabilities ultimately financed by the government are shown in red (bottom area), bonds ultimately financed by the household sector in green (middle area), and bonds ultimately financed by the foreign sector in gray (top area). The solid black line indicates the total amount of government bond liabilities relative to GDP.

holdings. This shows that, out of all bonds, 20.11% are held by households, 24.13% by the rest of the world, while the government (indirectly) holds 4.45% of its own debt. Panel B contains the corresponding information for the 14.1% of outstanding loans, relative to GDP. As expected, most of these loans are directly held by financial corporations, making the assignment to ultimate counterparties in the second stage unveiling particularly relevant for loans. This unveiling step suggests that 5.42% of the loans are ultimately financed by the domestic household sector while 7.18% are ultimately financed from abroad. Overall, we find that bond financing is more important, considering total liabilities but also considering each ultimate counterparty individually. However, loans still make up a significant fraction of government debt, both on the governments' liability side and on the asset sides of the other sectors.

The above results focus on sample averages. To also understand within-country variation, we show the evolution of bonds and loans over time for the same selected set of countries as in Figure 1, in Figure A2.3 and Figure A2.4, respectively. All panels show liabilities held by the rest of the world in gray (top area), by domestic households in green (middle area), and by the government itself in

**Figure A2.4:** *Unveiled Government Loans by country*




*Notes:* This figure shows the stock of government loan debt relative to GDP, broken down by ultimate financing counterparty, between 1980 and 2018 for selected countries. Panel (a) displays series for the United States, Japan, and a sample average excluding the United States and Japan. Panel (b) presents series for Germany, Spain, and Sweden. Across panels, government loan liabilities ultimately financed by the government are shown in red (bottom area), loan ultimately financed by the household sector in green (middle area), and loan ultimately financed by the foreign sector in gray (top area). The solid black line indicates the total amount of government loan liabilities relative to GDP.

red (bottom area). Total government debt in the respective instrument category is indicated by the solid black line.

Focusing on bonds in Figure A2.3, a clear trend toward increasing international funding is apparent, particularly among the group of European countries shown in the second row. By the end of our sample in 2018, government bonds ultimately financed from abroad make up the largest fraction of total government debt in all three European countries displayed. In contrast, the United States and Japan stand out due to their high levels of bond funding ultimately provided by domestic households, which, by the end of the sample period, constitute the largest share of their government bond liabilities. With the exception of Japan, none of these countries exhibit a substantial portion of government bond debt being indirectly financed by the government itself.

Figure A2.4 shows the unveiled time series for government loans. As expected, the level of loan liabilities relative to GDP is generally lower than for bonds. In particular, the United States effectively has no loan liabilities over the entire sample. In Japan, loans begin increasing in the early 1990s and continue to rise until the Great Financial Crisis, after which the trend reverses.

This increase is primarily financed by domestic households. Considering the full sample excluding Japan and the United States, we find that the ratio of loans to GDP is remarkably stable over time and roughly equally financed by the domestic household and foreign sectors (rest of the world). In Germany, loans remain fairly stable, fluctuating around 20% of GDP, with a slight shift toward foreign holdings over time. In contrast, Spain and Sweden experience sharp increases following the Euro Crisis and the Scandinavian Financial Crisis in the 1990s, respectively. In Spain, this rise is financed by domestic households and the rest of the world. A similar pattern emerges in Sweden in the 1990s.

Notably, these increases in loan holdings (and government loan liabilities, respectively) occur much more rapidly than the simultaneous increases in bond debt visible in Figure A2.3. This suggests that loan financing may be particularly relevant during crisis episodes. Across all panels, the trend toward more international funding is much more pronounced for bonds than for loans, consistent with the greater internationalization of bond markets. Overall, we find meaningful time variation in loan holdings across ultimate counterparties.

Taken together, our descriptive findings point towards some degree of substitutability between bonds and loans. This might be particularly relevant when funds are needed at short notice and cannot be raised through traditional bond markets quickly enough, e.g., due to low and decreasing creditworthiness and an accompanying surge in bond yields. The following section proposes a simple model of government finances to rationalize this behavior, linking the costs of credit to the government's choice between bonds and loans.

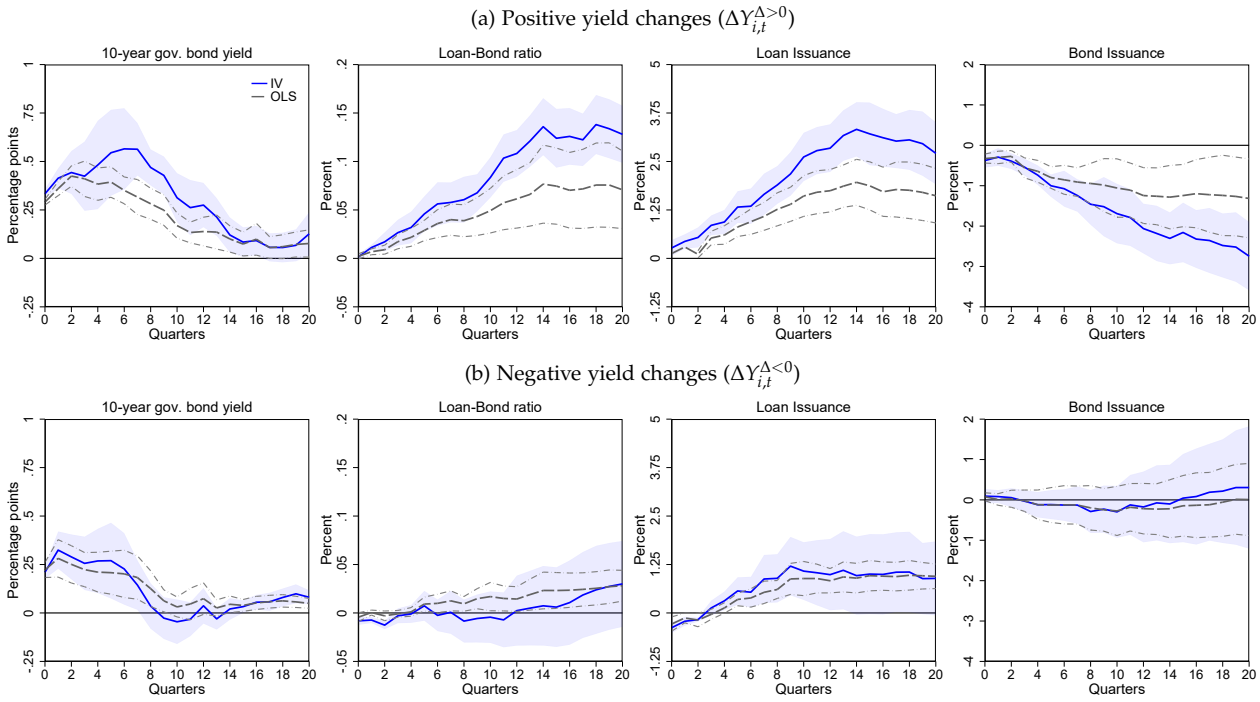
## A3. Government debt substitution: Additional Results and Robustness

**Table A3.2:** *Effects of yield changes on government funding choices using the high-frequency yield surprise, reduced form estimates*

| | $\Delta_5$ Loan-Bond ratio$_{i,t+4}$ | | | $\Sigma_{j=0}^{4}$ Loan Issuance$_{i,t+j}$ | | | $\Sigma_{j=0}^{4}$ Bond Issuance$_{i,t+j}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $YCS_{i,t}^{\mathcal{H}}$ | 0.082*** | | | 2.743*** | | | -1.876*** | | |
| | (0.025) | | | (0.733) | | | (0.490) | | |
| $YCS_{i,t}^{\mathcal{L}}$ | -0.053** | | | -0.899** | | | 0.902 | | |
| | (0.024) | | | (0.444) | | | (0.558) | | |
| $YCS_{i,t}^{\mathcal{HD}}$ | | 0.089*** | 0.078*** | | 3.127*** | 2.145*** | | -2.076*** | -1.596*** |
| | | (0.025) | (0.017) | | (0.940) | (0.333) | | (0.355) | (0.230) |
| $YCS_{i,t}^{\mathcal{LD}}$ | | -0.060 | -0.043* | | -1.690** | -0.125 | | 0.940 | 0.321 |
| | | (0.038) | (0.025) | | (0.787) | (0.697) | | (0.669) | (0.388) |
| $YCS_{i,t}^{\mathcal{HU}}$ | | 0.043 | 0.069*** | | -0.025 | 1.314*** | | -0.927 | -1.515 |
| | | (0.029) | (0.025) | | (0.591) | (0.357) | | (1.205) | (1.008) |
| $YCS_{i,t}^{\mathcal{LU}}$ | | -0.040* | -0.031 | | 0.218 | 0.588 | | 0.654 | 0.312 |
| | | (0.021) | (0.020) | | (0.399) | (0.377) | | (0.661) | (0.538) |
| $R^2$ | 0.177 | 0.179 | 0.205 | 0.377 | 0.390 | 0.615 | 0.097 | 0.097 | 0.122 |
| Country FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Foreign Assistance | | | ✓ | | | ✓ | | | ✓ |
| Observations | 2725 | 2725 | 2725 | 2725 | 2725 | 2725 | 2725 | 2725 | 2725 |

This table presents reduced form regression results based on Equation 9, as specified in the text. The dependent variables are the change in the loan-bond ratio between $t-1$ and $t+4$ in columns (1) to (4), the cumulative issuance of new government loans relative to GDP from $t$ to $t+4$ in columns (5) to (8), and the cumulative new issuance of government bond liabilities relative to GDP over the same period in columns (9) to (12). $YCS_{i,t}^{\mathcal{H}}$, and $YCS_{i,t}^{\mathcal{L}}$ refer to yield change surprises with higher and lower yields respectively. The additional superscript indicates yield changes due to credit rating downgrades ($\mathcal{D}$) and upgrades ($\mathcal{U}$), setting the regressor to zero when no rating change occurs. Controls include a quarterly lag of real GDP growth, CPI inflation, the ten-year government bond yield, the rating index, and total government debt. All specifications additionally include country and time fixed effects. Foreign assistance controls account for emergency lending from international institutions, as explained in the text. Standard errors are in parenthesis and clustered by country and year, and *,**,*** indicates significance at the 0.1, 0.05, 0.01 levels, respectively.

**Figure A3.5:** *Dynamic effects of yield changes on government funding choices using the high-frequency yield surprise, conditioning on rating change events*




*Notes:* This figure presents quarterly instrumental variable regression results based on Equation 9, as specified in the text. The dependent variables are the change in the ten-year government bond yield and the loan-bond ratio between $t-1$ and $t+h$ in the left panels, and the cumulative issuance of new government loans and bonds relative to GDP from $t$ to $t+h$ in the right panels. The top row focuses on positive yield changes and the bottom row focuses on negative yield changes. We instrument all positive yield changes occurring in quarters with credit rating downgrades with positive yield surprises from downgrades ($YCS_{i,t}^{\mathcal{HD}}$), and all negative yield changes occurring in quarters with credit rating upgrades with negative yield surprises from upgrades ($YCS_{i,t}^{\mathcal{LU}}$). Controls include a quarterly lag of real GDP growth, CPI inflation, the ten-year government bond yield, the rating index, and total government debt. All specifications additionally include country and time fixed effects. Foreign assistance controls account for emergency lending from international institutions, as explained in the text. The shaded ares are confidence bands at the 95 percent level, based on standard errors clustered by country and time.