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Believing in bail-in?
Market discipline and the pricing of bail-in bonds

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Abstract

Bail-in regulation is a centrepiece of the post-crisis overhaul of bank resolution. It requires major banks to maintain a sufficient amount of "bail-in debt" that can absorb losses during resolution. If resolution regimes are credible, investors in bail-in debt should have a strong incentive to monitor banks and price bail-in risk. We study the pricing of senior bail-in bonds to evaluate whether this is the case. We identify the bail-in risk premium by matching these bonds with comparable senior bonds that are issued by the same banking group but are not subject to bail-in risk. The premium is higher for riskier issuers, consistent with the notion that bond investors exert market discipline on banks. Yet the premium varies pro-cyclically: a decline in market-wide credit risk lowers the bail-in risk premium for all banks, with the compression much stronger for riskier issuers. Banks, in turn, time their bail-in bond issuance to take advantage of periods of low premia.

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"If investors in bank debt know that they will be bailed in if the bank fails, the pricing of that debt will exert discipline on risk taking."

Sir Jon Cunliffe, Deputy Governor, Bank of England, 5 June 2018

1. Introduction

Perhaps no other aspect of the Great Financial Crisis (GFC) attracted more attention than the "too-big-to-fail" impasse posed by large and complex banks. During the GFC, numerous governments were compelled to "bail out" (ie rescue) failing big banks using public funds, in order to prevent a systemic crisis that could have resulted from allowing regular bankruptcy. Recognising this, bank resolution regimes established or revised after the crisis rest on the principle that the unsecured creditors of a failing bank absorb losses through the write-down or conversion to equity of their claims. The "bail-in" of creditors intends to enable an orderly resolution process in which the parts of the bank that provide critical functions are recapitalised and maintained, while others may be wound down.

Bail-in regimes also seek to enhance market discipline.[1] If the risk of bail-in is more explicit and credible than before the GFC, investors in bail-in debt instruments should have stronger incentives to monitor a bank's risk of failure. And by factoring assessments of bail-in risk into their investment and pricing decisions, investors should be able to exert discipline on banks' risk-taking, as argued in the above quote from Cunliffe (2018).

This paper studies whether the market for bail-in debt imposes discipline on banks by analysing the pricing of senior unsecured bank bail-in bonds of global systemically important banks (G-SIBs) and other large banks. The senior bail-in bond market has been little studied so far given that internationally agreed minimum bail-in requirements for G-SIBs came into force only at the start of 2019. To our knowledge, this is the first comprehensive study of the pricing of senior bail-in bonds globally.

At least two reasons argue in favour of studying the pricing of bail-in risk through the lens of the senior creditor layer. One reason is the market's relative importance. The market for senior bail-in bonds issued by advanced-economy G-SIBs (more than $1.2 trillion around the end of 2018) is much larger than the comparable markets for (non-senior) loss-absorbing Additional Tier 1 (AT1) or Tier 2 capital instruments (each roughly $300 to $350 billion in size). Related to this, senior bail-in bonds tend to be more liquid, which enables senior bail-in bond investors to respond more promptly to changes in issuer risks relative to investors in other layers of loss-absorbing debt.

A second reason is that senior bail-in bonds allow more precise identification of investors' return for bearing bail-in risk. Senior bail-in bonds are often similar to other senior bonds, sometimes differing only in the explicit recognition that losses can occur in a bail-in event. In comparison, non-senior capital instruments (eg contingent convertibles) can have complex structural features (such as triggers for the suspension of coupon

[1] See Financial Stability Board (2014) for a definition of key attributes of effective resolution regimes. An assessment of the economic impact of the minimum standards for global systemically important banks' bail-in requirements ahead of its implementation identified enhanced market discipline as its main benefit (Bank for International Settlements (2015)). Another intended benefit of these standards is the reduction of competitive distortions arising from an implicit public subsidy of major banks' funding costs.

payments) and a different, typically narrower, investor base. These factors affect the relative pricing of instruments and thus blur the measurement of bail-in risk.

To ascertain investor pricing of bail-in risk, we identify a "bail-in risk premium" (BIRP), which we define as the secondary market spread of a senior bail-in bond above that of comparable senior non-bail-in bonds.[2] Our identification strategy to isolate bail-in risk from other confounding factors is based on comparing the option-adjusted spreads of bail-in and non-bail-in bonds issued by the same banking group, in the same currency and with a comparable remaining maturity.

Establishing the credibility of resolution regimes is a key policy priority (Financial Stability Board (2014), Philippon and Salord (2017)) and we organise our assessment of whether investors "believe in bail-in" around testing four hypotheses.[3]

First, we assess whether bail-in bonds exhibit a positive BIRP to compensate investors for the risk of being bailed in. We identify an average BIRP of around 20 basis points across a large sample of bail-in bonds issued by G-SIBs and other large banks for the period from March 2016 to end-2018. The BIRP varies significantly across economies: the average BIRP for European banks is about 30 basis points, whereas for Japanese G-SIBs it is merely 2 basis points. This finding for Japanese banks accords with the credit rating on their bail-in bonds incorporating an assumed high probability of pre-emptive government support (Standard & Poor's (2019)).

Second, we test whether the BIRP is higher (lower) for more (less) risky issuers. Consistent with the notion of market discipline, we find that the BIRP is positively related to the bank's bail-in credit rating and negatively related to its buffer of lower-ranking loss-absorbing debt instruments (ie AT1 and Tier 2 regulatory capital).

Third, we consider if the BIRP's sensitivity to issuer credit risk holds irrespective of market-wide conditions. We show that changes in market-wide credit conditions – as approximated by changes in a broad-based CDS index – have a particularly strong effect on the BIRP of riskier banks. For sufficiently favourable conditions, the BIRP of lower-rated issuers can be compressed to an extent that it becomes indistinguishable from the BIRP of higher-rated ones. This finding is consistent with the compression and expansion observed for credit spreads due to shifts in investor risk appetite.

Fourth, establishing a link to primary markets, we test whether banks strategically time their bail-in bond issuance to take advantage of periods during which their BIRP is low. In line with this conjecture, we find that a bank's probability of issuing bail-in bonds and the issuance amount rise in reaction to its BIRP being low in secondary markets. This suggests that changes in the BIRP are sufficiently large to affect banks' behaviour.

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[2] To the best of our knowledge, the term "bail-in risk premium" was first used by Davis and Saba (2016) in their assessment of hybrid debt securities issued by Australian banks.

[3] Our study assesses the ex ante disciplining aspect of the resolution regime, but not its effectiveness ex post. We do not assess whether the bail-in debt layer is large enough to avoid taxpayer losses under reasonable scenarios, or whether G-SIBs have in fact become resolvable. As argued in Philippon and Salord (2017), it may be enough for resolution to work in theory and in practice most – but not necessarily all – of the time to establish the regime's credibility.

Our finding that investors price bail-in risk pro-cyclically has implications for the design of bail-in regimes and banking supervision. When investor credit risk appetite is strong, the link between issuers' credit risk and the BIRP loosens. This opens up windows of opportunity for riskier banks to issue bail-in bonds at comparatively low cost. Yet it also implies weaker market discipline on these banks' risk-taking. Furthermore, the flipside of this observed behaviour is that a tightening in market conditions can trigger a significant rise in the BIRP, even in the absence of any changes in the issuer's underlying credit risk. Such an increase in the BIRP would push up the banks' cost of funding and, if large enough, could weigh on riskier issuers' ability to roll over their bail-in eligible debt at a palatable price. Our period of observation (2016–18) does not comprise an episode of wide-spread market stress.[4] Even so, the pro-cyclicality of the BIRP observed for even this comparatively tranquil period highlights the importance of calibrating bail-in regimes conservatively, encouraging banks to issue, in good times, large amounts of bail-in debt across a range of long-term maturities. And it underscores the value of prudent banking supervision to reinforce market discipline over the cycle.

The remainder of this paper is organised as follows. The next section reviews the related literature on market discipline and investor perceptions of government support for banks. The third section provides an overview of the institutional and regulatory features of the senior bail-in bond market. The fourth section explains our approach to identifying the BIRP and assesses the BIRP across the sample of banks and over time. Empirical analysis of how the BIRP depends on underlying credit risk and market-wide credit risk conditions is provided in the fifth section. The sixth section examines whether the timing of banks' bail-in bond issuance depends on market conditions. The final section concludes.

2. Related literature

Our assessment of the BIRP builds on an active research agenda on market discipline of banks. Much of this literature studies whether investors exert discipline on bank behaviour directly through the pricing of credit risk in financial markets.[5,6]

Previous research investigated this issue by examining the pricing of subordinated debt, since investors in these instruments should be particularly sensitive to issuer credit risk. Overall, the results underscore the importance of the credibility of public commitment, which fluctuates over time. Flannery and Sorescu (1996) find that market discipline on US banks was lacking in the early 1980s, but increased throughout that decade as the public

4 We note that one Spanish and three Italian banks failed or were recapitalised in June and July 2017, including the bail-in of junior creditors in Spain. However, these banks were of limited size and had well-known and longstanding issues with their profitability and loan performance. Their failure thus had neither any broader repercussions on financial markets (Bogdanova and Drehmann (2017)) nor any measurable impact on the BIRP of the banks in our sample (see also Figure 3, left-hand panel).

5 Market discipline can also work indirectly through the behaviour of others that influence the bank (Nguyen (2013). For one, market pricing signals could change the supervisors' risk assessment and prompt supervisory actions that alter banks' behaviour.

6 Another strand of the literature investigates whether risk premia are sufficiently large to change banks' risk-taking. Since bail-in regimes have only recently been introduced in the international framework for bank regulation, it is arguably too early to make a firm judgement on the effectiveness of measured BIRPs in containing excessive risk-taking by global banks. Earlier studies on the effect of market discipline on banks' risk-taking include, for example, Morgan and Stiroh (1999, 2001) and Covitz et al (2004).

support for banks was perceived to weaken. Sironi (2003) points to tighter market discipline on European banks towards the end of the 1990s, when the constraints on national governments to bail out banks tightened. For the more recent period (2002–08), Nguyen (2013) finds that subordinated debt had a mitigating effect on bank risk-taking in countries where national regulatory and institutional conditions were reinforcing market discipline, but not for systemically important banks or those with public sector shareholders.

Several papers have revisited the issues of market discipline on banks and market perceptions of too-big-to-fail after the GFC.[7] Hett and Schmidt (2017) document how bail-out expectations peaked in reaction to US government intervention during the GFC, while returning to pre-crisis levels after the initiation of the Dodd-Frank Act. Using premia of subordinated bank debt, Balasubramnian and Cyree (2014) find a sharp decline in the implicit too-big-to-fail subsidy for the largest US banks as a result of Dodd-Frank. Elyasiani and Keegan (2017) argue that bank-specific factors became relatively more important for the pricing of bonds issued by major US banks after the GFC, suggesting that market discipline has strengthened. However, other research has found that while senior bond prices are sensitive to issuer risk, this is not the case for the largest US banks (Allen et al (2018), Gao et al (2018), Acharya et al (2016) and Santos (2014)). For European banks, Pablos Nuevo (2019) finds no evidence of higher spreads on subordinated versus senior bonds yields in the aftermath of regulatory reforms in the EU. Our research complements this literature by expanding the analysis to the global senior bail-in bond market. Doing so allows us to infer the premium on senior bank debt that can be directly related to bail-in risk. And it allows us to assess differences in the credibility of the resolution regimes for the systemically most important banks.

A key feature of our approach is the identification of risk premia based on closely matched bond pairs. This relates to the analysis of European bank CDS spreads in Neuberg et al (2016). Comparing CDS contracts which cover losses from government intervention with those that do not, they infer a decline in the probability of bank bail-outs. At the same time, their results suggest that banks had insufficient bail-in eligible subordinated debt to protect senior bondholders from losses in a credit event. Our finding of a non-negligible BIRP suggests that these bondholders account for potential losses under bail-in.

Finally, our study relates to previous research on how market discipline affects the timing of banks' bond issuance (Covitz et al (2004), Covitz and Harrison (2004), Billett et al (1998)), and particularly on banks' issuance of long-term debt (van Rixtel et al (2016)), the category that bail-in bonds typically fall into. In line with these studies, we show that banks strategically time their bail-in bond issuance to take advantage of favourable market conditions.

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7 A related literature assesses how bank bail-ins in the euro area and changes in the resolution regime affected the pricing of financial instruments. Schäfer et al (2017) document that CDS spreads increased and bank equity prices declined in the aftermath of bail-ins. Likewise, Giuliana (2019) reports that the yield spread on secured and unsecured bonds widened as authorities' commitment to bail-in banks strengthened, and Cutura (2018) reports a yield difference of up to 15 basis points for bail-in eligible bonds at the time the EU implemented its resolution regime.

3. Institutional and regulatory background on senior bail-in bonds

The concept of bail-in is embedded in the internationally agreed Total Loss-Absorbing Capacity (TLAC) framework of the Financial Stability Board (FSB), which requires advanced economy G-SIBs to maintain a minimum amount of loss-absorbing capital from 1 January 2019. The TLAC requirement is met through regulatory capital as well as eligible debt liabilities. The inclusion of eligible debt liabilities in the TLAC requirement raises the total amount of funds that can be used to absorb losses of a failing bank, and thus enhances the capacity to recapitalise it during resolution (FSB (2015a)). As such, it adds to the credibility of bail-in regimes.

To be eligible for the TLAC requirement, bank debt instruments must meet certain criteria, including that they are unsecured and have a minimum remaining contractual maturity of at least one year. Certain liabilities are excluded, such as insured deposits and liabilities arising from derivative instruments (FSB (2015a, 2019)). The TLAC framework also requires the explicit subordination of bail-in eligible debt claims to liabilities excluded from TLAC in insolvency or resolution. This is to reduce the chance of a successful legal challenge requiring compensation payments to creditors under the principle that "no creditor is worse off" than they would be under liquidation.[8]

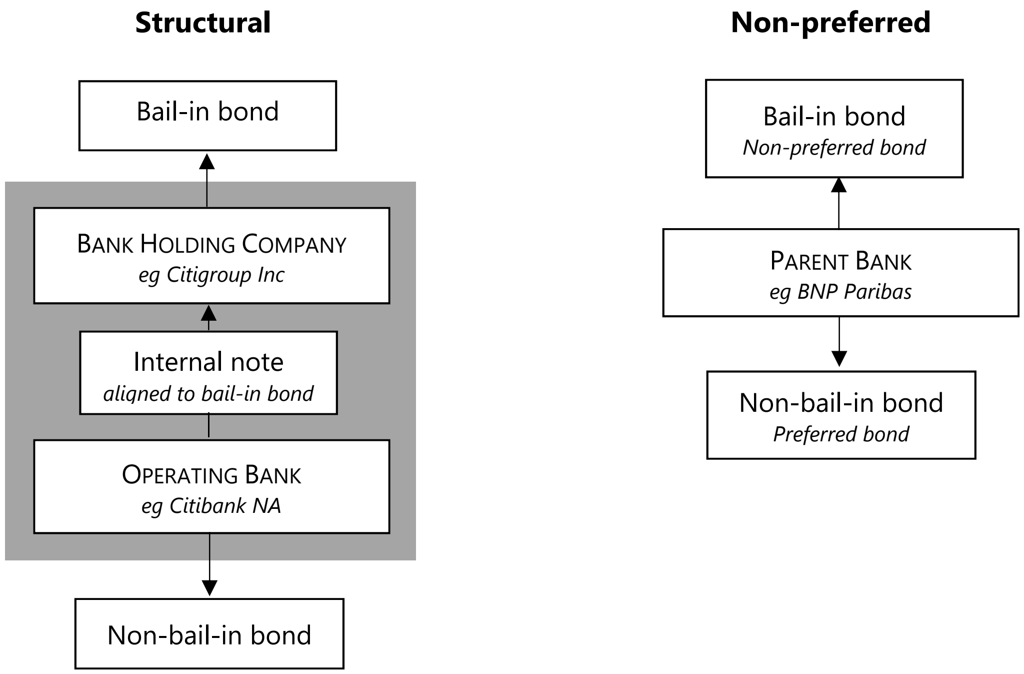
Our study focuses on the largest class of bail-in eligible debt instruments – senior bail-in bonds. We distinguish between two approaches to the subordination of senior unsecured bail-in bonds to non-eligible senior unsecured bonds (which, for simplicity, we term "non-bail-in bonds"). These are illustrated in a stylised form in Figure 1.

First, some banks issue senior bail-in bonds that are subordinated to other senior liabilities by the virtue of their company structure, which we refer to as the structural approach. Debt issued by a holding company (HoldCo) that is the nominated resolution entity of a group is considered TLAC-eligible because investors in these instruments are liable for the subsidiaries' losses during resolution. It is subordinated to senior bonds issued by an operating bank subsidiary (OpBank) (which we refer to as "non-bail-in bonds").

The HoldCo subordination and bail-in process may work as follows. HoldCo senior unsecured debt issuance is down-streamed to an OpBank through the issuance of an internal note that is aligned with this (bail-in eligible) bond. If the OpBank incurs losses sufficient for it to reach the point of non-viability, the HoldCo's internal investment can be written down, reducing the OpBank's liabilities, in effect recapitalising it and allowing its critical functions to be maintained. The regulatory assumption that the HoldCo has sufficient loss absorbency to capitalise the OpBank justifies that OpBank debt is not considered eligible for TLAC, even though such debt is not formally exempt from bail-in.

8 Our analysis focuses on "external" TLAC as opposed to "internal" TLAC. The latter refers to the distribution of loss-absorbing capacity within a banking group, which intends to encourage cross-border cooperation among a bank's home and host supervisors and to diminish incentives to ring-fence assets in the event of bank failure (FSB (2015a, 2019)).

Main approaches to issuing bail-in debt — Figure 1



Notes: The figure illustrates the two main approaches to issuing bail-in debt. The structural approach comprises the issuance of a bail-in bond by the bank holding company. The proceeds are down-streamed to the operating bank, a fully owned subsidiary, in return for an internal note. Bonds issued by the operating bank are not subject to bail-in under resolution. The non-preferred approach, in turn, is based on the parent bank issuing bail-in bonds that rank below the non-bail-in bonds issued by the same entity.

Second, the subordination of senior unsecured bail-in bonds can be achieved through an alternative approach whereby the operating parent bank issues a "non-preferred bond" (Figure 1). This bond resides in a creditor layer that ranks below the regular senior debt class in resolution.[9] Non-eligible senior unsecured bonds, so-called "preferred bonds", would fall in this latter class and are thus also referred to as non-bail-in bonds in our analysis.

Banks' approaches to issuing senior bail-in bonds have developed largely along national lines. In the United States, banks already had HoldCos whose debt was structurally subordinated to their operating banks. Large Dutch, Irish, Swiss and UK banks have also used HoldCo structures to issue bail-in bonds. Most other banks in the EU issue non-preferred bail-in bonds through their operating parent bank. National legislation in place across the EU specifically allows for non-preferred bond issuance (and also requires the instrument's documentation to specify its ranking below other senior unsecured debt liabilities).[10] The harmonised EU bail-in regime, referred to as minimum requirement for

[9] This new creditor layer has been referred to as Tier 3 debt, since it ranks one layer higher than Tier 2 (junior) securities in the regulatory capital framework.

[10] EU Member States were required to have legislation in place allowing non-preferred issuance by the end of 2018, which is at the end of our study period. Prior to this, they had their own transitional arrangements. In France, non-preferred bond issuance was provided for as a new type of senior debt through legislation introduced in late 2016. Major Spanish banks issued non-preferred bonds through a subordination clause in the bond contract. In Germany, legislation introduced in 2015 allowed for all senior unsecured bank bonds to be bailed in under resolution.

own funds and eligible liabilities (MREL), can in principle be applied to all banks in the EU. Hence, our analysis below includes a number of large European banks that are not classified as G-SIBs, but are subject to MREL.

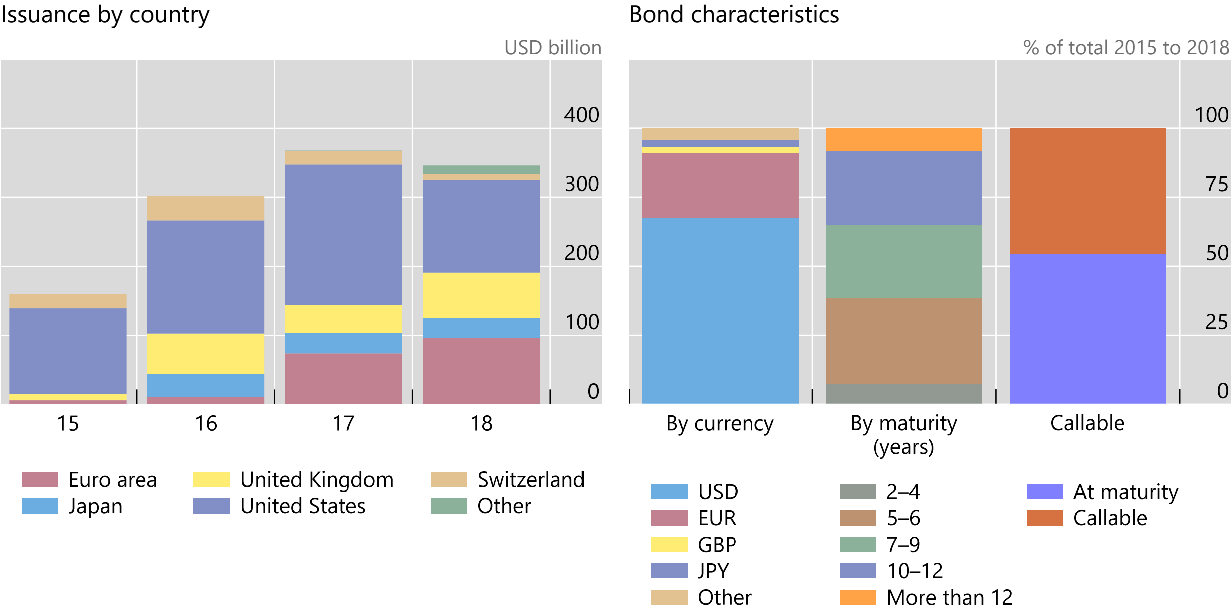
4. Identification of the bail-in risk premium (BIRP)

To identify the BIRP, we match bail-in bonds with comparable non-bail-in bonds issued within the same banking group. This matched-bond BIRP is then analysed across time, and on our cross-section of banks.

4.1. Data on bail-in bond issuance

We gather from Bloomberg bonds issued during 2015–18 that are identified as bail-in securities. Bail-in issuance records are limited to those that are senior unsecured and with a maturity greater than one year.[11] This sample consists of 2,164 bail-in bonds, issued by 68 banks. Total issuance in this period amounts to almost $1.2 trillion (Figure 2, left-hand panel), providing a comprehensive picture of global bail-in bond issuance if compared with public sector estimates (FSB (2019)).

Senior bail-in bond market characteristics (2015–18) Figure 2



Notes: Issuance data comprise 2,164 senior bail-in bonds, issued by 68 banks from 16 jurisdictions.

Sources: Bloomberg; banks' disclosures.

[11] We cross-check ISINs in this list with banks' bond disclosures. Based on this process a small number of ISINs were excluded (mainly relating to operating bank securities that were classified as bail-in securities) or included (those not present in the Bloomberg sample).

About 90% of total issuance was by advanced economy banks classified as G-SIBs in 2017. In addition, a handful of mid-sized European banks have issued bail-in bonds in pursuit of MREL requirements.[12] US banks have been the dominant issuers of bail-in bonds, accounting for around 50% of total issuance over 2015–18. Apart from their relative size, this reflects that the US legislative framework for bail-in was introduced earlier than elsewhere through the Dodd-Frank Act in 2014.[13] European and Japanese banks have ramped up their issuance in more recent years as their national bail-in regulatory frameworks have been clarified.

In terms of the characteristics of senior bail-in bonds, the bulk of issuance was in USD, with much of the remainder issued in EUR. Issuance was largely at the 5-, 6-, 7- and 10-year tenors (Figure 2, right-hand panel). The concentration of issuance in USD and in a small number of tenors probably reflects the strong presence of institutional investors in this market segment,[14] which typically require sufficient liquidity in the underlying securities. Another noteworthy feature of senior bail-in bonds is that many are callable. Because debt with a residual maturity of less than one year is not eligible for TLAC, bail-in bond contracts often include an option allowing the issuer to call the bond before this threshold is crossed. Since the call option is embedded in the bond price, we need to adjust for the option value to obtain an unbiased estimate of the BIRP.

4.2. Identification of the BIRP from matched bonds

The pricing of risk in debt markets is commonly identified using pooled regressions. A relevant example for our study is the literature on systemically important banks: relative risk premia can be identified using a large sample of bank bonds, a range of bond and issuer controls, and a dummy variable indicating those bonds that are issued by banks judged too-big-to-fail (eg Santos (2014) and Acharya et al (2016)). An important drawback of this approach is that relative risk premia can reflect time-varying differences in unobserved issuer characteristics. Indeed, Collin-Dufresne et al (2001) and Elton et al (2001) show that a significant part of credit spreads is unexplained by credit risk factors, suggesting that bank-specific non-credit factors need to be controlled for.

We overcome these problems in our study by matching bonds issued by a single banking group. Specifically, we identify pairs of bail-in and non-bail-in senior unsecured bonds issued by entities affiliated with the same banking group. In the case of banking groups that issue bail-in bonds through a structural subordination approach (see Table A

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[12] This sample of bail-in bonds appears to be close to the total population of bail-in bonds. The total outstanding size of the G-SIB bail-in bond market at end-2018 was estimated to be $1.3 trillion, based on the disclosures of these banks.

[13] Debt previously issued by US bank holding companies before the introduction of the Dodd-Frank resolution regime in 2014 was grandfathered in as eligible bail-in debt. Some US bank bail-in bonds were therefore issued in earlier years. These bonds are not included in our study.

[14] We do not study the investor base for global banks' bail-in debt securities. Pigrum et al (2016) analyse the investor base for bail-in debt securities issued by euro area banks using the ECB's Securities Holdings Statistics. They find that nearly 40% of bail-in eligible debt securities are held outside the euro area. For bail-in debt held within the euro area, euro area banks accounted for one-third, other financial institutions (including money market funds, other investment funds, insurers and pension funds) a bit more than 40%, and the non-financial sector (mainly households) less than one-quarter.

in the Appendix), bail-in bonds issued by the holding company are paired with bonds issued by an affiliated operating bank. In other cases, non-preferred (ie bail-in) bonds are paired with preferred (ie non-bail-in) bonds issued by the same parent entity.[15] We require these bond pairs to be denominated in the same currency, and to have a maturity date within a window of ±6 months, since differences in these bond characteristics could affect relative pricing.[16] In sum, our matching approach isolates the bail-in risk from bank-specific determinants of bond spreads, as well as from two key bond-specific characteristics.

We use these bond pairs to identify the BIRP. For each matched bond *m*, issued by the banking group *b*, subject to the bail-in regime in country *c*, we measure the BIRP in week *t* as the difference between the option-adjusted spread (OAS) in secondary markets on the bail-in bond, *i*, and the OAS on the corresponding non-bail-in bond, *j*:

$$BIRP_{m,b,c,t} = \text{BAIL-IN } OAS_{i,b,c,t} - \text{NON-BAIL-IN } OAS_{j,b,c,t} \,. \quad (1)$$

The OAS is the z-spread – the bond's credit spread over the relevant benchmark yield curve – adjusted for embedded options. Our choice of the OAS reflects the fact that the majority of the bail-in bonds are callable (Figure 2, right-hand panel). By matching OAS within a narrow maturity window, we also limit the duration mismatch that is present in typical credit spread measures (Gilchrist and Zakrajšek (2012)).

Our BIRP estimates are based on secondary market OAS because we want to ascertain how the BIRP evolves over time. In addition, if banks time their bail-in bond issuance opportunistically to benefit from favourable market conditions – as we show in Section 6 – primary market estimates of the BIRP could be biased downwards.[17]

4.3. Construction of the matched-bond dataset

We retrieve from Thomson Reuters Eikon all senior unsecured bonds issued by the above banking groups, and outstanding as of August 2018. Bail-in bonds are then distinguished from non-bail-in bonds based on the above bail-in bond issuance records from Bloomberg. We focus on the large and most liquid bonds that are most relevant for our analysis and for which the pricing data are most accurate. Specifically, we restrict the sample to (i) publicly issued, fixed coupon bonds; (ii) denominated in one of the major currencies (EUR, USD, JPY, GBP); (iii) with an original maturity of at least two years; and (iv) an issuance amount of least $100 million. This dataset contains 919 bail-in bonds and 1,474 non-bail-in bonds. We exclude a small number of issuers with a non-investment grade credit rating on bail-in bonds (ie BB+ or lower) during any period in our sample, since the pricing

15 Neither of these matching processes can be applied to German banks, since over the sample period all their senior unsecured bonds are bail-in eligible by statute.

16 For instance, bonds issued by the same banking group but denominated in different currencies have been found to respond differently to changes in issuer risk (Hofmann et al (2019)).

17 Such a bias has been documented for banks' subordinated bank debt (eg Covitz et al (2004), Covitz and Harrison (2004)) and contingent convertible bonds (Hesse (2018)).

dynamics of these bonds are likely to differ from those of investment grade bonds (eg due to different investor clienteles).

We then match pairs of bail-in and non-bail-in bonds, allowing bonds to be matched multiple times. For all matched bonds we gather data on weekly average OAS in secondary markets up until the first week of January 2019. These data were available for 141 bail-in bonds and 111 non-bail-in bonds issued by 23 banking groups (see the Appendix for the list of banks) and resulted in 160 matched pairs.[18] Data coverage improves significantly as of March 2016 – we therefore define this as the start of our observation period. Whenever a bail-in bond is matched with multiple non-bail-in bonds, we average across these pair-level BIRPs to ensure that we do not bias our results towards these bail-in bonds over those with only a single match.[19] In addition, we winsorise the BIRP estimates at the 1% level – a standard value in the literature (eg Archaya et al (2016), Hett and Schmidt (2017)) – to account for outliers.

Our final sample consists of exactly 100 matched bail-in bonds. Within this, 76 and 24 bail-in bonds are issued by banks under the structural and non-preferred subordination approaches, respectively.

Table 1 depicts the summary statistics for the bail-in and non-bail-in subsamples as well as the resulting matched bonds. Most notably, the average OAS of the bail-in bonds exceeds the OAS of non-bail-in bonds by about 27 basis points (bps), providing some initial evidence of investors pricing a BIRP. Yet the bail-in and non-bail-in bonds also differ along other important dimensions. Indeed, standard t-tests (not reported) reject the null hypothesis of equal means for all of the reported variables in Table 1. Our approach of matching bonds by their currency of denomination and, with some tolerance, maturity date, helps account for such differences. In addition, we control for age, nominal value and remaining maturity in all regressions (Section 5), to deal with any other liquidity and credit risk differences between the matched bonds.

4.4. BIRP across different issuers and economies

Based on the matched bonds, we assess the BIRP across different issuers and economies. Our conjecture is for a positive BIRP, as stated in our first hypothesis:

Hypothesis 1: *Bail-in bonds exhibit a positive BIRP to compensate investors for the risk of being bailed in.*

The summary statistics tally with this conjecture, on average, across the matched bonds reported in Table 1. Across bond pairs, we obtain an average BIRP of 20 basis points over

[18] While sufficient price information was only available for a minority of bail-in bonds, these bonds are likely to be the most actively traded and thus provide the most precise signals of changes in investors' assessment of the banks' credit risk.

[19] Our results for the BIRP remain qualitatively unchanged if we skip this step.

the period from March 2016 to January 2019. The average BIRP varies significantly during this period, ranging from less than 10 to almost 70 bps (Figure 3, left-hand panel).[20]

There is also considerable dispersion in the BIRP across the matched bonds: the BIRP is 3 bps and 33 bps at the 25th and 75th percentiles of the distribution, respectively. In large part this reflects variation in the BIRP along the dimension of the banks' home economy (Table 2). At one end of the sample, UK and other European banks' average BIRP is around 30 bps, while at the other end Japanese banks' average BIRP is about 2 bps. At 14 bps, the average BIRPs for US banks lie within this range.

Bond summary statistics — Table 1

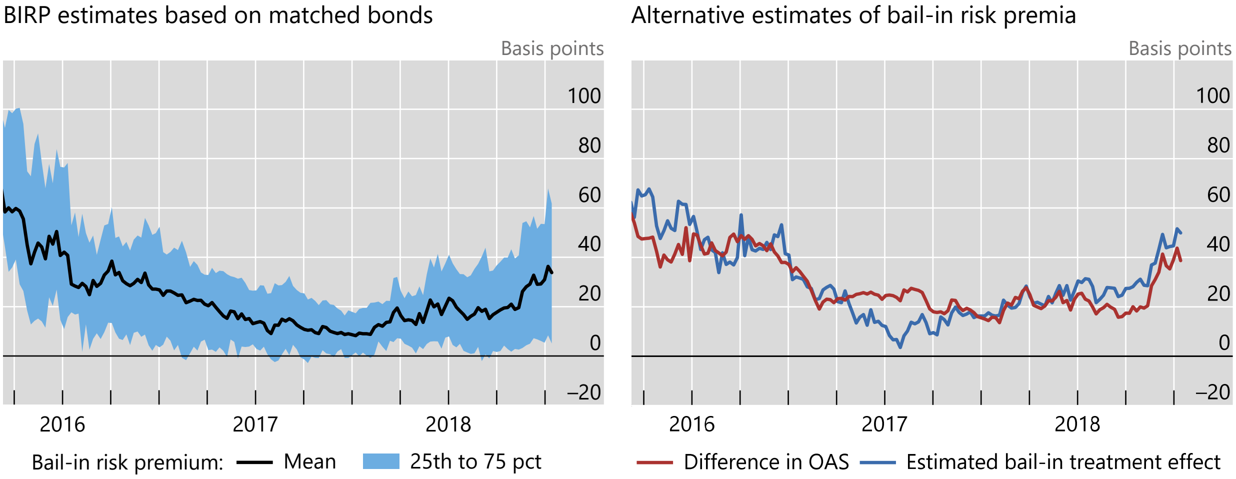
	P10	P25	P50	P75	P90	Std Dev	Mean	N
Bail-in bonds								
Option-adjusted spread	0.372	0.517	0.741	1.043	1.379	0.401	0.819	15162
Maturity	2.083	2.833	3.917	5.000	7.250	1.975	4.272	15162
Age	0.365	0.904	1.904	3.596	6.654	2.287	2.642	15162
Nominal value	6.426	6.945	7.313	7.719	7.824	0.660	7.232	141
Denominated in USD	0	0	1	1	1	0.48	0.65	141
Non-bail-in bonds								
Option-adjusted spread	0.164	0.295	0.492	0.733	0.996	0.346	0.553	13144
Maturity	2.583	4.000	5.167	6.250	7.500	1.902	5.161	13144
Age	0.500	1.212	2.692	4.894	6.808	2.487	3.267	13144
Nominal value	4.913	6.215	6.933	7.238	7.601	0.876	6.668	111
Denominated in USD	0	0	0	1	1	0.470	0.324	111
Matched bonds								
BIRP	–0.061	0.035	0.150	0.331	0.532	0.258	0.197	7778
Maturity	1.865	2.577	3.769	4.827	6.500	1.926	4.002	7778
Age	1.231	1.615	2.404	3.423	4.596	1.815	2.856	7778
Nominal value	6.382	6.829	7.182	7.467	7.809	0.655	7.073	100
Denominated in USD	0	0	1	1	1	0.490	0.610	100
Matched bond ratio: age	0.220	0.292	0.458	0.919	1.307	0.459	0.642	7778
Matched bond ratio: nominal value	–0.440	–0.145	0.248	0.884	1.473	0.789	0.392	100

Notes: Unbalanced sample of 141 bail-in bonds and 100 non-bail-in bonds, which can be matched to a total of 100 bond pairs with non-missing bail-in risk premia. Weekly observations for the first week of March 2016 to the first week of January 2019. The table reports the 10th (P10) to 90th (P90) percentile as well as the standard deviation (St Dev), mean and number of observations (N) for bail-in bonds, non-bail-in bonds, and matched bonds, respectively. *Option-adjusted spread*: weekly average of the bond's option-adjusted spread in per cent; *Maturity*: remaining maturity in years; *Age*: years since issuance; *Nominal value*: nominal value at issuance in log of US$ millions; *Denominated in USD*: indicator variable equal to 1 if the bond is denominated in USD, zero otherwise; *BIRP:* bail-in risk premium of matched bonds in basis points; For *matched bonds*, maturity, age, nominal value and currency denomination, refers to the matched *bail-in* bonds; *Matched bond ratio: age*: ratio of the age of bail-in and matched non-bail-in bonds, in logs; *Matched bond ratio: nominal value:* ratio of the nominal value of bail-in and matched non-bail-in bonds, in logs.

[20] There are few benchmarks to compare our results with. For one, a survey of market participants prior to the introduction of most bail-in regimes expected senior unsecured bond spreads to rise by 35 bps (FSB (2015b)). This may suggest that what is deemed by investors to be appropriate compensation for bail-in risk can vary over time, consistent with the time variation in the BIRP observed in our study.

Bail-in risk premium (BIRP) and alternative estimation approaches

Figure 3



Notes: The left-hand panel depicts the average bail-in risk premium (BIRP) that results from the matching of bail-in and non-bail-in bonds (black line) and the corresponding 25th to 75th percentile range (blue shaded area). The right-hand panel plots the difference in the average OAS of bail-in bonds and the average OAS of non-bail-in bonds (red line); and the estimated (treatment) effect on bail-in bonds (blue line) based on nearest-neighbour matching using the following bond-specific covariates: age, nominal value, remaining maturity, remaining maturity squared, currency of denomination, and issuing banking group (required to match exactly).

In many cases, the BIRP seems large enough to affect bank behaviour. For example, at end-2018, the average UK bank in our sample had issued senior bail-in bonds equivalent to roughly $35 billion. Assuming these bonds fully replaced non-bail-in debt, an average BIRP of 29 bps for UK banks would imply additional funding costs of roughly $102 million per year.[21] By raising debt funding costs, the pricing of bail-in risk is likely to incentivise banks to reduce their risk-taking. For example, banks might opt to rebalance their funding mix in favour of equity, thus lowering their leverage.[22]

Bail-in risk premium

Table 2

Economy	P25	P50	P75	Std Dev	Mean	N	Bail-in bonds
Europe (excl UK)	0.151	0.302	0.465	0.252	0.300	2333	33
Japan	–0.063	0.023	0.094	0.191	0.024	1869	22
United Kingdom	0.087	0.223	0.422	0.295	0.290	1931	19
United States	0.057	0.120	0.197	0.139	0.139	1645	26
All	0.035	0.150	0.331	0.258	0.197	7778	100

The table reports the following statistics for the bail-in risk premium (BIRP, in per cent) in each economy: 25th (P25) to 75th (P75) percentile, standard deviation (St Dev), mean, number of observations (N), and the number of matched bail-in bonds. The BIRP is equal to the difference between the option-adjusted spread of matched bail-in and non-bail-in bond pairs, averaged across each bail-in bond.

21 Determining the impact on funding costs may be less straightforward because marginal funding costs for other newly issued debt instruments (such as non-bail-in senior debt or subordinated debt) could adjust as bail-in issuance rises.

22 Higher funding costs can be viewed as an indication of the success of bail-in regimes, since at least part of these costs reflect a reduction in the implicit public sector guarantee provided to failing banks.

4.5. Alternative approaches to estimating bail-in risk premia

We are confident that matching bonds based on the above approach yields the most accurate measure of the BIRP, but other approaches could be considered. As a robustness check, we use several alternative techniques to estimate a bail-in risk premium from our sample of (matched) bail-in and non-bail-in bonds. Overall, these alternative estimates are consistent with our results based on preferred approach of matching bonds.

First, we estimate the (treatment) effect on bail-in bonds' OAS based on a standard nearest neighbour matching approach. We match each bail-in bond with its four closest non-bail-in neighbours and allow for replacement of the control bonds, ie a non-bail-in bond can be a neighbour for several bail-in bonds. The choice of the number of neighbours follows the recommendation in Abadie and Imbens (2011), while Smith and Todd (2005) emphasise that replacement enhances the matching precision. We match the bonds on a set of covariates that is broader than the three criteria used in our benchmark approach. Specifically, we include the z-score of the log issuance amount ($ million), age (in years), remaining maturity (in years), remaining maturity squared, currency of denomination (1 if USD, 0 if EUR),[23] and the issuing banking group. The latter variable is required to match exactly.

The results are shown as the blue line in Figure 3 (right-hand panel). Although the level tends to differ a little, the trend in the series is similar to that for the BIRP estimates discussed in Section 4.3 (see also Figure 3, left-hand panel) – the correlation coefficient between these two series is 0.93. It is worth noting that the trend for the unconditional simple difference between the average OAS on bail-in and non-bail-in bonds (shown as the red line in the right-hand panel of Figure 3; see also Table 1) is also similar – it has a correlation coefficient of 0.86 with our benchmark measure of the BIRP. In sum, these alternative estimates of the risk premium provide us with some confidence that our matching criteria are sound.

Another robustness check involves estimating the bail-in risk premium for the same sample of bonds using a pooled regression. Specifically, we regress the OAS on a bail-in dummy variable while controlling for differences in the bond and issuer characteristics based on the following linear regression:

$$OAS_{i,b,c,t} = \alpha + \beta \times bail\text{-}in + \gamma_1 X_{i,t} + \gamma_2 X_{b,c,t-1} + \varepsilon_{i,b,c,t} \quad , \qquad (2)$$

where $OAS_{i,b,c,t}$ represents the weekly average OAS of bond i issued by bank b domiciled in country c in week t. If investors demand a risk premium on bail-in bonds, we expect to observe a positive coefficient ($\beta > 0$) on the bail-in dummy. ε represents the error term. $X_{i,t}$ controls for differences in the contractual terms of the bond (ie volume, age, maturity, maturity squared), whereas $X_{b,c,t-1}$ accounts for differences in (lagged) issuer characteristics (eg expected default frequency or total assets). On top of that, we control for time,

[23] This robustness check excludes bonds denominated in other currencies given the difficulty of measuring proximity for a categorical variable such as the currency of denomination.

currency, issuer or country fixed effects as detailed in Table 3. For brevity, we omit noting the fixed effects in the regression equations throughout this paper.

The results in Table 3 confirm the existence of a risk premium on bail-in bonds. At close to 30 bps on average, this estimate is not statistically different from the mean for the matched-bond BIRP (at the 99% confidence level).

Pooled sample: alternative estimates of the bail-in risk premium — Table 3

Dependent variable:	Option-adjusted spread; weekly average in per cent				
	(1)	(2)	(3)	(4)	(5)
Bail-in	0.279***	0.292***	0.296***	0.301***	0.302***
	(0.042)	(0.044)	(0.044)	(0.040)	(0.043)
Observations	28,945	28,681	27,138	26,788	26,631
R-squared	0.761	0.705	0.725	0.739	0.734
Bank-level controls		EDF	EDF, TA, ROA	EDF, TA, ROA, CET1, non-CET1	EDF, ROA, leverage
Bond-level controls	y	y	y	y	y
Fixed effects					
week, currency	y	y	y	y	y
issuing group	y				
country		y	y	y	y

*/**/*** indicates statistical significance at the 10/5/1% level. OLS regressions of equation (2) with robust standard errors, clustered by bank issuing group, in parentheses. Bank-level controls are lagged (EDF by 1 week, all others by 1 quarter) and in terms of their z-score (zero mean and unity standard deviation): EDF = expected default frequency over 1-year horizon; TA = total assets; ROA = four-quarter rolling average return on assets; CET1 = Common Equity Tier 1 ratio; leverage = total assets divided by common equity. Bond-level controls comprise nominal value (z-score), age (in years), maturity (in years) and maturity × maturity.

Finally, we test whether the BIRP accords with an estimate of the bail-in risk premium obtained from bank CDS contracts. OAS are conceptually similar to CDS spreads. In our main analysis, we use OAS on individual bonds rather than CDS spreads because reliable CDS data are available only for a much smaller number of banks, and for a relatively short time series for some of these banks. Furthermore, where CDS data are available they tend to be largely for the 5-year tenor, whereas using bail-in bonds enables us to infer the BIRP across the entire maturity spectrum.

We calculate CDS spread differences to obtain an approximation of the premium paid to insure against a credit event that would only affect the bail-in bond. For banking groups issuing structurally subordinated bail-in bonds, we calculate the difference between the CDS spread on the HoldCo and the equivalent spread on the OpCo. For the other banks, we compute the difference between the CDS spread on the non-preferred senior unsecured bonds and the equivalent spread on the preferred senior unsecured bonds. In each case, we use the 5-year on-the-run contract available from Markit. Spread differences were available for 15 banking groups in our sample, with data coverage and quality suggesting to consider observations as of September 2017.

We would expect the CDS spread difference to be positively correlated with the matched-bond BIRP. Consistent with this prior, we find a positive and highly significant correlation between these two measures (Table 4). A regression of the BIRP on the CDS spread difference explains more than half of the variation in the BIRP, if issuer fixed effects are taken into account (Table 4, column 2). Given the close ties between the CDS and bond markets, this finding lends further support to our BIRP measure.

Bail-in risk premium and CDS spread difference — Table 4

Dependent variable:	Bail-in risk premium (BIRP); weekly average, in per cent			
	(1)	(2)	(3)	(4)
CDS spread difference	0.836***	0.981***	0.994***	1.045***
	(0.181)	(0.225)	(0.221)	(0.240)
Matched bond maturity				0.044***
				(0.008)
Observations	3,269	3,269	3,269	3,269
R-squared	0.240	0.599	0.635	0.665
Fixed effects				
issuing group		y	y	y
currency			y	y

*/**/*** indicates statistical significance at the 10/5/1% level. Dependent variable: Bail-in risk premium (BIRP); OLS regressions with robust standard errors, clustered by bank issuing group, in parentheses. Period of observation: first week of September 2017 to the first week of January 2019. Based on 15 banks for which CDS spread differences were available.

5. Empirical analysis of the BIRP

In this section, we study the BIRP's key determinants to explore whether bond investors are exerting market discipline on banks. We start by examining how cross-sectional variation in the BIRP is related to issuer-specific risk factors. Next, we consider to what extent the pricing of the BIRP varies with changes in market risk factors over time. We conclude this section by investigating the interaction of the above risk factors in terms of their impact on the BIRP.

5.1. Assessing the determinants of the BIRP

Based on the approach outlined in Section 4, the BIRP represents the bond investors' assessments of the risk of loss from bail-in, which depends on a variety of *risk factors*. It also captures characteristics, X, that are specific to the matched bond, m, such as the remaining maturity of the underlying securities or differences in the liquidity premia of the latter. A general representation of the BIRP in week t on the matched bond m, issued by bank b, and subject to the bail-in regime of country c, is thus given by:

$$BIRP_{m,b,c,t} = \alpha + f\ (risk\ factors)_{b,c,t} + \gamma\ X_{m,t} + \varepsilon_{m,b,c,t}\ , \quad (3)$$

with constant α and $\varepsilon_{m,b,c,t}$ representing the error term.

Many risk factors could affect the pricing of bank bonds (eg Archaya et al (2016), Neuberg et al (2016), Elyasani and Keegan (2017)). These factors can be broadly grouped into two categories: (i) *issuer risk factors*, which quantify differences in the credit risk across issuing banks; and (ii) *market risk factors*, which measure time-varying investor risk appetite against the macroeconomic backdrop. For each of these factors, we consider a limited set of measures in order to explain variation in the BIRP. We discuss our selection below, while providing the summary statistics and definitions of the risk factors in Table 5.

Risk factor summary statistics Table 5

Issuer risk factors	P10	P25	P50	P75	P90	StdDev	Mean	N
Bail-in credit rating (grade)	BBB	BBB+	A–	A–	A			215
Bail-in credit rating (scale)	13.000	14.000	15.000	15.000	16.000	0.841	14.540	215
Notch differential	–3.000	–2.000	–2.000	–1.000	–1.000	0.686	–1.926	215
EDF 1-year (%)	0.241	0.286	0.360	0.432	0.558	0.153	0.386	2012
Total assets (US$ trillion)	0.549	1.010	1.673	1.952	2.590	0.702	1.598	215
CET1 ratio (%)	11.254	11.767	12.470	14.145	15.100	1.509	12.915	215
Non-CET1 ratio (%)	3.233	3.960	4.910	6.571	7.456	1.564	5.200	215
Return on assets (%)	0.034	0.296	0.382	0.587	0.991	0.356	0.441	215
Leverage (ratio)	11.134	15.169	19.015	22.981	26.674	5.841	19.324	215
Market risk factors								
US CDS Index (bps)	53.638	58.292	62.254	68.430	78.389	9.351	64.075	2402
US term spread (TS) (%)	0.788	0.959	1.085	1.245	1.546	0.309	1.108	2402
Market risk premium (%)	–1.600	–0.490	0.310	1.260	2.050	1.894	0.196	2402
VIX (points)	10.048	11.252	12.709	16.050	20.658	4.420	14.235	2402
MOVE (points)	47.980	49.900	55.160	64.500	71.400	9.036	57.599	2402
Issuer country term TS (%)	0.100	0.526	0.935	1.129	1.346	0.491	0.843	2359
StDev of issuer-country TS	0.022	0.057	0.078	0.103	0.143	0.046	0.084	2201

Notes: Unbalanced sample comprising 23 issuing banking groups from 9 jurisdictions for the first quarter of 2016 to the fourth quarter of 2018 (see Table A in the Appendix for the list of banks). The table reports the 10th (P10) to 90th (P90) percentile as well as the standard deviation (St Dev), mean and number of observations (N) based on quarterly data for issuer risk factors (weekly for EDF 1-year) and weekly data for market risk factors.

Issuer risk factors: *Bail-in credit rating (grade):* Rating assigned by Standard & Poor's to the parent bank's non-preferred senior unsecured bonds or the rating assigned to the holding company's senior unsecured bonds under structural subordination (see Figure 1). *Bail-in credit rating (scale):* numeric equivalent based on a scale of 1 (rating C) to 21 (rating AAA). *Notch differential:* difference between the bail-in credit rating and the credit rating on the banking group's non-bail-in bonds. For issuers of non-preferred senior unsecured bonds, the corresponding non-bail-in bonds are senior preferred unsecured bonds issued by the parent bank. For issuers of bail-in bonds under structural subordination, the corresponding non-bail-in bonds are the senior unsecured bonds issued by the operating bank. *EDF 1-year*: Moody's expected default frequency (EDF) over a one-year horizon. *Total assets*: total assets in trillions of US dollars. *CET1 ratio*: Common Equity Tier 1 ratio. *Non-CET1 ratio*: sum of Additional Tier 1 and Tier 2 capital as a percentage of total risk-weighted assets. *Return on assets*: four-quarter rolling average of annualised return on average assets. *Leverage*: total assets divided by total equity.

Market risk factors: *US CDS index:* CDX North America IG index, comprised of 5-year CDS contracts for companies from financial and non-financial sectors. *US term spread*: difference between the yield on 10-year US Treasury securities and three-month US Treasury bills. *Market risk premium:* excess return on the US stock market over one-month US Treasury bill rate (K R French data library). *VIX:* CBOE Volatility Index. *MOVE:* Merrill Lynch Option Volatility Estimate. *Issuer-country TS.* difference between the yield on 10-year and three-month securities issued by the sovereign in which the issuing bank is domiciled. *StDev of issuer country TS:* standard deviation of issuer-country TS over the past 90 days.

Sources: K R French data library; Bloomberg; Markit; SNL Financial; Thomson Reuters.

Issuer risk factors are those relevant at the level of the banking group, either the holding company or parent bank depending on the bail-in issuance approach used (see Figure 1).

Credit ratings are key information for our study. We include the *bail-in credit rating,* which is the long-term rating on senior non-preferred debt issued by the parent bank or senior unsecured bonds issued by the bank holding company. We use the rating assigned by Standard & Poor's, which offered the best coverage for our sample, and map these on a numeric scale from 1 (*C*) to 21 (*AAA*). Bail-in ratings vary between BBB and A across the sample of (investment grade) issuing banks. We also include the *notch differential* between the bank's bail-in credit rating and its corresponding non-bail-in credit rating assigned by Standard & Poor's. The notch differential between bail-in and non-bail in bonds is always negative. It can vary across banks based on risk factors such as the strength of the issuer's credit risk profile, as well as the support provided to bail-in debt by the group's buffer of loss-absorbing capital (senior or non-senior) or its sovereign. For instance, the rating differential between bail-in and non-bail in bonds is only one notch for all three Japanese G-SIBs in our sample, whereas it is either 2 or 3 notches for the US banks. This difference partly reflects Standard & Poor's classifying the government propensity to support a systemically important bank as "highly supportive" for the case of Japan as compared with "uncertain" for the case of the United States (Standard & Poor's (2019)).

We supplement the credit rating information with a weekly market-based credit risk variable, Moody's 1-year Expected Default Frequency (EDF). We also include several quarterly balance sheet measures of credit risk from SNL Financial that are standard in the literature: the Common Equity Tier 1 (CET1) capital ratio or, as an alternative measure of capitalisation, bank leverage in terms of total assets divided by common equity; a four-quarter trailing measure of the return on assets to approximate the bank's profitability and repayment capacity; and the log of total assets as a rough gauge of systemic importance. In addition, we include the ratio of non-CET1 regulatory capital (ie AT1 and Tier 2 instruments) to risk-weighted assets, a proxy for the buffer of hybrid capital and liabilities that would absorb losses in resolution before holders of senior unsecured bail-in bonds.

For the *market risk factors* we consider the following variables: a broad-based CDS index composed of 5-year CDS on North American financial and non-financial investment grade companies (Markit CDX North America IG index); the US term spread defined as the difference between the yield on 10-year and 3-month US Treasury securities; the equity market risk premium (ie the excess return on US equities over the one on 3-months US Treasury bills from K R French's data library) and the VIX as proxies of risk appetite in equity markets; the MOVE index to measure bond market volatility; the issuer country term spread (ie the difference between the yield on 10-year and 3-month securities of the issuing bank's sovereign) and its standard deviation over the past 90 days.

For the *matched bond characteristics* ($X_{m,t}$), we follow the literature and consider several proxies of liquidity premia. We calculate the log ratio of the bail-in bond's age (years since issuance) and that of the matched non-bail-in bond as well as the corresponding measure for the bonds' nominal value at issuance. Table 1 provides the summary statistics of these measures. Furthermore, we control for the matched bonds' remaining maturity (in levels and squared) based on the value observed for the bail-in bond.[24]

A challenge for our empirical analysis of the risk factors is that theory provides no clear guidance on the specific functional form for *f (.)* in equation (3). Importantly, different risk factors could amplify each other's effect. We would, for example, expect the effect of issuer risk on the BIRP to be particularly strong during times of elevated investor risk aversion. Thus, we opt for a pragmatic approach in specifying the estimation parameters.

We start from the following parametric specification, which incorporates all the main risk factors in a linear manner:

$$BIRP_{m,b,c,t} = \alpha + \beta_{issuer}\, issuer\ risk_{b,c,t-1} + \beta_{market}\, market\ risk_{c,t-1} + \gamma\, X_{m,t} + \varepsilon_{m,b,c,t}\,. \quad (4)$$

We run the regression on the z-scores of the individual risk factors (with the exception of the notch differential) to account for the large differences in the variance of the explanatory variables. The coefficient estimates can thus be interpreted as the effect of a one-standard deviation of the risk factor from its sample mean. Furthermore, following the literature convention (eg Archaya et al (2016)), we use the first lag of the risk factors to address endogeneity concerns and adjust all standard errors for heteroscedasticity and within correlation clustered at the issuer level.[25]

5.2. Issuer risk factors

We start by estimating equation (4) using different combinations of potential issuer risk factors to test the following hypothesis:

Hypothesis 2: *BIRPs are positively related to credit risk across issuing banks.*

As an interim step, we control for market risk factors by using weekly fixed effects. Based on the regression results, we select the key issuer risk factors to focus on in the remainder of the analysis. Table 6 presents the main regression results.

The bail-in bond issuer's credit rating features as a prominent driver of variation in the BIRP across banks. The results in the first line of Table 6 indicate that a one-standard deviation increase in the issuer's bail-in credit rating – equivalent to an improvement in the rating grade by 0.8 notches – reduces the BIRP by about 8 to 13 bps. We note that the

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[24] Given the tight matching of the bonds, all our results are robust to substituting this variable with the remaining maturity of the non-bail-in bonds (averaged in the case of multiple matched bonds) and to adding the difference between the remaining maturity of the bail-in bonds and the matched non-bail-in bonds as an additional control variable.

[25] Bank credit ratings are based on a variety of bank-specific risk factors such as the strength of the bank's business operations, capital, earnings, or funding profile. The BIRP is thus unlikely to meaningfully affect a bank's contemporaneous rating through its impact on the bank's funding costs. Nevertheless, to rule out any potential endogeneity concerns, we conduct a standard Durbin-Wu-Hausman test and confirm that we cannot reject the hypothesis that the bail-in rating is exogenous. On top of that, we estimate whether particularly high or low BIRPs help to predict changes in the bank's bail-in rating. We estimate a logit regression of observed rating changes, using their exact dates, on the absolute value of the bank's BIRP (less the sample mean or less the bank's mean BIRP over the past 12 weeks) including lags of one to eight weeks and the squared terms thereof. We find no evidence that the BIRP has any predictive power, supporting our treatment of the bail-credit rating as an exogenous variable.

Cross-sectional drivers of the bail-in risk premium — Table 6

Dependent variable:	Bail-in risk premium (BIRP), weekly average, in per cent				
	(1)	(2)	(3)	(4)	(5)
Issuer risk factors					
Bail-in credit rating	–0.089***	–0.105***	–0.114***	–0.126***	–0.079***
	(0.030)	(0.019)	(0.035)	(0.036)	(0.018)
Notch differential			0.043	0.048	
			(0.103)	(0.093)	
1-year EDF		0.009	0.008	0.011	0.025
		(0.018)	(0.018)	(0.018)	(0.025)
Total assets		0.013	0.001	0.033	0.051*
		(0.030)	(0.044)	(0.043)	(0.029)
CET1 ratio		–0.006	–0.001		0.034**
		(0.025)	(0.029)		(0.016)
Non-CET1 capital ratio		–0.092**	–0.088**		–0.004
		(0.041)	(0.038)		(0.029)
Leverage				–0.091	
				(0.064)	
Return on assets		0.024**	0.018	0.023	0.001
		(0.010)	(0.013)	(0.016)	(0.016)
Non-preferred issuance					0.088
					(0.092)
Matched bond characteristics					
Nominal value (ratio)	–0.037**	0.011	0.011	0.011	–0.017
	(0.015)	(0.020)	(0.022)	(0.022)	(0.017)
Age (ratio)	0.099**	0.049	0.049	0.042	0.121**
	(0.045)	(0.045)	(0.045)	(0.044)	(0.053)
Maturity	0.169***	0.139***	0.138***	0.141***	0.108*
	(0.052)	(0.042)	(0.042)	(0.043)	(0.052)
Maturity × maturity	–0.012**	–0.012**	–0.012**	–0.012**	–0.010*
	(0.006)	(0.004)	(0.004)	(0.004)	(0.005)
Country fixed effects		y	y	y	
Currency fixed effects		y	y	y	y
Week fixed effects	y	y	y	y	y
Observations	7,778	6,628	6,628	6,628	6,628
R–squared	0.311	0.505	0.506	0.493	0.431

*/**/*** indicates statistical significance at the 10/5/1% level. OLS regressions with robust standard errors, clustered by bank issuing group, in parentheses. Bail-in credit rating, 1-year EDF, total assets, CET1 ratio, non-CET1 capital ratio, leverage and return on assets (ROA) measured in terms of their z-score and lagged by one week (EDF) or one quarter (total assets, all capital ratios and ROA). Non-preferred issuance equal to one (zero otherwise) if the bail-in bond is issued as non-preferred senior unsecured bond.

effect of the notch differential, insignificant in the regressions reported, is dwarfed by the country fixed-effects. As noted above, the rating agencies' assessment of the bail-in rating and thus the notch differential seems to take into account differences in national resolution regimes.[26]

An increase in the non-CET1 regulatory capital ratio is associated with a lower BIRP, reflecting that this capital provides senior bail-in creditors with additional protection against loss. For instance, a one-standard deviation increase in the non-CET1 capital ratio, equivalent to a rise in the ratio by less than 1.6 percentage points (from its mean of 5.2%), is estimated to lower the BIRP by 9 basis points. Other issuer-specific measures, such as the 1-year EDF, total assets, leverage, the CET1 ratio or return on assets are insignificant or add relatively little to predicting the BIRP.

Country fixed effects (not reported) allow us to control for differences in jurisdictions' bail-in regimes, as well as other time-invariant country-level factors. Using the UK as the reference country, we find that the BIRP for Japanese banks is about 27 bps lower (based on the regressions in Table 6, column 1) than for UK banks, controlling for differences in banks' credit ratings and matched bond characteristics. This is consistent with the 28 bps difference that results from comparing the means of UK and Japanese banks' BIRP (Table 2). This result could imply that investors are placing a lower likelihood of a Japanese bank being bailed in than a comparable UK bank, possibly reflecting some lack of clarity about the Japanese authorities' intention to initiate bail-in during a bank resolution scenario as argued in FSB (2016) and Risk.net (2017).[27]

To test whether a bank's approach to subordinating bail-in bonds affects the BIRP, we also regress the latter on an indicator variable distinguishing between non-preferred bonds and those subject to structural subordination (recall Figure 1). This test does not reveal any systematic differences in the BIRP on these bonds (Table 6, column 5).[28]

Our controls for the matched bond characteristics yield the expected signs and support our matching approach. For one, we find a small negative impact on the BIRP of the relative nominal value of the bail-in/non-bail-in pairs for some specifications, whereas an increase in the relative age of the matched securities contributes to raising the BIRP. These estimates are consistent with the pricing of bond liquidity premia, suggesting that larger and more recent issuances exhibit better liquidity and thus lower yields (eg Longstaff et al (2005)). Given our sample choice of large and liquid bonds for which OAS data are available, and our close matching of securities along key dimensions, the impact on the BIRP of relative differences in size and age are modest and often statistically insignificant.

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26 For regressions without country fixed effects, the coefficient estimates on the notch differential is negative (ie a larger notch downgrade from non-bail-in bonds to bail-in bonds in absolute value is associated with a larger BIRP) and statistically significant.

27 Another possible explanation is significant market segmentation. For example, a much narrower investor base for Japanese non-bail-in bonds (which are issued by the operating banks) could increase liquidity risk relative to that on bail-in bonds (which are issued by the holding company).

28 Since the bail-in approach is largely determined by the issuing bank's home jurisdiction, the inclusion of such an indicator requires dropping the country fixed effects to avoid multicollinearity.

The BIRP's term structure can be gauged from the coefficient estimates on the matched bond pairs' remaining maturity and the squared term thereof. The BIRP increases, albeit at a decreasing rate, for matched bonds with a longer remaining maturity. This is consistent with the higher probability of a bail-in occurring over a longer period, as is common in credit market pricing.[29]

Overall, the regression results prove robust to different choices of issuer risk factors, with issuer credit ratings particularly informative in explaining cross-sectional variation in the BIRP. This result is consistent with bond investors' wide-spread use of the credit ratings provided by the leading rating agencies. We thus proceed by using the broadest set of risk factors from our baseline specifications (Table 6, column 3), while focusing on credit ratings in our assessment of the interaction of issuer and market risk factors.[30]

5.3. Market risk factors

We now turn to the market risk factors. In Table 7, we depict the regression results that follow from adding market risk factors to our selection of issuer risk factors, while keeping the set of matched bond controls unchanged (coefficients not tabulated).

The impact of the CDS index stands out. An increase in the index – a gauge of greater investor concerns about credit risk – pushes up the BIRP across banks. Specifically, we find that a one-standard deviation increase in the index (equivalent to a rise by 9.3 points for our period of observation) raises the average BIRP by about 7 bps. Other measures of market conditions, such as the US term spread or the VIX, appear to have little additional explanatory power during our period of observation (columns 2 and 3).

In column 4 of Table 7, we replace the US term spread with the corresponding measure based on the sovereign bond yields of the issuer's home jurisdiction. We also include, as a substitute for the MOVE index, the standard deviation of the issuer country term spread, measured over the past quarter, to account for volatility in yields which could drive up the BIRP. These changes have little impact on the coefficient estimates of the CDS index.

Finally, we note that the coefficient estimates for the issuer risk factors prove robust to the various specification choices reported in Table 7.

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29 Because the OAS is the credit spread above the benchmark interest rate curve, higher interest rate risk over longer maturities should not be a driver of the BIRP.

30 Substituting the time fixed effects in Table 6 with the proposed market risk factors in Table 7 has little impact on the coefficient estimates of the matched bond controls, which we do not report in Table 7. The results are available from the authors upon request.

The effect of market risk factors on the bail-in risk premium — Table 7

Dependent variable:	Bail-in risk premium (BIRP), weekly average, in per cent			
	(1)	(2)	(3)	(4)
Issuer risk factors				
Bail-in credit rating	–0.105***	–0.106***	–0.108***	–0.091**
	(0.036)	(0.035)	(0.035)	(0.039)
Notch differential	0.034	0.038	0.043	0.003
	(0.106)	(0.102)	(0.101)	(0.112)
1-year EDF	0.021	0.019	0.016	0.021
	(0.012)	(0.013)	(0.013)	(0.014)
Total assets	–0.000	–0.002	–0.002	0.002
	(0.039)	(0.040)	(0.040)	(0.041)
CET1 ratio	–0.015	–0.010	–0.008	–0.023
	(0.029)	(0.027)	(0.027)	(0.030)
Non-CET1 capital ratio	–0.095**	–0.092**	–0.090**	–0.098**
	(0.037)	(0.035)	(0.035)	(0.038)
Return on assets	0.016	0.016	0.015	0.020
	(0.013)	(0.012)	(0.012)	(0.012)
Market risk factors				
US CDS index	0.071***	0.076***	0.070***	0.075***
	(0.019)	(0.018)	(0.018)	(0.020)
US term spread (TS)		0.012	–0.003	
		(0.010)	(0.011)	
Market risk premium			–0.003	–0.003
			(0.002)	(0.002)
VIX			–0.013	–0.004
			(0.010)	(0.007)
MOVE			0.019**	
			(0.009)	
Issuer country TS				0.027
				(0.032)
StDev of issuer country TS				–0.008
				(0.015)
Observations	6,628	6,628	6,628	6,329
R–squared	0.486	0.487	0.489	0.486

*/**/*** indicates statistical significance at the 10/5/1% level. OLS regressions of equation (4) with robust standard errors, clustered by bank issuing group, in parentheses. All regressions include currency fixed effects and country fixed effects and controls for matched bond characteristics (ie relative age, relative nominal value, maturity and maturity squared). Credit rating, 1-year EDF, total assets, CET1 ratio, non-CET1 capital ratio, return on assets (ROA) and all market risk factors measured in terms of their z-score and lagged by one week (EDF) or one quarter (total assets, capital ratios and ROA, market risk factors).

5.4. Risk factor interactions

Risk factors are likely to reinforce each other. While investors tend to be less alert to credit risk during times of buoyant market conditions, a sudden loss in investor risk appetite could have a disproportionate impact on the BIRP of more risky issuers. We frame our analysis by considering whether we can reject the following hypothesis:

Hypothesis 3: *The BIRP's sensitivity to issuer credit risk holds irrespective of market-wide conditions.*

We expand the baseline regression in (4) by interacting the issuer credit rating with the market risk factors to test for the interaction of risk factors:

$$BIRP_{m,b,c,t} = \alpha + \beta_{issuer}\ issuer\ risk_{b,t-1} + \beta_{market}\ market_{c,t-1} + \beta_{interaction}\ bail\ in\text{-}credit\ rating_{b,t-1} \times market_{c,t-1} + \gamma X_{m,t} + \varepsilon_{m,b,c,t}\ . \quad (5)$$

This specification provides a parsimonious setup, incorporating our above findings on the bail-in credit rating representing the most relevant issuer risk factors. We present the coefficient estimates in Table 8.

We focus on the rating interaction terms in the lower part of Table 8, noting that the coefficient estimates on the issuer and market risk factors as well as the bail-in regime and matched bond characteristics (unreported) are little changed.

The main takeaway from the interaction terms is the dampening effect on the BIRP for highly rated issuers during times of elevated investor risk aversion (ie high CDS index). Equivalently, the finding predicts a sharp rise in the BIRP on lower-rated issuers during such market conditions. We illustrate this result in Figure 4 (left-hand panel), showing the z-score of the CDS index (zero mean, unit standard deviation) on the horizontal axis and the predicted BIRP at sample means on the right-hand scale of the vertical axis. The left-hand scale of the latter depicts the density of the CDS index.

Our estimates predict that an increase of the CDS index by one standard deviation raises the BIRP for a bond rated BBB by about 12 bps. For a bond rated A–, ie two notches higher, the same increase would amount to a rise in the BIRP by less than 4 bps.

The flipside of this result is the implied compression of the BIRP on the most risky issuers during times of abundant risk appetite. For instance, a one-standard deviation decline in the CDS index from its sample mean lowers the predicted BIRP on lower-rated issuers by enough that it becomes statistically insignificant from the BIRP for the higher-rated issuers. The finding that the BIRP is not sensitive to issuer credit risk under easier market conditions suggests that Hypothesis 3 can be rejected.

The right-hand panel of Figure 4 illustrates the impact of changing market-wide conditions over the sample period. From mid-2017 to mid-2018, the (unconditional) average BIRP of lower-rated (BBB) bail-in bonds fell to levels close to or equivalent to the average BIRP of higher-rated (A–) ones. Yet as CDS spreads picked up again towards the

Assessing the interaction of risk factors — Table 8

	Dependent variable:	Bail-in risk premium (BIRP), weekly average, in per cent			
		(1)	(2)	(3)	(4)
Issuer risk factors	Bail-in credit rating	–0.103***	–0.103***	–0.102***	–0.079**
		(0.032)	(0.028)	(0.027)	(0.033)
	Notch differential	0.027	0.031	0.038	–0.001
		(0.097)	(0.095)	(0.093)	(0.105)
	1-year EDF	0.010	0.008	0.003	0.006
		(0.015)	(0.014)	(0.014)	(0.015)
	Total assets	0.001	–0.001	–0.003	0.001
		(0.036)	(0.037)	(0.038)	(0.039)
	CET1 ratio	–0.013	–0.009	–0.007	–0.020
		(0.029)	(0.027)	(0.026)	(0.029)
	Non-CET1 capital ratio	–0.098**	–0.095**	–0.094**	–0.100**
		(0.037)	(0.036)	(0.036)	(0.039)
	Return on assets	0.016	0.015	0.012	0.017
		(0.013)	(0.013)	(0.013)	(0.013)
Market risk factors	US CDS index	0.074***	0.079***	0.074***	0.082***
		(0.016)	(0.014)	(0.013)	(0.017)
	US term spread (TS)		0.012	–0.006	
			(0.010)	(0.011)	
	Market risk premium			–0.003	–0.002
				(0.002)	(0.002)
	VIX			–0.018*	–0.008
				(0.010)	(0.008)
	MOVE			0.023***	
				(0.008)	
	Issuer country TS				0.027
					(0.031)
	StDev of TS				–0.010
					(0.016)
Interaction terms	*Bail-in credit rating*				
	x US CDS index	–0.039**	–0.039***	–0.035***	–0.036***
		(0.015)	(0.013)	(0.012)	(0.010)
	x US TS		–0.003	0.010	
			(0.011)	(0.011)	
	x Market risk premium			0.002	0.005*
				(0.003)	(0.002)
	x VIX			0.012	0.008
				(0.016)	(0.016)
	x MOVE			–0.015*	
				(0.008)	
	x Issuer country TS (ITS)				–0.003
					(0.015)
	x StDev of ITS				–0.015
					(0.010)
	Observations	6,628	6,628	6,628	6,329
	R–squared	0.502	0.503	0.506	0.501

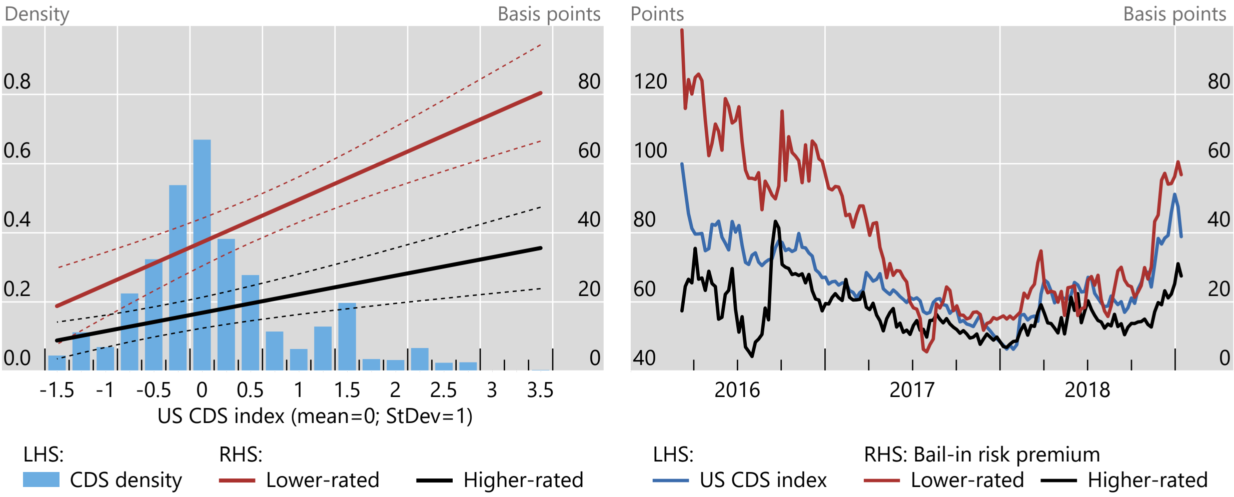
*/**/*** indicates statistical significance at the 10/5/1% level. OLS regressions of equation (5) with robust standard errors, clustered by bank issuing group, in parentheses. All regressions comprise currency fixed effects and controls for matched bond characteristics (ie age ratio, nominal value ratio, maturity and maturity squared).

end of 2018, the difference in the BIRPs widened again, with funding conditions tightening rapidly for lower-rated issuers. We note that credit ratings did not change for any of the banks in our sample during this time, nor were there substantial changes in bank fundamentals.

The impact of risk factors on the bail-in risk premium (BIRP) — Figure 4

Predicted BIRP: low CDS index compresses spread of lower-rated issuers over higher-rated ones

Actual BIRP: favourable market conditions squeeze spread on lower-rated issuers; tighter conditions widen it



Notes: The left-hand panel plots the predicted BIRP (right-hand scale) at different values of the standardised US CDS index (horizontal axis) for higher-rated bail-in bonds (A– rating, black solid line) and lower-rated bonds (BBB rating, red solid line). The dashed lines depict the corresponding 95% confidence interval. All other explanatory variables are evaluated at their sample means. The blue bars show the density of the US CDS index (left-hand scale). The estimates are based on the regression shown in Table 8, column 3. The right-hand panel presents the observed average BIRP for higher-rated (black line) and lower-rated (red line) bail-in bonds as well as the evolution of the US CDS index.

6. Market timing of bail-in bond issuance

We conclude our empirical analysis by studying the timing of banks' bail-in bond issuance. The pro-cyclicality of the BIRP provides strong incentives for banks to time their bail-in bond issuance in order to take advantage of favourable market conditions. This issuance pattern would imply that the disciplining effect of (primary) bond markets on bail-in bond issuers is weaker than otherwise. We test the following hypothesis:

Hypothesis 4: *Banks time their bail-in bond issuance to take advantage of periods during which their BIRP is relatively low.*

This analysis links the risk factors that determine the pricing of bail-in bonds in secondary markets to banks' issuing activity in primary markets. Investor arbitrage should ensure a tight link between these two markets. Accordingly, we find that a comparatively low BIRP in secondary markets over the preceding weeks raises the probability of issuing bail-in bonds. Furthermore, a low BIRP contributes to raising the nominal issuance amount.

Our primary market study encompasses the 23 major banking groups that we studied in the previous sections. It makes use of the full set of bail-in bonds issued by these banks, including bonds that we did not match to non-bail-in bonds. The total number of bail-in bonds used in this part of the empirical analysis is 727, which is more than 40% of the bail-in bonds in the sample identified in Section 4.1.

We estimate the effect of the BIRP on the probability of a bank b issuing a bail-in bond in a given week t based on the standard logistic regression:

$$P\left(issue_{b,t} = 1\right) = \Phi\left[\alpha + \beta_{issuer}\, X_{b,t-1} + \delta\, BIRP_{b,t-1}\right] + \varepsilon_{b,t} \quad (6).$$

We control, in $X_{b,t-1}$, for banks' total assets to account for the fact that larger banks have larger funding needs and are thus generally more likely to issue. In addition, we include the non-CET1 capital ratio to approximate banks' existing stock of debt instruments that are eligible to meet regulatory bail-in requirements. We standardise both variables and lag them by one quarter in the regressions.

We test whether banks strategically time their bail-in bond issuance by issuing more when their BIRP is comparatively low (ie $\delta<0$). Our measure of the BIRP is the average predicted BIRP for each bank's outstanding bail-in bonds based on the regression in Table 8 (Column 3), keeping the remaining maturity constant at 5 years. This measure is comparable across banks, thus allowing us to control for differences in the BIRP that are driven by the maturity profile, while preserving other characteristics (eg the currency mix) of the bank's issuance preferences.

Columns 1 to 3 in Table 9 report the BIRP's marginal effect on the bail-in bond issuance probability, evaluated at the sample means. Here, we consider for each bank the average value of the BIRP's z-score over the past week, four weeks and eight weeks, respectively. This seems consistent with the horizon over which a bank would typically be able to time its issuance.

Our estimates suggest that a one-standard deviation decline in the lagged BIRP (equivalent to a 10 bps decline for the average bank) raises the issuance probability by up to 1.6 percentage points (Table 9, Column 1). The unconditional issuance probability, by comparison, was 26% for the banks in our sample. To put this estimate into perspective, we note that the BIRP on lower-rated issuers declined from about 60 bps in early 2017 to less than 10 bps at end-July 2017, which taken at face value would imply an 8 percentage point increase in the issuance probability.

The effect is strongest if the previous week's BIRP is considered and wanes as we take the BIRP over the past eight weeks into account. This suggests that banks have some leeway in timing their issuance to recent market developments.

We proceed by testing whether a low BIRP also supports the nominal issuance amounts. To do so, we regress the weekly amount of individual banks' gross issuance on the lagged BIRP z-scores. The use of gross issuance data suggests employing a tobit framework to account for the lack of negative observations in our dependent variable.

In line with the above results, we find that a one-standard deviation decline in the BIRP in the week ahead of the issuance raises the average bank's weekly issuance by about $125 million (Table 9, Column 4). For comparison, the weekly issuance of the average bank amounted to $1.05 billion.[31] Coefficient estimates based on evaluating the BIRP over a longer period have the same sign, but tend to be statistically insignificant.

Overall, our finding suggests that banks' bail-in bond issuance responds to changes in the BIRP observed in secondary markets. This behaviour reduces the impact of a rise in the BIRP on banks' marginal funding costs, particularly for riskier banks.

The impact of the bail-in risk premium on bond issuance — Table 9

Dependent variable:	Issuance probability (weekly)			Issuance amount (weekly, USD billions)		
	logit regressions, marginal effects			tobit regressions		
	(1)	(2)	(3)	(4)	(5)	(6)
z-score of BIRP						
average over previous:						
week	–0.020***			–0.125**		
	(0.008)			(0.063)		
4 weeks		–0.016**			–0.082	
		(0.008)			(0.066)	
8 weeks			–0.013			–0.069
			(0.009)			(0.069)
Controls						
Total assets	0.025	0.025	0.025	0.309*	0.322*	0.318**
	(0.027)	(0.026)	(0.026)	(0.165)	(0.169)	(0.155)
Non-CET1 capital ratio	–0.094***	–0.091***	–0.088***	–0.580***	–0.564***	–0.510***
	(0.023)	(0.022)	(0.021)	(0.176)	(0.175)	(0.158)
Observations	2,099	2,024	1,924	2,099	2,024	1,924
Pseudo R–squared	0.061	0.058	0.054	0.030	0.029	0.027

*/**/*** indicates statistical significance at the 10/5/1% level. Dependent variable: Issuance probability based on an indicator variable, equal to 1 if the bank issued in a given week and zero otherwise in regressions (1) to (3); nominal amount issued in billions of US dollars in regressions (4) to (6). In columns (1) to (3), we report the marginal effect on the issuance probability, evaluated at the sample means; in columns (4) to (6) we report the coefficient estimates of the tobit regression. Total assets and the non-CET1 capital ratio are in terms of the variables' z–scores, lagged by one quarter. Robust standard errors, clustered by bank issuing group, in parentheses.

7. Concluding remarks

Bail-in regimes are a core component of the post-crisis overhaul of bank resolution. These regimes require banks to issue sufficient amounts of "bail-in" debt to ensure that a failing bank can be resolved in orderly way, without disrupting crucial financial services. The expectation that investors in bail-in debt would exert discipline on banks through their pricing decisions is another key element of these regimes.

We shed light on the existence and strength of market discipline in senior bail-in bond markets. There are four main findings. First, we identify a bail-in risk premium (BIRP),

[31] This number is based on excluding weeks in which individual banks did not issue.

evidence that investors are in fact pricing bail-in risk. Second, investors in riskier banks are compensated through a larger BIRP. Third, discrimination across banks becomes weak when market-wide credit conditions ease. Fourth, we show that issuers exploit this weakening in investor monitoring by timing their bail-in bond issuance to favourable market conditions.

Our estimates may be interpreted as a lower bound on the effect of issuer and market risk factors on the BIRP for two reasons. First, our study focuses on large banks that frequently tap bond markets and issue in large amounts. This allows for a global comparison across the systemically most important banks and provides for an accurate measure of the BIRP based on tightly matched bonds in liquid markets. Smaller banks, with less regular presence in primary bond markets, could face greater challenges in building up their stock of required bail-in eligible debt. Studying how the risk premia on these banks compares with those of G-SIBs provides an interesting avenue for future research.

Second, our results stem from the analysis of a comparatively calm period of observation (2016–18). This period was marked by relatively low volatility in bond markets, amid investors' search for yield in a very low interest rate environment. Examining how the bail-in bond market performs under stress remains a topic for future research. An extrapolation of our results to periods of stress suggests that riskier issuers could be exposed to material increases in the cost of bail-in debt. Although banks can time their issuance to some extent, prolonged periods of stress could force some banks to tap the market at exceptionally high cost.

From a policy perspective, the observed pro-cyclicality in the BIRP reinforces the value of a conservatively calibrated bail-in regime alongside stringent supervision to ensure that, during good times, banks build up their resilience and keep their risk-taking in check.

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Appendix

Bail-in and matched non-bail-in bond issuers		Table A
STRUCTURAL BAIL-IN BOND ISSUANCE		
Bank holding company	**Operating company**	**Country**
Bank of America Corp	Bank of America NA	United States
Barclays Plc	Barclays Bank Plc	United Kingdom
Citigroup Inc	Citibank NA	United States
Credit Suisse Group Funding (Guernsey) Ltd	Credit Suisse AG (incl. UK branch)	Switzerland
Goldman Sachs Group Inc	Goldman Sachs Bank USA	United States
HSBC Holdings Plc	HSBC Bank Plc	United Kingdom
ING Groep NV	ING Bank NV	The Netherlands
JPMorgan Chase & Co	JPMorgan Chase Bank NA	United States
KBC Groep NV	KBC Ifima SA	Belgium
Lloyds Banking Group Plc	Lloyds Bank Plc	United Kingdom
Mitsubishi UFJ Financial Group Inc	Mitsubishi UFJ Trust and Banking Corp	Japan
Mizuho Financial Group Inc	Mizuho Bank Ltd	Japan
Santander UK Group Holdings Plc	Santander UK Plc	United Kingdom
Sumitomo Mitsui Financial Group Inc	Sumitomo Mitsui Banking Corp	Japan
UBS Group Funding Switzerland AG	UBS AG (incl. UK branch)	Switzerland
Wells Fargo & Co	Wells Fargo Bank NA	United States
NON-PERFERRED BAIL-IN BOND ISSUANCE		
Parent bank (bail-in & non-bail-in issuer)		**Country**
Banco Santander SA		Spain
BNP Paribas SA		France
BPCE SA		France
Caixabank SA		Spain
Credit Agricole SA		France
Danske Bank A/S		Denmark
Societe Generale SA		France

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