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Sovereign risk and financial risk☆

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ABSTRACT

In this paper, we study the interplay between sovereign risk and global financial risk. We show that a substantial portion of the comovement among sovereign spreads is accounted for by changes in global financial risk. We construct bond-level sovereign spreads for dollar-denominated bonds issued by over 50 countries from 1995 to 2020 and use various indicators to measure global financial risk. Through panel regressions and local projection analysis, we find that an increase in global financial risk causes a large and persistent widening of sovereign bond spreads. These effects are strongest when measuring global risk using the excess bond premium – a measure of the risk-bearing capacity of U.S. financial intermediaries. The spillover effects of global financial risk are more pronounced for speculative-grade sovereign bonds.

1. Introduction

In this paper, we study the interplay between sovereign risk and financial risk. In the increasingly interconnected world economy, global financial institutions play a more important role in underwriting sovereign bonds to meet the demands of borrowing countries. Therefore, the financial conditions or risk-bearing capacity of global financial institutions can be a major global financial risk factor that drives sovereign spreads. In this paper, we examine the spillover effect of global financial risk on sovereign risk and show that the conditions of global financial markets and country spreads are intricately related.

Empirically, we show that a substantial portion of the comovement among sovereign spreads can be accounted for by global financial risk factors. We use the following three measures of global financial risk: the “excess bond premium” (EBP) proposed by Gilchrist and Zakrajšek (2012), the “global financial cycle” (GFC) proposed by Miranda-Agrippino and Rey (2020), and the well-known VIX index. According to Gilchrist and Zakrajšek (2012), the EBP provides a quantitative measure of the risk-attitudes of financial intermediaries. The impact of the EBP on sovereign risk measures reflects the spillover from the U.S. banking

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sector onto the sovereign debt market. Miranda-Agrippino and Rey (2020) show that the GFC factor explains a significant portion of the variation in risky asset prices on a global scale, possibly reflecting aggregate uncertainty or risk aversion. The first two measures are both closely related to the third measure, or the VIX, which is another commonly used measure of global financial risk.

To measure sovereign risk, we use pricing information from the secondary markets for both sovereign bonds (cash) and derivatives, particularly credit default swaps (CDS). First, we examine to what extent movements in sovereign spreads in the secondary sovereign bond (cash) markets are determined by local risk factors, such as fluctuations in exchange rates and local stock market returns, versus global financial risk factors. Specifically, we use secondary-market prices of dollar-denominated sovereign bonds to construct yield spreads between sovereign bond yields and yields on the appropriately defined default risk-free securities, constructed using zero-coupon U.S. Treasury yields. We obtain security-level data on all relevant characteristics for virtually all sovereign bonds outstanding during the 1995–2020 sample period for a sample of over 50 countries. The micro-level aspect of our data set allows us to construct credit spreads at the issuance level for all bonds issued in U.S. dollars. Second, we also utilize the commonly used CDS sovereign spreads to study the impact of global financial risk on the sovereign derivative market. In addition, we calculate the CDS-bond basis and explore how much of the sovereign CDS-bond basis is explained by global financial risk factors.

To gauge the quantitative significance of the relationship between global financial risk and sovereign spreads, we estimate a panel regression that allows us to control directly for local risk factors. These estimation results imply strong linkages between global risk factors and sovereign spreads. This relationship is especially strong for speculative-grade bonds. Quantitatively, our estimation results indicate that spreads on investment-grade sovereign debt widen by 8 basis points in conjunction with a one-standard-deviation increase in the EBP and the VIX, and by 12 basis points in conjunction with the same increase in the GFC. The effects are much stronger for speculative-grade bond spreads that widen by 31, 71, and 38 basis points following a one-standard deviation increase in the EBP, the GFC, or the VIX, respectively. The large differences in the estimated EBP coefficients between investment- and speculative-grade countries are consistent with the notion that fluctuations in the risk-bearing capacity of financial intermediaries have a disproportionate effect on the prices of riskier assets. Sovereign bond spreads are also sensitive to local risk factors, such as, local stock market return volatility and exchange rate volatility.

The regression results described above do not disentangle the simultaneous effects of multiple sources of global risk on sovereign bond spreads. We therefore expand the panel data framework and use local projection analysis to examine the causal effect of increases in global financial risk on sovereign spreads.

The local projection estimates imply that a 25 basis point shock to the EBP leads to a 5 basis point rise in investment-grade sovereign spreads and a 15 basis point rise in speculative-grade spreads. These effects rise slowly over time and peak at the 12-month horizon and are therefore long-lasting. These estimates are also robust across identification procedures that place the EBP before or after the GFC and VIX in a causal identification scheme based on a Cholesky decomposition.

In contrast, the effect of an increase in global risk as measured by a shock to the GFC is highly transitory for both investment-grade and speculative-grade bonds. An increase in risk measured by the GFC also leads to a compression of sovereign spreads at longer horizons. This finding is consistent with the notion that increased risk taking today leads to reversals at future dates. Our results also suggest relatively weak responses of sovereign spreads to the VIX. All told, these results imply a special role for the health of U.S. financial intermediaries as measured by the EBP as a determining factor in pricing sovereign default risk.

In addition, we also allow for country heterogeneity in the impact of global financial risk on measures of sovereign risk. For both the panel regression and the local projection analysis, we allow for country-specific factor loading on the global factors. All of our empirical findings are robust to allowing for heterogeneous responses across countries. Moreover, the cross-country estimates confirm that the temporal dimension of responses to global financial factors is robust. The response of speculative-grade sovereign spreads to the GFC is estimated to be short-lived across the entire distribution of country-specific responses, whereas the response to the EBP is highly persistent and peaks in the 6- to 18-month horizon across the entire range of country-level estimates.

Our analysis of sovereign CDS spreads and the CDS-bond basis provides further confirmation of the robustness of our results. We again find significant but short-lived responses of sovereign CDS spreads for speculative-grade countries to global financial risk when measured using the GFC and long-lasting effects when measured using the EBP. Moreover, the estimated responses to the EBP are significantly larger than the responses to the GFC. We also use the CDS data to construct the CDS-bond basis – the difference between sovereign spreads in the CDS and cash markets. In normal times, this basis is relatively small, but in times of acute global financial distress it exhibits significant fluctuations. On average, our estimates imply significant comovement between the sovereign bond market and derivative markets, however, with a somewhat more elevated response of CDS spreads relative to cash market spreads for both the GFC and EBP at short horizons but no long-lasting differences. On the whole, these findings suggest that the same pricing concerns permeate both markets.

Lastly, motivated by the empirical evidence, we explore the theoretical linkages between the total intermediation capacity of the financial sector and sovereign bond risk premiums. For illustrative purposes, we adapt the setup of Shin (2012) to study sovereign debt pricing. In particular, we endogenize sovereign default and demonstrate how a more binding value-at-risk constraint reduces the risk capacity of financial intermediaries and subsequently increases sovereign risk and sovereign bond spreads. In particular, the global financial risk would arise from a reduced risk capacity of financial intermediaries or a higher level of aggregate uncertainty. In the presence of such global financial risk, banks are forced to deleverage and reduce their investment in sovereign bonds, which in turn increases financing costs for sovereign governments and results in increased sovereign risk and larger sovereign bond spreads. Our theoretical model captures this channel both theoretically and numerically.

Our paper is closely related to these strands of literature on sovereign default and global financial risk.[1] First, Borri and Verdelhan (2011) and Lizarazo (2009) introduce risk-averse lenders into the structural model of sovereign default to generate additional risk premia on sovereign debt beyond the default frequency. Bai et al. (2019) and Morelli et al. further study global risk and the financial capacity of international financial intermediaries as determinants of sovereign spread dynamics in quantitative models. Coimbra (2020) analyzes the dynamic link between banking sector capitalization and sovereign bond yields. Compared to these papers, we examine the impact of global financial risk on sovereign bond spreads using three broad measures of global financial conditions. Our results point out the importance of the global factors in general and, more specifically, the risk-bearing capacity of U.S. financial intermediaries for the pricing of sovereign bonds. In addition, our empirical findings regarding the long-lasting effects of global financial risk on sovereign risk provide a new and interesting direction for future theoretical studies.

Second, in terms of empirical research on the determinants of sovereign spreads, Uribe and Yue (2006), Akinci (2013), and Gilchrist et al. (2019) study the effect of global shocks, in particular U.S. interest rate and monetary shocks, on sovereign spreads. Longstaff et al. (2011) and Ang and Longstaff (2013) decompose the sovereign CDS spread into local and global components and show the importance of global components. In our paper, we explicitly measure global financial risk based on various indicators and study their impact on sovereign default risk beyond those coming from other global factors including U.S. monetary shocks. In addition, we examine the responsiveness of both sovereign bond spreads and CDS spreads to global financial factors. We find that global financial risk factors have broadly similar effects across the sovereign bond markets and the derivative markets. Further confirmation of these findings is documented in our analysis of the relationship between global risk factors and the CDS-bond basis.

Lastly, our paper is related to recent research that emphasizes the importance of a global financial cycle, such as Rey (2013) and Miranda-Agrippino and Rey (2020). In particular, Rey (2013) relates the VIX to the common factor in international asset prices as the VIX is arguably a measure of uncertainty and risk aversion in such markets. Miranda-Agrippino and Rey (2020) further estimate the global factor in risky asset prices, which we refer to as the global financial factor or GFC. In our paper, we employ both the VIX and the GFC as well as the excess bond premium constructed in Gilchrist and Zakrajšek (2012) using U.S. corporate bond spreads. This approach allows us to understand the extent to which shocks to these global factors transmit to the sovereign bond market. Our finding that documents an economically large and long-lasting effect of the excess bond premium on sovereign spreads vis-à-vis the more transitory response to the GFC constitutes a novel finding and suggests that the U.S. financial cycle is an important determinant of the global financial cycle.

In the remainder of the paper, we first describe the data used to measure sovereign spreads and global financial risk in Section 2. We then conduct the empirical analysis on the effect of global financial risk on sovereign spreads in Section 3. Finally, in Section 4 we interpret the empirical results using a simple two-period model with endogenous sovereign default and a financial intermediary subject to value-at-risk constraint. Section 5 offers concluding remarks.

2. Measuring sovereign risk and global risk

In our empirical analysis, we examine to what extent movements in sovereign risk measures are determined by global risk factors versus local risk factors (e.g., fluctuations in exchange rates and local stock market returns). In the first two subsections, we describe how we measure sovereign risk and global financial risk, respectively. In the following subsections, we then present an empirical analysis based on these measures.

2.1. Sovereign risk

To measure sovereign risk, we use pricing information from the secondary markets for sovereign bonds. Specifically, we construct sovereign bond spreads based on the security-level data obtained from Refinitiv Eikon for around 1800 dollar-denominated sovereign bonds issued by both advanced and emerging market economies over the past 25 years between 1995 and 2020.[2] The data contain all relevant characteristics for virtually all sovereign bonds outstanding during the sample period for a sample of 53 countries. For each issuance, our data include information on the secondary market price, coupon, maturity and par value, and the currency in which the bond is issued. We then construct for each individual bond issue a theoretical risk-free security that replicates exactly the promised cash flows of the corresponding sovereign debt claim. For example, consider a sovereign bond *j* issued

[1] A large literature studies endogenous sovereign default risk in a structural model, following the approach in Eaton and Gersovitz (1981), and Arellano (2008). Schmitt-Grohe and Uribe (2017) (chapter 13) and Wei and Yue (2019) provide an extensive literature review on the empirical and theoretical studies of sovereign default.

[2] The issuance and pricing of local-currency-denominated sovereign bonds are an increasingly important issue for the study of the sovereign debt market (see, for example, Du and Schreger (2016), Corradin and Rodriguez-Moreno (2016), John Caramichael and Liao (2021), and Du and Schreger (2021)). Global financial risk may potentially have an impact on the bonds denominated in local currency to a different degree, yet we do not explore that issue in this paper and leave it for future research.

Table 1
Summary statistics.

	Mean	Std. Dev.	Minimum	Median	Maximum
(a) *Sovereign bond market*					
No. of bonds per country/month	10.3	46	1	4	865
Par value ($ millions)	934.4	1096	<0.1	650.0	18,670
Time to maturity (years)	8.49	8.40	0.16	6.38	99.94
Yield to maturity (pct.)	3.78	3.02	0.09	3.06	23.52
Credit spread (bps.)	231	225	0.01	164	1998
(b) *Global financial risk factors*					
EBP (bps.)	2	60	−115	−14	325
GFC (std. deviations)	−0.33	0.88	−2.85	−0.25	2.69
VIX (pct.)	19.54	7.69	9.51	17.53	59.89

Note: Panel (a) reports summary statistics for the selected characteristics of our panel of dollar-denominated sovereign bonds, whereas panel (b) reports summary statistics for measures of global financial risk (see the text for details).

by country k that at time t is promising a sequence of cash flows $\{C(s) : s = 1, 2, \cdots, S\}$ consisting of the regular coupon payments and the repayment of the principal at maturity. In period t, the price of this bond is given by

$$P_{j,k,t} = \sum_{s=1}^{S} C(s) D(t_s),$$

where $D(t) = e^{-r_t t}$ is the discount function. To calculate the price of a corresponding risk-free security for dollar-denominated bonds, we discount the promised cash flow sequence $\{C(s) : s = 1, 2, \cdots, S\}$ using continuously compounded zero-coupon Treasury yields in period t, obtained from the daily estimates of the U.S. Treasury yield curve reported by Gürkaynak et al. (2007).

Table 1 summarizes the relevant features of our micro data set. Panel A of Table 1 provides summary statistics for our sovereign bond sample. The sample is at monthly frequency from January 1995 to October 2020 for around 1800 securities issued by 53 countries. We have close to 100,000 observations at a monthly frequency. For these bonds, in any given month, the median country in our sample has four bonds outstanding. This number varies between a minimum of 1 and and a maximum of 865 (Israel). The median and mean maturity are around 6 to 8 years with a large standard deviation. After dropping all bonds with spreads that exceed 2000 basis points, the average yield to maturity is 378 basis points. The average credit spread is 231 basis points, indicating that on average, most countries exhibit a premium relative to U.S. Treasury securities. In our sovereign bond analysis, we control for sovereign credit ratings. In our sample, close to 70% of the bonds have investment-grade ratings; the rest have speculative-grade bond ratings.

Because the number of bonds outstanding varies substantially from country to country, we also construct sovereign bond spreads at the country level using a weighted average of individual bond spreads. The weights in any period depend on the market value of each outstanding issuance relative to the total outstanding market value that is issued in a given currency.

Fig. 1 plots the dynamics of sovereign spreads. The top panel is for investment-grade bonds, and the bottom panel is for speculative-grade bonds. The solid blue lines depict the median credit spreads; the shaded bands denote the corresponding interquartile ranges, a measure of the variation in credit spreads across countries at a point in time. It displays the time-series behavior of the median value along with the interquartile range of the resulting dollar-denominated sovereign spreads constructed at the country level.

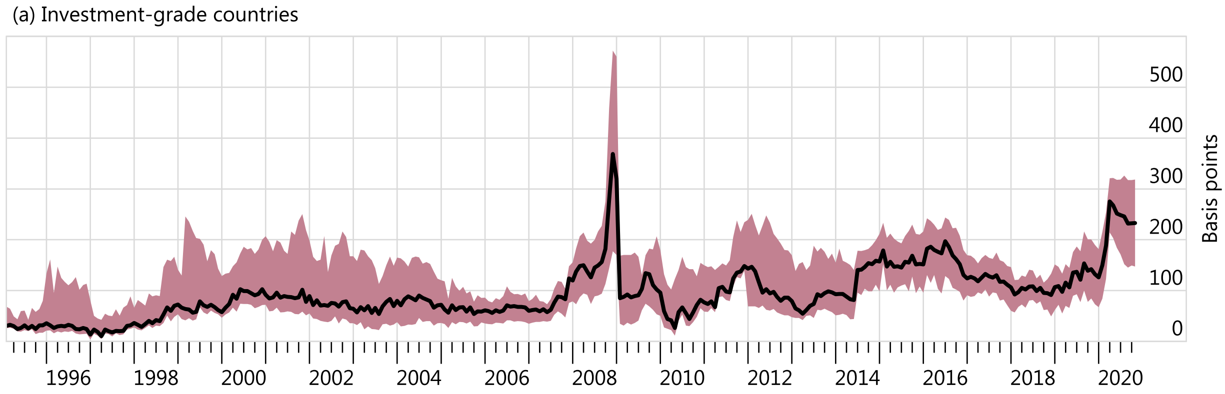
The width of the interquartile ranges reveals a large amount of variation in credit spreads across countries and suggests that country-specific factors are an important determinant of credit spreads. The figure captures well the historical episodes that led to disruptions in sovereign debt markets. Recurrent debt crises mostly happened in countries with speculative-grade ratings. There is a modest rise in the speculative-grade bond spread during the Asian financial crisis in 1997, followed by a more substantial increase during the Russian default crisis and the LTCM bankruptcy in 1998. The 2002 Argentine default drove up the median sovereign bond spreads. Sovereign spreads widened too in 2011 as the European debt crisis intensified.

At the same time, credit spreads also appear to have a substantial common or global component. Clearly, the 2008–2009 global financial crisis stands out as a period of extraordinary increases in sovereign credit spreads, particularly as it came after a period of remarkable compression. During the recent COVID-19 pandemic, sovereign spreads also surged to a relatively high level across all the countries including spreads for investment-grade bonds and speculative-grade bonds. Sovereign spreads remain at an elevated level at the end of our sample.

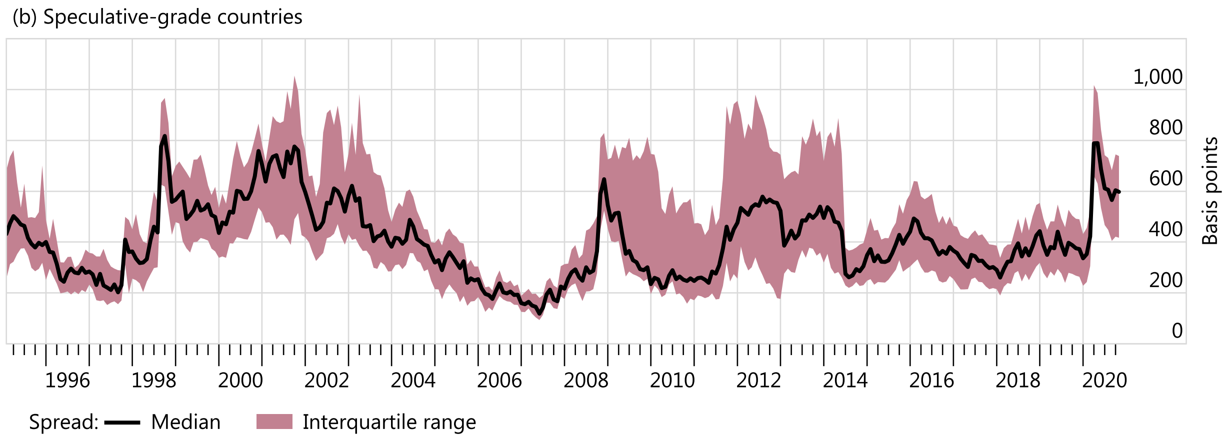
2.2. Global financial risk

The question we want to ask is whether global financial risk plays a role in driving common dynamics in sovereign spreads. To measure global financial risk, we consider the following three measures.

The first measure is the so-called excess bond premium (EBP) proposed by Gilchrist and Zakrajšek (2012) as the difference between the average U.S. corporate bond spread and the average expected default risk. As an indicator of financial distress



(a)



(b)

Fig. 1. Sovereign bond spreads. Note: Panel (a) depicts the time series of selected cross-sectional moments of credit spreads on dollar-denominated sovereign bonds at month-end for countries with an investment-grade credit rating, whereas panel (b) depicts the corresponding moments for countries with a speculative-grade credit rating.

based on spreads of corporate bonds issued by U.S. nonfinancial company, the EBP is used to proxy for the risk attitudes of financial intermediaries. As shown in Gilchrist and Zakrajšek (2012), the EBP comoves closely with the balance sheet conditions of the key financial intermediaries.[3] As such, it provides a useful summary measure of the effective risk-bearing capacity of the financial sector. In this paper, we follow Gilchrist and Zakrajšek (2012) to calculate the daily EBP and extend the coverage to October 2020.

The second measure is the global factor proposed in Miranda-Agrippino and Rey (2020) that characterizes the global financial cycle (GFC). Throughout this paper, we refer to this factor as the GFC factor. Miranda-Agrippino and Rey (2020) show that the GFC factor explains a significant portion of the variation in risky asset prices on a global scale. It is interpreted as an indicator of aggregate volatility or aggregate risk aversion in financial markets. The GFC factor in Miranda-Agrippino and Rey (2020) correlates positively with risky asset prices. To facilitate comparisons with other global factors, we use the negative of the factor in their paper as the GFC factor; that is, an increase in the GFC factor in this paper reflects an increase in aggregate uncertainty or risk aversion. The sample coverage of the GFC factor is up to December 2019.

Both measures are closely related to the VIX. Commonly known as the “fear gauge”, it is typically used as a measure of global financial risk. The VIX is a useful proxy for risk aversion and uncertainty (see, e.g., Rey, 2013).

Panel B of Table 1 presents the summary statistics for the three measures of global financial risk factors. All three measures exhibit a great degree of variability. Fig. 2 plots these three global financial risk factors between 1990 and 2020. The comovement between these factors is evident in the figure. In particular, the correlation is 0.43 between the EBP (solid blue line) and the GFC (dashed red line), 0.67 between the EBP and the VIX (dotted black line), and 0.27 between the GFC and the VIX. The figure also shows substantial countercyclical variation. Consider the EBP as an example. The EBP increased notably in early 2000 with the

[3] Gilchrist and Zakrajšek (2012) show that the excess bond premium comoves closely with conditions in financial markets, as measured by changes in lending standards from the Senior Loan Officer Survey conducted by the Board of Governors, the rate of return on assets in the banking sector, and over the recent time period, perceived default risk in the financial sector as measured by CDS rates for large financial institutions that serve as broker-dealers.

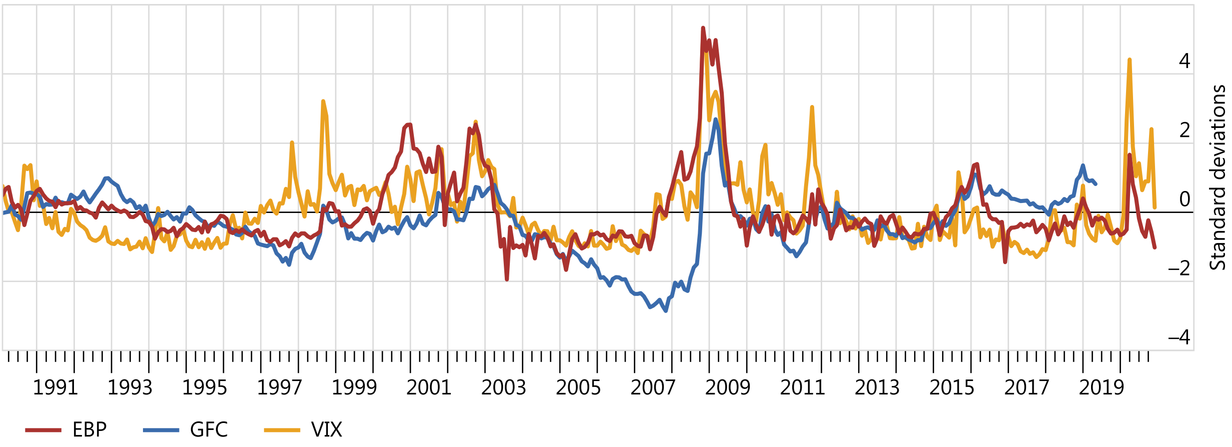


Fig. 2. Global financial risk factors. Note: The lines in the figure depict the time series of global financial risk factors at month-end: EBP = excess bond premium; GFC = global financial cycle; and VIX = option-implied volatility on the S&P 500 stock price index. All series have been standardized.

bursting of the tech bubble, remained relatively low during the 2003–2007 period, which is perceived to be an episode in which banks were willing to take on substantial risk, and began to rise again as U.S. housing price growth fell during the beginning of 2007. The excess bond premium reached an all-time high of 300 basis points following the collapse of Lehman Brothers during the U.S. financial crisis. More recently, the EBP has fluctuated in a relatively narrow range, though it increased somewhat in 2015 as the Federal Reserve lifted interest rates from zero and again in 2020 during the COVID-19 pandemic. Overall, movements in the EBP correlate well not only with relevant historical episodes but also with other proxies, such as the VIX and GFC.

In the subsequent empirical analysis, we use all three measures (EBP, GFC, and VIX) to proxy for global financial risk. The results regarding the EBP are particularly interesting because its calculation does not use any global asset market prices. Our empirical analysis thus sheds light on the magnitude of the spillover from the U.S. financial intermediaries onto spreads of sovereign bonds and CDS.

3. Empirical results

In this section, we present our empirical findings from the sovereign bond and CDS markets. We find strong empirical evidence that global financial risk factors drive the comovement among sovereign spreads, especially in the speculative-grade segment of the market. We begin this analysis by documenting the contemporaneous relationship among sovereign spreads and both global and local financial conditions. We then consider longer horizon regressions that allow us to examine the extent to which global financial conditions have a persistent effect in these markets. This analysis also includes a local projection that traces out the response of sovereign spreads to identified shocks to global factors. We end with a discussion of the sovereign CDS data and the implications for the CDS basis.

3.1. Empirical evidence from the sovereign bond markets

First, we examine to what extent movements in sovereign spreads in the secondary sovereign bond (cash) markets are determined by local risk factors, such as fluctuations in exchange rates and local stock market returns, versus global financial risk factors.

We use secondary-market prices of dollar-denominated sovereign debt securities to construct yield spreads between sovereign bond yields and yields on the appropriately defined default risk-free securities, constructed using zero-coupon U.S. Treasury yields. We next estimate a panel regression to gauge the quantitative significance of the EBP in determining those spreads. We consider regressions of the form

$$s_{j,k,t} = \beta' \mathbf{g}_t + \gamma' \mathbf{z}_{k,t} + \theta' \mathbf{x}_{j,k,t} + \eta_k + \varepsilon_{j,k,t} \tag{1}$$

where $s_{j,k,t}$ is the sovereign spread for bond j issued by country k at time t. The control variables include global factors $\mathbf{g}_t$ that are the real yield on the U.S. 2-year bond ("RR"), the slope of the U.S. yield curve ("TS," defined as the difference between 10- and 2-year Treasury yields), the S&P 500 return ("SP500"), the EBP, the GFC, and the VIX. The country-specific factors $\mathbf{z}_{k,t}$ contains country-specific information that includes idiosyncratic stock returns, defined as the part of a country's 3-month stock returns not correlated with the world stock return, the 3-month change in exchange rates in excess of changes in the broad nominal dollar or euro, and the country-specific stock market and FX volatility measures described above. The regressions also control for country fixed effects η_k. Finally, $\mathbf{x}_{j,k,t}$ contains bond-specific information such as duration, coupon, and par value for bond j of country k at time t. We allow

Table 2
Global financial risk factors and sovereign bond spreads (baseline panel specification).

	Investment-grade countries				Speculative-grade countries			
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBP_t	0.13***	.	.	0.07	0.52***	.	.	0.11
	(0.05)			(0.05)	(0.11)			(0.14)
GFC_t	.	0.14***	.	0.12***	.	0.81***	.	0.83***
		(0.03)		(0.04)		(0.09)		(0.09)
VIX_t	.	.	0.01***	−0.00	.	.	0.05***	−0.02
			(0.00)	(0.00)			(0.01)	(0.01)
$RealT02y_t$	−0.16***	−0.13***	−0.16***	−0.14***	0.47***	0.59***	0.45***	0.60***
	(0.04)	(0.05)	(0.04)	(0.04)	(0.14)	(0.12)	(0.13)	(0.12)
$TermSpr_t$	−0.04	−0.03	−0.06	−0.04	0.78***	0.63***	0.67***	0.67***
	(0.05)	(0.05)	(0.04)	(0.05)	(0.20)	(0.18)	(0.19)	(0.18)
$RetS\&P500_t$	−0.02	−0.01	0.33	0.08	−0.77	−1.26	0.58	−1.97
	(0.33)	(0.33)	(0.36)	(0.33)	(1.45)	(1.47)	(1.52)	(1.59)
$RetStk_{k,t}^{3m}$	−0.01	−0.13	−0.08	−0.09	−0.57	−0.93***	−0.63*	−0.96***
	(0.14)	(0.14)	(0.14)	(0.14)	(0.37)	(0.35)	(0.36)	(0.35)
$VolRetStk_{k,t}^{3m}$	41.56***	42.68***	41.98***	39.92***	44.43***	41.32**	41.40***	44.92***
	(6.22)	(5.24)	(6.12)	(6.39)	(15.68)	(16.15)	(15.29)	(15.86)
$RetFX_{k,t}^{3m}$	1.91***	1.84***	1.80***	1.89***	2.00***	1.82***	1.97***	1.79***
	(0.27)	(0.26)	(0.28)	(0.27)	(0.70)	(0.64)	(0.67)	(0.64)
$VolRetFX_{k,t}^{3m}$	35.52***	31.62***	38.28***	29.09***	27.16**	23.65**	32.65***	22.69**
	(8.44)	(9.01)	(8.21)	(8.76)	(11.17)	(11.15)	(11.05)	(11.40)
R^2	0.73	0.73	0.72	0.73	0.65	0.69	0.65	0.69
Observations	65,116	65,116	65,116	65,116	21,605	21,605	21,605	21,605

Note: The dependent variable in all specifications is $s_{j,k,t}$, the credit spread on sovereign bond j (issued by country k) at the end of month t (in basis points). The entries in the table denote the OLS estimates of coefficients associated with the specified explanatory variable. In addition to the global financial risk factors, EBP_t, GFC_t, and VIX_t, these include *(i)* standard global risk factors: $RealT02y_t$ = real 2-year U.S. Treasury yield; $TermSpr_t$ = 10y/2y U.S. Treasury term spread; RetS \$ $P500_t$ = monthly return on the S&P 500 stock price index; and *(ii)* country-specific (i.e., local) risk factors: $RetStk_{k,t}^{3m}$ = 3-month return on the stock index of country k; $VolRetStk_{k,t}^{3m}$ = realized volatility of daily stock returns of country k from month $t-2$ to month t; $RetFX_{k,t}^{3m}$ = 3-month foreign currency return of country k; and $VolRetFX_{k,t}^{3m}$ = realized volatility of daily foreign exchange returns of country k from month $t-2$ to month t. All specifications include country fixed effects and a set of bond-specific controls (not reported). Asymptotic standard errors reported in parentheses are clustered across countries and time: $^{*}p < .10$; $^{**}p < .05$; and $^{***}p < .01$.

the response of sovereign bonds to local risk factors and global risk factors to vary depending on whether a country's debt is investment grade (rating Baa or above) or speculative grade (below Baa rating).

Table 2 presents the regression results for sovereign bond spreads for investment-grade bonds (see Columns 1–4) and for speculative-grade bonds (see Columns 5–8). Each global financial risk measure, when included individually in the regressions, is a significant determinant of sovereign bond spreads. For example, a one-standard-deviation increase in the EBP implies an increase of about an 8 (or 31) basis point widening of spreads on investment-grade (or speculative-grade) bonds. Similarly, a one-standard-deviation increase in the GFC implies an increase of a 12 (or 71) basis point widening of spreads on investment-grade (or speculative-grade) bonds. The impact of the VIX is similar to that of the EBP in terms of economic magnitude. The large differences in the estimated coefficients for the global financial risk measures between investment- and speculative-grade countries are consistent with the notion that fluctuations in the risk-bearing capacity of financial intermediaries or aggregate uncertainty or risk aversion all have a disproportionate effect on prices of riskier assets. Only the GFC remains significant in the contemporaneous regressions for sovereign bond spreads.

In addition, we find that sovereign bond spreads are also sensitive to the U.S. real interest rate. The sovereign bond spreads for countries with speculative-grade debt are also sensitive to the slope of the U.S. Treasury yield curve. Moreover, local risk factors such as the local stock return and foreign exchange volatility are significant determinants of sovereign bond spreads.

The regression results in Table 2 show the contemporaneous effects of global factors on sovereign bond spreads. How persistent are such effects? We address this question by running regressions similar to Eq. (1), except that the explanatory variables are lagged by a certain number of months. Table 3 reports the results of those regressions with the lag ranging from 1 month up to 18 months for both investment-grade and speculative-grade bonds (see Panel A and Panel B, respectively).

The results in Table 3 show that the global factors' effects are indeed persistent. It shows that the effect of the EBP increases with the horizon and starts to be significant at the 3-month horizon for investment-grade bonds or the 2-month horizon for speculative-grade bonds. A one-standard-deviation increase in the EBP six months ago increases investment-grade (or speculative-grade) bond spreads today by around 18 (or 38) basis points.

In contrast, the GFC's impact on investment-grade bonds is rather transitory: its impact becomes insignificant after a one-month lag. The GFC's impact on speculative-grade bonds is more persistent but dies out after six months or longer. In addition,

Table 3

Persistent effects of global financial risk factors on sovereign bond spreads (homogeneous global risk factor loadings).

	Global financial risk factor at lag p (in months)								
	$p = 1$	$p = 2$	$p = 3$	$p = 4$	$p = 5$	$p = 6$	$p = 9$	$p = 12$	$p = 18$
(a) *Investment-grade countries*									
EBP$_{t-p}$	0.06	0.11	0.15*	0.23***	0.26***	0.30***	0.23***	0.26***	−0.05
	(0.06)	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.06)	(0.07)
GFC$_{t-p}$	0.07*	0.01	−0.05	−0.10**	−0.14***	−0.18***	−0.27***	−0.28***	−0.18***
	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)
VIX$_{t-p}$	0.00	0.00	−0.00	−0.00	−0.01	−0.01	0.01	0.01	0.03*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(b) *Speculative-grade countries*									
EBP$_{t-p}$	0.22	0.41**	0.47***	0.53***	0.56***	0.64***	0.61***	0.61***	0.28*
	(0.15)	(0.16)	(0.17)	(0.17)	(0.16)	(0.16)	(0.18)	(0.16)	(0.16)
GFC$_{t-p}$	0.72***	0.57***	0.46***	0.33***	0.24**	0.16	−0.02	−0.18	−0.41***
	(0.09)	(0.10)	(0.11)	(0.11)	(0.11)	(0.12)	(0.12)	(0.13)	(0.10
VIX$_{t-p}$	−0.03*	−0.04**	−0.04**	−0.04**	−0.04**	−0.04**t	−0.02	−0.01	0.05***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)

Note: The dependent variable in all specifications is $s_{j,k,t}$, the credit spread on sovereign bond j (issued by country$k$) at the end of month$t$ (in basis points). The entries in the table denote the OLS estimates of coefficients associated with the specified global financial risk factor at month$t-p$, $p = 1, 2, 3, 4, 5, 6, 9, 12, 18$. In addition to the specified global financial risk factor, each specification includes country fixed effects, standard global risk factors, country-specific risk factors, and a set of bond-specific controls (see the text for details). Coefficients on the global risk factors are restricted to be the same across countries. Asymptotic standard errors reported in parentheses are clustered across countries and time: $^*p < .10$; $^{**}p < .05$; and $^{***}p < .01$.

the effects of VIX are more transient. For example, they are insignificant for investment-grade bonds and even carry a wrong, negative, sign for speculative-grade bonds. Their magnitude is small too.

Lastly, we allow for the regression coefficients on all the global factors to be country-specific. Table 4 reports the average coefficients on the three global financial risk factors in the regressions with the explanatory variables lagged by 1 month to 18 months. Panel A reports the average loading for all the countries in the sample. We find that the EBP has a persistent and significant impact on sovereign spreads even when we allow for country heterogeneity. Yet, the GFC and the VIX do not significantly increase the sovereign spreads for a typical country in this case. Panel B shows the average loading for countries with investment grade ratings. The comparison to Table 3 is similar. Panel C is for the speculative-grade countries. Our main empirical finding

Table 4

Persistent effects of global financial risk factors on sovereign bond spreads (heterogeneous global risk factor loadings).

	Global financial risk factor at lag p (in months)								
	$p = 1$	$p = 2$	$p = 3$	$p = 4$	$p = 5$	$p = 6$	$p = 9$	$p = 12$	$p = 18$
(a) *All countries*									
EBP$_{t-p}$	0.44***	0.50***	0.41***	0.57***	0.53***	0.44***	0.36***	0.68***	−0.04
	(0.12)	(0.11)	(0.11)	(0.11)	(0.12)	(0.14)	(0.13)	(0.18)	(0.14)
GFC$_{t-p}$	0.08	0.04	−0.11*	−0.17**	−0.24***	−0.38***	−0.76***	−0.50***	−0.32***
	(0.06)	(0.07)	(0.06)	(0.08)	(0.08)	(0.09)	(0.10)	(0.18)	(0.12)
VIX$_{t-p}$	0.00	0.01	0.00	0.00	−0.00	−0.01	0.01	0.01	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(b) *Investment-grade countries*									
EBP$_{t-p}$	0.33*	0.41***	0.19	0.38***	0.30**	0.07	−0.05	0.79***	−0.03
	(0.18)	(0.15)	(0.14)	(0.14)	(0.14)	(0.20)	(0.19)	(0.24)	(0.19)
GFC$_{t-p}$	−0.27***	−0.22**	−0.35***	−0.32***	−0.35***	−0.50***	−0.91***	−0.52*	−0.43**
	(0.08)	(0.10)	(0.09)	(0.13)	(0.11)	(0.15)	(0.15)	(0.28)	(0.20)
VIX$_{t-p}$	0.01	0.01	0.00	−0.00	−0.01	−0.02	−0.00	0.02	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
(c) *Speculative-grade countries*									
EBP$_{t-p}$	0.55***	0.60***	0.64***	0.77***	0.77***	0.83***	0.78***	0.57***	−0.05
	(0.13)	(0.12)	(0.13)	(0.14)	(0.15)	(0.15)	(0.15)	(0.20)	(0.19)
GFC$_{t-p}$	0.44***	0.30***	0.15*	−0.02	−0.13	−0.24***	−0.60***	−0.49***	−0.22*
	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.10)	(0.18)	(0.13)
GFC$_{t-p}$	0.00	0.00	0.00	0.00	0.01	0.00	0.03	−0.00	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)

Note: The dependent variable in all specifications is $s_{j,k,t}$, the credit spread on sovereign bond j (issued by country k) at the end of month t (in basis points). The entries in the table denote the average of OLS estimates of country-specific coefficients associated with the specified global financial risk factor at month $t-p$, $p = 1, 2, 3, 4, 5, 6, 9, 12, 18$. In addition to the specified global financial risk factor, each specification includes country fixed effects, standard global risk factors, country-specific factors, and a set of bond-specific controls (see the text for details). Coefficients on the global risk factors are allowed to vary across countries. Asymptotic standard errors reported in parentheses are clustered across countries and time: $^*p < .10$; $^{**}p < .05$; and $^{***}p < .01$.

largely holds. In particular, the average regression coefficients for the EBP and GFC are slightly larger than those in Table 3. The EBP has a bigger and more persistent impact on sovereign bond spreads. Yet, the average loading of the speculative-grade bonds on the GFC is significant and positive over a shorter horizon.

3.2. The effect of financial conditions on sovereign bond spreads

The previous analysis highlights the empirical linkages between financial conditions in U.S. bond markets as measured by the excess bond premium and global financial conditions as measured by the GFC and sovereign spreads. We now consider the causal linkages between these variables using a local projection regression analysis.

Formally, we consider regressions of the form

$$\begin{aligned} s_{j,k,t+h} &= \sum_{p=1}^{P} \rho_{h,p} s_{j,k,t-p} + \sum_{p=1}^{P} \beta'_{h,p} \mathbf{g}_{t-p} + \sum_{p=0}^{P} \gamma'_{h,p} \tilde{\mathbf{z}}_{k,t-p} + \theta'_h \mathbf{x}_{j,k,t} \\ &+ \phi'_{k,h} \tilde{\mathbf{g}}_t + \eta_{h,k} + \varepsilon_{j,k,t+h} \end{aligned} \tag{2}$$

where $s_{j,k,t+h}$ is the spread on sovereign bond j for country k at time $t+h$. Here, $\mathbf{g}_t$ is the vector of the global factors included in regression Eq. (1) (the real yield on the U.S. 2-year bond "RR", the slope of the U.S. yield curve "TS,", the S&P 500 return "SP500", the EBP, the GFC, and the VIX).

We identify a shock to the global financial risk factors by constructing orthogonalized residuals for the contemporaneous information contained in this regression. Specifically $\tilde{\mathbf{g}}_t$ are constructed as the orthogonalized residuals obtained from a regression of $\mathbf{g}_t$ on six lags of $\mathbf{g}_t$. When constructing these residuals, we use a Cholesky decomposition that orders the variables as they are listed above. This implies that the EBP is ordered after all other variables in $\mathbf{g}_t$ except the GFC. We also normalize each element of $\tilde{\mathbf{g}}_t$ by its standard deviation. The coefficient vector $\phi_{k,h}$ is then understood as the estimated impulse response of the sovereign spread $s_{j,k,t+h}$ at horizon h to a one-standard-deviation shock that is identified using the relevant ordering. For the sake of comparison, we also consider an alternative ordering where the EBP is ordered last, that is, after the GFC.

When estimating the local projection, we include a vector of country-specific variables $\mathbf{z}_{k,t}$ along with bond-specific controls $\mathbf{x}_{j,k,t}$. Although not necessary for identification, these variables absorb residual variance and hence increase the precision of the estimates of $\phi_{k,h}$. We consider the information in $\mathbf{z}_{k,t}$ as the component that is orthogonal to information contained in $\mathbf{g}_t$. That is, $\tilde{\mathbf{z}}_{k,t}$ is the vector of residuals obtained from a regression of $\mathbf{z}_{k,t}$ on current and p lagged values of $\mathbf{g}_t$ along with p lagged values of $\mathbf{z}_{k,t}$. This ensures that the inclusion of local information does not alter the identification scheme imposed on the aggregate variables contained in $\mathbf{g}_t$.

The regressions are estimated for horizons that range from 1 month to 24 months. We set $p=6$ so that we are using contemporaneous data along with six months of lagged information to estimate the local projection. All regressions are estimated using the par value of the individual bond as a weight. Standard errors are obtained using a two-way clustering over countries and dates. This allows for an arbitrary correlation among bonds within a country and corrects for the serial correlation in the error structure that is induced by the overlapping data employed in an h horizon regression. We estimate separate regressions for investment-grade and speculative-grade sovereign spreads. This allows us to compute separate impulse responses for each class of bonds.

Fig. 3 reports the results of this estimation. Each panel plots the estimated impulse response along with the 90% confidence bands for the case in which the EBP is ordered before the GFC (denoted Order 1 in the figure). The upper panels report the response of investment-grade and speculative-grade sovereign bond spreads to a one-standard-deviation innovation in the excess bond premium (roughly 25 basis points). For comparison purposes, the lower panels report the response of these spreads to a one-standard-deviation shock to the GFC.

Consistent with the regression results described above, a shock to the excess bond premium has little effect upon impact but has an economically large effect as the horizon grows. The peak response occurs at the 12-month horizon for both investment-grade and speculative-grade bonds. The peak response for investment grade bonds is on the order of 5 basis points, whereas the peak response for speculative-grade bonds is on the order of 15 basis points. These responses are quite similar in magnitude to the responses of U.S. corporate bond spreads to the EBP documented in earlier research. These responses are also estimated to be statistically significant effects at this horizon. The effects subside over time and are indistinguishable from zero after 24 months.

Again consistent with the regression results described above, a shock to the GFC has an economically large and statistically significant effect on sovereign bonds in the near term. The peak response occurs within the first three months and is similar in magnitude to the peak response obtained from the EBP. The estimated effects are zero at the 6-month horizon and exhibit a reversal beyond that. This reversal is quantitatively large and, in the case of investment-grade bonds, statistically significant over the 15- to 24-month horizon. This implies that a *loosening* of global financial conditions provides a temporary boost to sovereign bond markets that is then met by higher sovereign bond spreads in the future. This contrasts with the estimated effect of the EBP, which shows no evidence of a reversal.

For comparison purposes, Fig. 3 also reports these impulse responses for the case in which the EBP is ordered after the GFC. That is, EBP shocks are assumed to have no contemporaneous effect on global financial conditions as measured by the GFC. The estimated impulse responses correspond to the green lines designated as "Order 2." This reversal of the ordering has virtually no

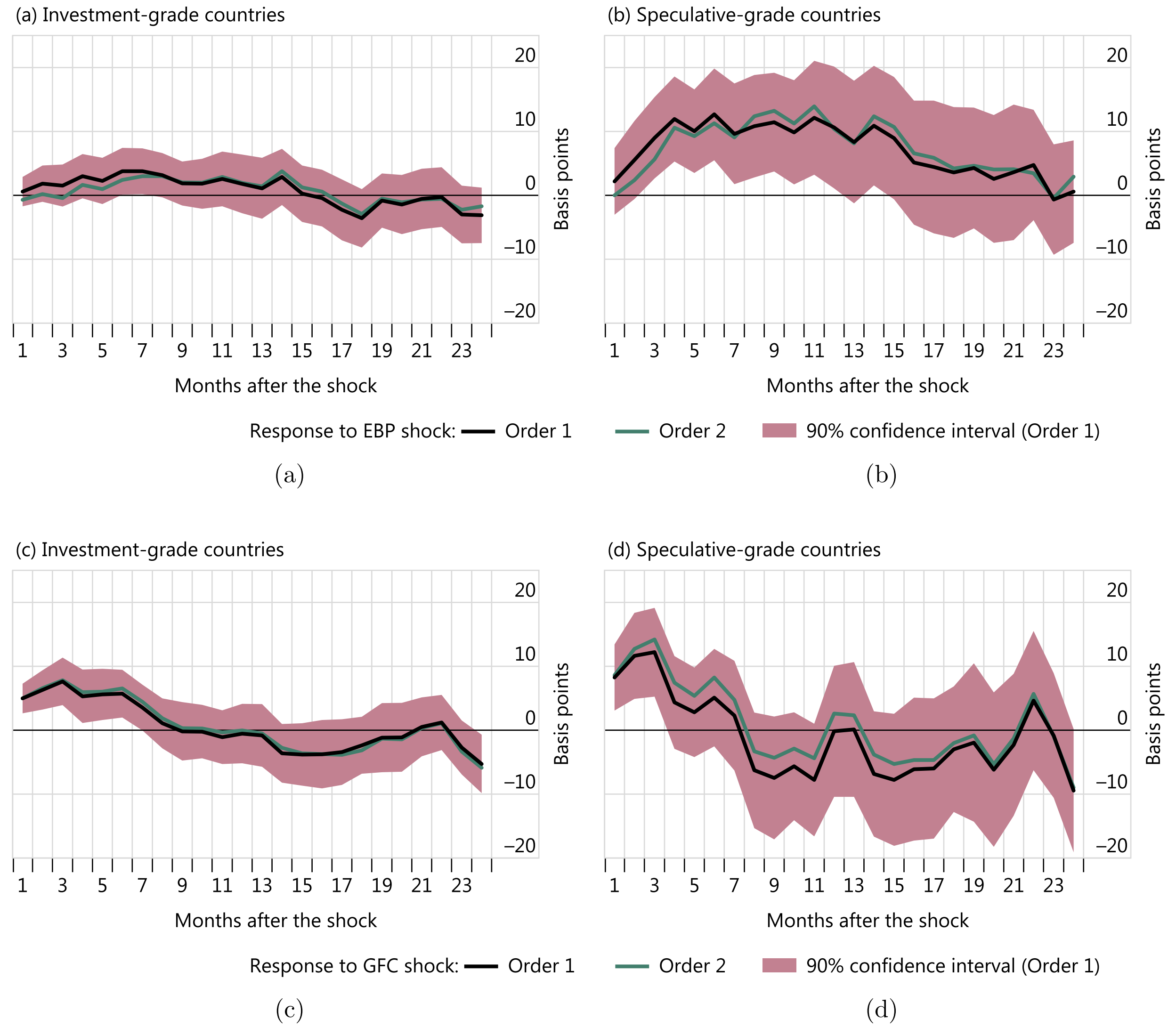


Fig. 3. The impact of a global financial risk shocks on sovereign bond spreads (L-P impulse responses with homogeneous global risk factor loadings). Note: Panels (a) and (b) depict responses of sovereign bond spreads to an orthogonalized shock of one standard deviation to the EBP, whereas panels (c) and (d) depict responses of sovereign spreads to an orthogonalized shock of one standard deviation to the GFC. In all specifications, the coefficients on global risk factors are assumed to be the same across countries. The responses of spreads labeled Order 1 (black lines) correspond to a recursive ordering of global risk factors in which the EBP is ordered before the GFC; the responses of spreads labeled Order 2 (green lines) correspond to a recursive ordering of global risk factors in which the GFC is ordered before the EBP. Shaded bands denote the 90% confidence intervals—associated with Order 1 identification scheme—based on the covariance matrix of parameters clustered across countries and time (see the text for details).

impact on the estimated responses and thus highlights the robustness of the finding that the fluctuations in U.S. financial markets that are specific to the excess bond premium cause a significant deterioration in the sovereign bond market, as measured by widening bond spreads at the 6- to 18-month horizon.

Although not shown here, we have also estimated the response of sovereign spreads to the VIX. In contrast to the EBP, we find no significant effect of an identified shock to the VIX on sovereign spreads, even though the VIX is ordered before the EBP in our local projection framework. These results suggest that the excess bond premium plays a special role in determining risk premia in the sovereign bond market, and this finding is consistent with the notion that the risk-bearing capacity of global financial intermediaries that determine outcomes in U.S. corporate bond markets strongly influences outcomes in the sovereign bond market as well.

As a robustness exercise, we also consider a local projection that allows the response coefficients to the three global factors—VIX, EBP, and GFC—to be country-specific. This is the local projection equivalent to the heterogeneous regression framework adopted in Table 4. This analysis also allows us to consider individual country responses. We first sort countries by their average credit rating in the sample and then classify a country as either speculative grade or investment grade. We then reestimate Eq. (2) for each group of countries separately, allowing for country-specific responses to the three global factors contained in $\tilde{x}_t$. We also

Fig. 4. The impact of a global financial risk shocks on sovereign bond spreads (L-P impulse responses with heterogeneous global risk factor loadings). Note: Panels (a) and (b) depict, at each horizon, the average response of sovereign bond spreads to an orthogonalized shock of one standard deviation to the EBP, whereas panels (c) and(d) depict, at each horizon, the average response of sovereign spreads to an orthogonalized shock of one standard deviation to the GFC. In all specifications, the coefficients on global risk factors are allowed to vary across countries. The orthogonalization of global financial risk shocks is based on the recursive ordering of global risk factors in which the EBP is ordered before the GFC (Order 1). Shaded bands in each panel denote the corresponding 90% confidence intervals based on the covariance matrix of parameters clustered across countries and time (see the text for details).

include three lags of the global factors $\tilde{x}_t$ with country-specific coefficients. To avoid a proliferation in parameters, the other controls are specified as before and maintain constant coefficients across countries. Again, the use of additional controls in the local projection increases precision but does not alter our underlying identification scheme that extracts identified shocks from the macro variables contained in x_t.

Estimating country-specific responses over 24 months requires a sufficient number of observations for each country. Thus, to conduct this exercise, we have 22 speculative-grade and 20 investment-grade countries in our sample rather than 24 and 29, respectively, when estimating with all available countries.

Fig. 4 displays the country-average impulse response to both the EBP and the GFC for the investment-grade and speculative-grade groupings of countries. These responses are strikingly similar to those reported in Fig. 3, which restricts the response coefficients to be equal across countries within a given rating category. Again, we see essentially no response of sovereign spreads to either the EBP or the GFC for countries with investment-grade ratings. In contrast, we again see an economically large and protracted response of sovereign spreads to the EBP for countries with speculative-grade ratings. We also see a short-lived response of credit spreads to the GFC for speculative-grade countries, followed by signs of reversal.

We now consider the country-specific responses for the six countries with the largest presence within each grouping during our sample period (defined in terms of the par value of dollar-denominated bonds outstanding for all countries with at least 15 years of data). These six countries account for roughly 60% of the dollar-denominated bonds outstanding in our sample. Fig. 5 displays results for the countries with a speculative-grade ranking. These impulse responses are remarkably uniform across countries. Again, we observe a hump-shaped response to the EBP across all six countries and a relatively short-lived positive response followed by a reversal in response to the GFC. The main difference between these results and the average response shown in Fig. 4 is that the magnitude of the sovereign spread response to the EBP is somewhat muted in these countries relative to the average. This finding is consistent with this set of countries being less risky than the average speculative-grade country and hence able to maintain a large presence in the dollar-denominated sovereign bond market.

Fig. 6 displays the same impulses responses for the six investment-grade countries with the largest presence in the dollar-denominated sovereign bond market. Consistent with the average country response reported in Fig. 4, we observe almost no response of sovereign spreads to either the EBP or the GFC across this group of countries.

Table 5 summarizes the distribution of estimated impulse responses obtained from the heterogeneous local projection estimates. For each country, we first compute the average response over a specific 6-month horizon. Each row then reports the distribution of this average response for countries sorted by rating category. The interquartile range of responses across countries is relatively tight. These estimates provide further confirmation that the distribution of responses to both the EBP and GFC is centered around zero across nearly all horizons for countries listed as investment grade. These estimates also confirm that the peak response to the GFC for countries listed as speculative grade occurs in the first six months across the entire distribution. In contrast, across the entire distribution, the peak response to the EBP is delayed and occurs at either the 7- to 12-month, or 13- to 18-month horizon for these speculative-grade countries.

In summary, local projection estimates imply that speculative-grade sovereign bonds increase significantly in response to a deterioration in global financial conditions, as measured by both the GFC and the EBP. In contrast, we find very little response of sovereign spreads to global financial conditions for investment-grade bonds. Importantly, the effect of the GFC on speculative-grade bonds peaks early and dies out within 6 months. In contrast, the effect of the EBP is both larger in magnitude and peaks at a horizon that is closer to 12 months and only subsides after 2 years. These results provide further evidence in support of the notion that financial distress in the U.S. financial sector as measured by the EBP has economically large and persistent spillovers into the riskier, speculative-grade segment of the dollar-denominated sovereign bond market.

3.3. Further evidence from the sovereign CDS market

Besides sovereign bond spreads, sovereign CDS premiums are another important measure of sovereign risk (see, e.g., Longstaff et al., 2011). It is therefore interesting to examine the impact of global financial risk factors on sovereign CDS premiums. Differential movements between the CDS premiums and the sovereign spreads also provide information about liquidity concerns as well as funding strains in the cash market relative to the derivatives market. We therefore also consider the relationship between the global financial risk factors and the CDS basis – the difference between sovereign CDS premiums and spreads on sovereign bonds of matched duration.

We begin with an analysis of the relationship between global financial risk and sovereign CDS premiums. In particular, we estimate Eq. (1) for sovereign CDS premiums instead of sovereign bond spreads. Similar as before, in the contemporaneous regression analysis, we find that a one-standard-deviation increase in the EBP (respectively, GFC and VIX) is associated with an increase in the CDS premium of 11.8 (respectively, 10.7 and 13.4) basis points for investment-grade countries.[4]

To further understand the temporal pattern of the linkages between the global financial risk factors and sovereign risk, we estimate regressions similar to (3) in which we use lagged values for all explanatory variables, including the global financial risk factors. The results are reported in Table 6. As shown Panel A of the table, for investment-grade countries, these global financial risk factors have few temporal effects on the CDS premiums. In contrast, from Panel B of the table, we can see that for speculative-grade countries, the coefficient on the GFC is significant at the 1- and 2-month horizons, whereas the EBP becomes significant at a longer horizon (e.g., 4 to 6 months). In contrast, the effect of VIX is largely insignificant in the presence of these two global factorsthese global financial risk factors hav.

It is worth noting that the coefficient estimates reported for the CDS spreads in Table 6 are much larger in absolute value than those reported for the sovereign spreads in Table 3. These estimates are not directly comparable, however, as the data that are available in terms of both sample period and country coverage differ significantly across these two tables. As we discuss below, studying the CDS basis imposes a common sample and allows for a more direct comparison.

The CDS-bond basis is defined as the difference between sovereign CDS premiums and sovereign bond spreads for CDS contracts and bonds that are matched in duration. To construct the basis, we obtain interpolated CDS premiums using the sovereign CDS data from Markit. For each bond in each period, we then subtract the bond's spread from the duration-matched CDS premium following the methodology in Oehmke and Zawadowski (2015) and Kim et al. (2016).

Fig. 7 plots the median CDS-bond basis as well as the interquartile ranges depicted by the shaded band between January 2003 and October 2020 for both investment-grade countries (Panel A) and speculative-grade countries (Panel B). As shown in the figure, the basis is typically small and close to zero in normal times, indicating similarity in the dynamics of CDS premiums and sovereign bond spreads. However, it exhibits dramatic fluctuations in times of distress. For example, the CDS-bond basis for speculative-grade countries dropped to a historically low level of -203 basis points in November 2008 at the height of the global

[4] Due to space constraints, the regression results are not reported in the text but are available upon request.

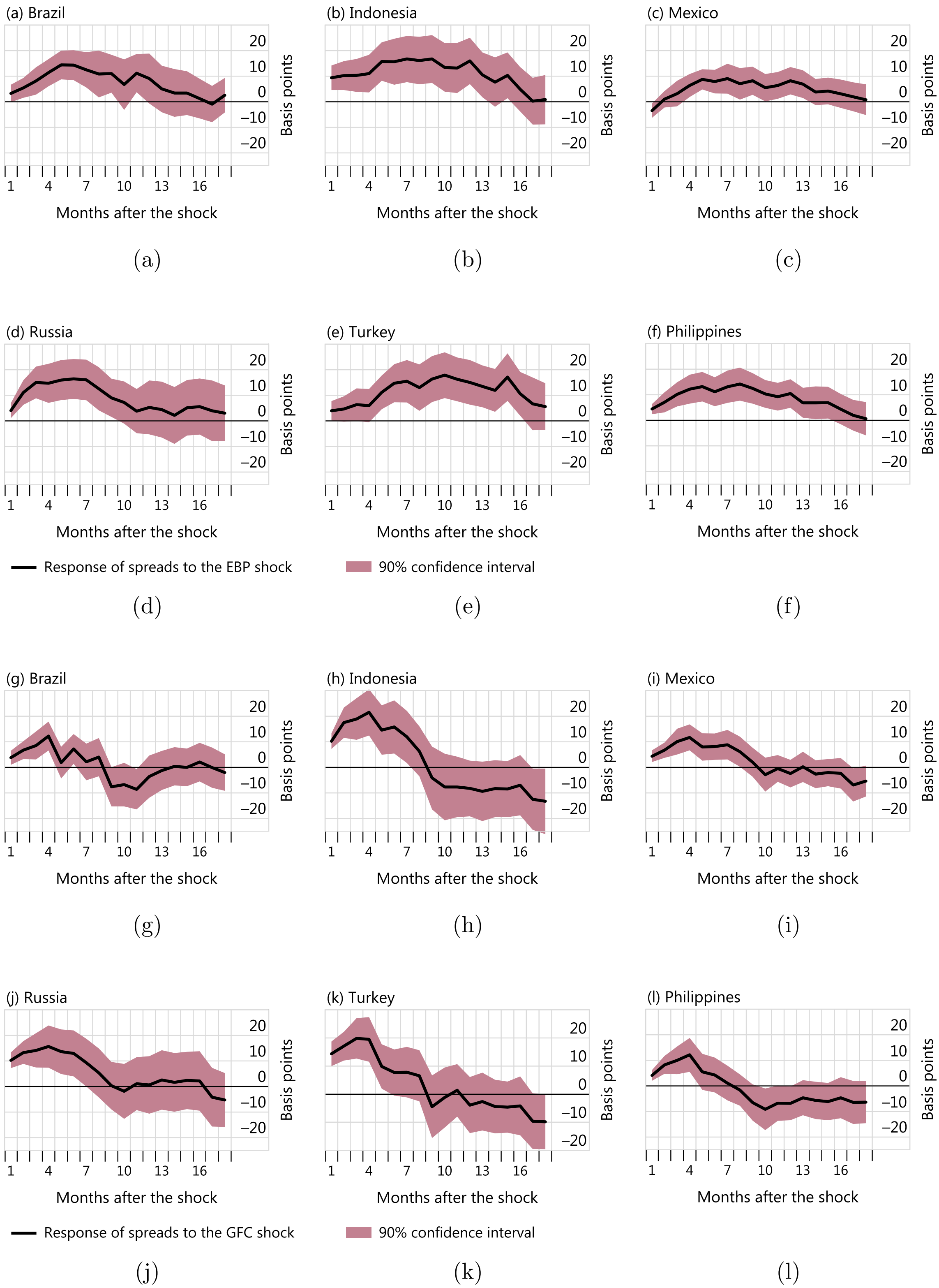


Fig. 5. The impact of a global financial risk shocks on sovereign bond spreads (selected speculative-grade countries). Note: Panels (a)–(f) depict the country-specific responses of sovereign bond spreads to an orthogonalized shock of one standard deviation to the EBP, whereas panels (g)–(l) depict the corresponding responses of sovereign spreads to an orthogonalized shock of one standard deviation to the GFC. The orthogonalization of global financial risk shocks is based on the recursive ordering of global risk factors in which the EBP is ordered before the GFC (Order 1). Shaded bands in each panel denote the corresponding 90% confidence intervals based on the covariance matrix of parameters clustered across countries and time (see the text for details).

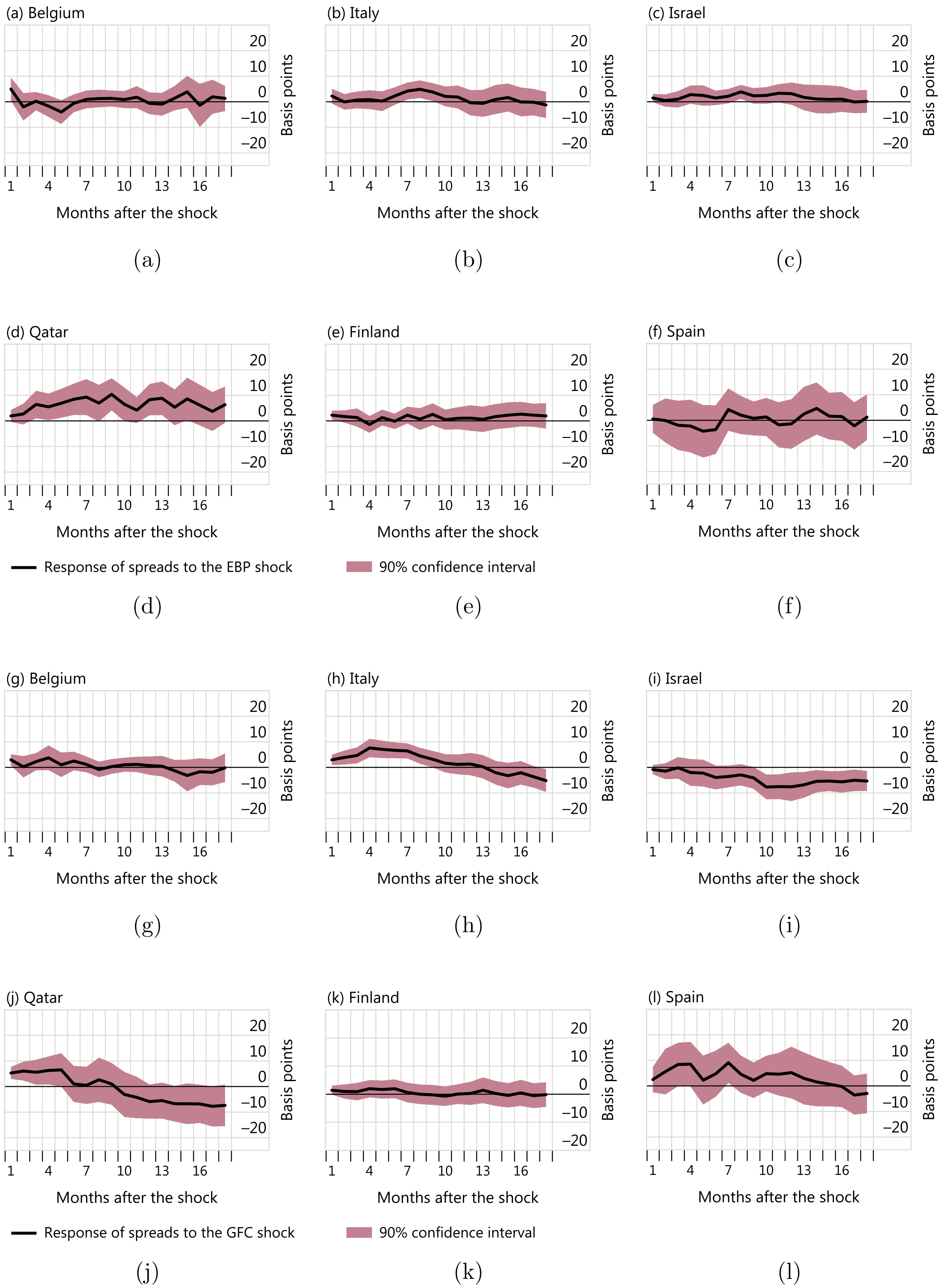


Fig. 6. The impact of a global financial risk shocks on sovereign bond spreads (selected investment-grade countries). Note: Panels (a)–(f) depict the country-specific responses of sovereign bond spreads to an orthogonalized shock of one standard deviation to the EBP, whereas panels (g)–(l) depict the corresponding responses of sovereign spreads to an orthogonalized shock of one standard deviation to the GFC. The orthogonalization of global financial risk shocks is based on the recursive ordering of global risk factors in which the EBP is ordered before the GFC (Order 1). Shaded bands in each panel denote the corresponding 90% confidence intervals based on the covariance matrix of parameters clustered across countries and time (see the text for details).

Table 5
Cross-country distribution of sovereign bond spread responses (heterogeneous global risk factor loadings).

	Percentile				
Response horizon	5	25	50	75	95
(a) *EBP shock: investment-grade countries*					
1m–6m	−0.02	0.00	0.01	0.04	0.07
7m–12m	−0.06	0.00	0.02	0.05	0.08
13m–18m	−0.06	−0.02	0.01	0.05	0.08
19m–24m	−0.10	−0.02	0.01	0.03	0.08
(b) *EBP shock: speculative-grade countries*					
1m–6m	−0.12	0.04	0.07	0.10	0.13
7m–12m	0.00	0.08	0.10	0.15	0.22
13m–18m	0.00	0.03	0.05	0.13	0.49
19m–24m	−0.05	0.00	0.02	0.07	0.18
(c) *GFC shock: investment-grade countries*					
1m–6m	−0.02	0.01	0.04	0.06	0.10
7m–12m	−0.06	−0.04	0.00	0.03	0.14
13m–18m	−0.09	−0.06	−0.02	0.01	0.07
19m–24m	−0.16	−0.06	−0.01	0.00	0.15
(d) *GFC shock: speculative-grade countries*					
1m–6m	0.00	0.07	0.11	0.14	0.36
7m–12m	−0.05	−0.01	0.02	0.10	0.32
13m–18m	−0.18	−0.06	−0.01	0.05	0.20
19m–24m	−0.18	−0.04	0.00	0.06	0.15

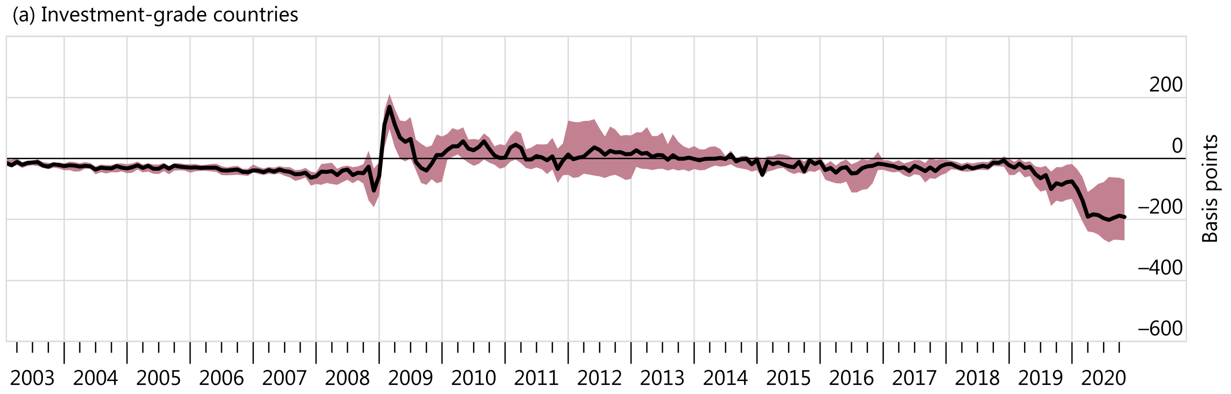
Note: The entries in the table denote the specified percentile of the response of sovereign bond spreads (in basis points) across countries to a one standard deviation orthogonalized shock in the specified global financial risk factor, based on Order 1 identification scheme (see the text for details). For each country, the estimated response of sovereign bond spreads to the global financial risk factor shock is averaged over the specified response horizon (in months).

Table 6
Persistent effects of global financial risk factors on sovereign CDS spreads (homogeneous global risk factor loadings).

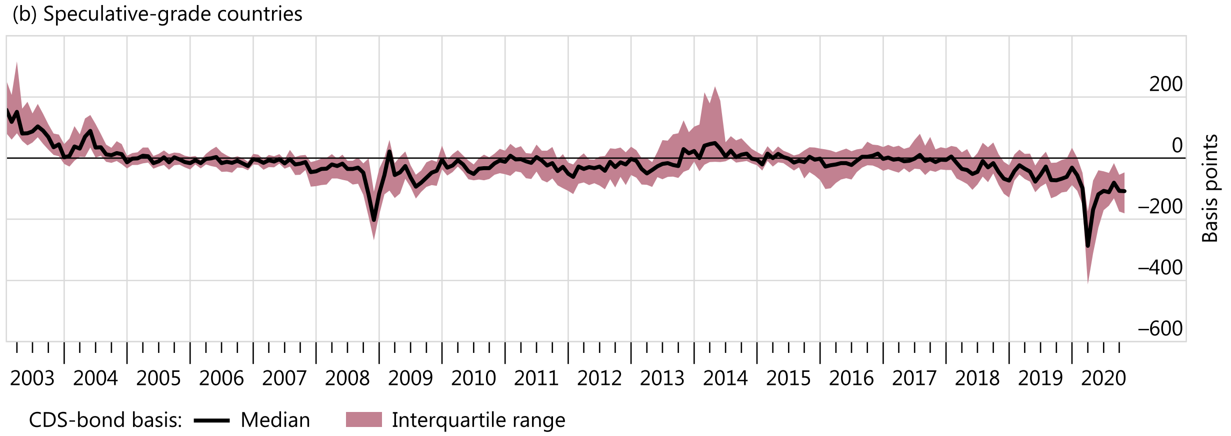
	Global financial risk factor at lag p (in months)								
	$p=1$	$p=2$	$p=3$	$p=4$	$p=5$	$p=6$	$p=9$	$p=12$	$p=18$
(a) *Investment-grade countries*									
EBP_{t-p}	0.04	0.08	0.10	0.16	0.19	0.22	0.19	0.22*	0.02
	(0.10)	(0.10)	(0.11)	(0.12)	(0.13)	(0.14)	(0.13)	(0.11)	(0.10)
GFC_{t-p}	0.05	−0.00	−0.05	−0.10*	0.14**	−0.18***	−0.27***	−0.29***	−0.26***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
VIX_{t-p}	0.01	0.01	0.01	0.00	−0.00	−0.00	0.01	0.01	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(b) *Speculative-grade countries*									
EBP_{t-p}	1.35*	1.56*	1.60*	1.63**	1.57**	1.47**	0.87*	0.30	−2.60
	(0.76)	(0.79)	(0.80)	(0.76)	(0.65)	(0.56)	(0.49)	(0.78)	(3.00)
GFC_{t-p}	0.94***	0.73***	0.56**t	0.46	0.39	0.32	0.20	0.10	1.57
	(0.26)	(0.24)	(0.25)	(0.27)	(0.30)	(0.35)	(0.50)	(0.58)	(1.88)
VIX_{t-p}	−0.12	−0.15	−0.16*	−0.17	−0.17*	−0.15	−0.08	−0.04	0.14
	(0.08)	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.08)	(0.05)	(0.11)

Note: The dependent variable in all specifications is $\text{CDS}_{k,t}$, the 5-year sovereign CDS spread for country k at the end of month t (in basis points). The entries in the table denote the OLS estimates of coefficients associated with the specified global financial risk factor at month $t-p$, $p = 1, 2, 3, 4, 5, 6, 9, 12, 18$. In addition to the specified global financial risk factor, each specification includes country fixed effects, standard global risk factors, and country-specific risk factors (see the text for details). Coefficients on the global risk factors are restricted to be the same across countries. Asymptotic standard errors reported in parentheses are clustered across countries and time: *$p < .10$; **$p < .05$; and ***$p < .01$.

financial crisis. Recently, as the pandemic broke out, the basis for those countries dropped substantially again to -287 basis points in March 2020. Interestingly, the basis for countries with investment-grade ratings veered into positive territory during the global financial crisis but took a much more dramatic nosedive during the pandemic relative to the global financial crisis: it dropped to nearly -200 basis points in March 2020 and has remained elevated since then. We suspect that the spike upward during the global financial crisis reflects concerns regarding counterparty risk in the wake of the Lehmann Brothers collapse. In contrast, the negative sign and large magnitude of the CDS-bond basis during the pandemic are indications of large and persistent selling pressure from investors trying to obtain cash by liquidating cash instruments such as sovereign bonds instead of synthetic



(a)



(b)

Fig. 7. Sovereign CDS-Bond basis. Note: Panel (a) shows the time series of selected cross-sectional moments of sovereign CDS-bond basis at month-end for countries with an investment-grade credit rating, whereas panel (b) shows the corresponding moments for countries with a speculative-grade credit rating (see the text for details).

instruments such as the CDS. Haddad et al. (2021) document such "dash for cash" phenomenon for the U.S. corporate bond market; our paper provides further evidence for international sovereign bond markets.[5]

Table 7 reports the regression results that estimate the persistent effects of global financial risk factors on the CDS-bond basis. It is directly comparable to Table 3 or Table 6, except that the dependent variable is now the CDS-bond basis instead of the bond spread or the CDS premium. In addition, the sample used to construct the basis is the same sample used to estimate the CDS response so that one can make direct comparisons between the coefficient estimates reported in Tables 6 and 7.

The estimates reported in Table 7 imply that the EBP has a negligible impact on the basis, whereas the GFC's impact is significant and positive. The estimated effect from the GFC is short-lived, however, and dissipates after five months. The effects of the VIX on the CDS-bond basis is strongly negative across the same horizon. This finding is consistent with the VIX being a good proxy for liquidity concerns that generate a "dash for cash" phenomenon that results in a substantially negative CDS-bond basis during highly uncertain crisis periods such as the global financial crisis and the COVID-19 pandemic.

Comparing the response of the CDS premium to the CDS-bond basis allows us to infer the response of sovereign spreads to global financial risk factors for the sample of countries with both CDS contracts and sovereign bonds outstanding. These estimates imply a 120 basis point response to the EBP at the 6-month horizon – roughly double what we obtain using estimates from the full sample of sovereign spreads that are reported in Table 3. This evidence provides further support for the strength of the linkages between financial conditions in the U.S. financial sector as measured by the EBP and the sovereign bond market.

In summary, while the CDS-bond basis responds modestly to global financial risk factors, the signs of the responses differ across variables and are relatively short-lived. This finding, combined with the underlying responses to the CDS premiums

[5] Bai and Collin-Dufresne (2019) argue that the CDS-bond basis in the corporate bond market indicates "limits of arbitrage" as the basis is usually associated with bonds with higher frictions measured by trading liquidity, funding cost, counterparty risk, and collateral quality. Jiang et al. (2021) and Mota (2021) argue that the CDS-bond basis captures the safety premium or the convenience yield.

Table 7
Persistent effects of global financial risk factors on sovereign CDS-bond basis (homogeneous global risk factor loadings).

	Global financial risk factor at lag p (in months)								
	$p=1$	$p=2$	$p=3$	$p=4$	$p=5$	$p=6$	$p=9$	$p=12$	$p=18$
(a) *Investment-grade countries*									
EBP_{t-p}	0.08*	0.04	−0.00	−0.03	−0.06	−0.08*	−0.02	0.02	0.10***
	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
GFC_{t-p}	0.10***	0.09***	0.08***	0.07***	0.06**	0.06**	0.07**	0.03	−0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
VIX_{t-p}	−0.02***	−0.01***	−0.01**	−0.01**	−0.00	0.00	−0.00	−0.00	−0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
(b) *Speculative-grade countries*									
EBP_{t-p}	0.63*	0.57*	0.45	0.38	0.32	0.29	0.24	−0.28	−1.91*
	(0.34)	(0.34)	(0.33)	(0.34)	(0.33)	(0.33)	(0.34)	(0.37)	(1.06)
GFC_{t-p}	0.44**	0.38**	0.32***	0.25***	0.16**	0.09	−0.02	−0.16	−0.17
	(0.19)	(0.16)	(0.12)	(0.09)	(0.07)	(0.09)	(0.18)	(0.26)	(0.29)
VIX_{t-p}	−0.13***	−0.12**	−0.11**	−0.11**	−0.09**	−0.09*	−0.08*	−0.02	0.14*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.08)

Note: The dependent variable in all specifications is $\text{basis}_{k,t}$, the sovereign CDS-bond basis for country k at the end of month t (in basis points). The entries in the table denote the OLS estimates of coefficients associated with the specified global financial risk factor at month $t-p$, $p=1, 2, 3, 4, 5, 6, 9, 12, 18$. In addition to the specified global financial risk factor, each specification includes country fixed effects, standard global risk factors, and country-specific risk factors (see the text for details). Coefficients on the global risk factors are restricted to be the same across countries. Asymptotic standard errors reported in parentheses are clustered across countries and time: $^{*}p<.10$; $^{**}p<.05$; and $^{***}p<.01$.

documented in Table 6, implies a robust set of results indicating that increased global financial risk leads to economically significant increases in sovereign risk in both the cash and derivatives markets. Given the broad similarity of the empirical results for the sovereign bond spreads and CDS spreads, we next aim to illustrate the mechanism through which global financial risk affects sovereign spreads by analyzing the determinants of sovereign bond prices in a model with global financial intermediaries that face value-at-risk constraints.

4. Interpretation of the results

The empirical analysis establishes the relation between the global financial risk factor and sovereign bond spreads. The global factor is linked to the aggregate degree of risk aversion of the market. The existing research, such as Lizarazo (2009) and Borri and Verdelhan (2011), has shown that allowing risk-averse lenders leads to an additional risk premium in sovereign bond pricing. Recent work by Morelli et al. and Bai et al. (2019) further examines the role of global financial risk in accounting for the comovements in sovereign spreads. We now turn to a simple model to illustrate the empirical results shown earlier. In particular, we adopt the approach used in Danielsson et al. (2011), simplified by Adrian and Shin (2011) and Miranda-Agrippino and Rey (2020), to study global financial risk as a source of variation in sovereign spreads.[6]

We are not wedded to a model, but for illustrative purposes, here we use the setup of Shin (2012). Shin (2012) presents a model of direct and intermediated credit to borrowers. We adapt this setup and endogenize the sovereign default to demonstrate how a more binding value-at-risk constraint reduces the risk capacity of financial intermediaries and then subsequently increases sovereign risk and sovereign bond spreads. In particular, because the financial intermediaries are subject to a value-at-risk constraint, their risk-bearing capacity is limited and would vary as the constraint is subject to changes. Through a numerical exercise, we illustrate how such changes can constitute global financial risk and account for the variation in sovereign spreads.

4.1. Sovereign borrower

In the simple model, there are a continuum of sovereign borrowers. Each sovereign borrower i lives for two periods. In period 0, the sovereign has no income. In period 1, country i receives a random income given by $\exp(z_i)$. The random variable z_i depends on two components: $z_i = \rho Y + y_i$, , where Y is the aggregate fundamental factor that affects all countries, and y_i is the idiosyncratic factor for country i. The parameter ρ is the weight of a country's income on the common factor.

We assume that both the aggregate and idiosyncratic factors are drawn from independent normal distributions where $Y \sim N(0,\sigma_Y^2)$ and $y \sim N\left(0,\sigma_y^2\right)$. Therefore, z_i has the distribution of $N(0,\sigma_z^2)$ where $\sigma_z^2 = \rho^2\sigma_Y^2 + \sigma_y^2$.

The preference of the sovereign borrower is given by

$$u(c_0) + \beta u(c_1). \tag{3}$$

[6] In a related work, Coimbra (2020) quantitatively analyzes the feedback effect between the banking leverage and sovereign spreads using a dynamic model with the similar setup.

Because the sovereign country is risk averse, the country has the incentive to borrow in period 0 to smooth consumption. The country can borrow in the form of one-period discount bonds. The price of the sovereign bond is given by $q(b)$. The price on sovereign bonds may be lower than the price of risk-free bonds because the country can repudiate its debt repayment. We assume that if the country defaults, the income it can enjoy drops to $(1-\phi)\exp(z_i)$. The parameter ϕ captures the penalty of defaulting.[7]

The sovereign borrower's problem is

$$\max_b u(q(b)b) + \beta \int \max\{u(e^z - b), u((1-\phi)e^z)\} \mathrm{dP}(z), \tag{4}$$

subject to the constraint $b > 0$. It is straightforward to show that the default cutoff z^* in period 1 is given by $\exp(z^*) - b = (1-\phi)\exp(z^*)$. That is, at the default cutoff z^*, the government is indifferent between default or no default.

Given the level of debt b, the default probability is thus given by

$$p(b) = \Phi\left(\frac{z^*}{\sigma_z}\right) = \Phi\left(\frac{\ln(b/\phi)}{\sigma_z}\right). \tag{5}$$

4.2. Banks

The supply of credit to sovereign borrowers comes from two sources. The first source is households who directly invest in a diversified sovereign bond portfolio. The second is through the financial sector or financial intermediaries. We first describe the bank's credit supply. Then we will turn to the direct bond investors. In the model, the banks take in deposits from households and invest in sovereign bond markets.

As in Shin (2012), banks are risk neutral and maximize profit subject only to a value-at-risk (VaR) constraint that limits the probability of bank failure. According to the VaR constraint, the bank manages its investment so that the probability of bank failure is below some threshold level $\alpha > 0$.[8] As long as all banks are subject to the same VaR constraint, an aggregation result holds. Therefore, we treat the whole banking sector as one bank.

The bank is able to diversify sovereign bond holdings by lending small amounts to a large number of sovereign borrowers. The total amount the bank lends out is denoted by $q(b)B^b$ at time 0, which are the assets on the bank's balance sheet. The contractual repayment to the bank is B^b, the notional assets in period 1. The lending is financed by bank equity E and deposit and money market funding L. The cost of debt financing is denoted by r_f. We assumes that bank deposits are fully guaranteed by the government. Therefore, the interest rate on bank liability is the risk-free rate r_f. So, the bank owes $(1 + r_f)L$ in period 1.

Taking the sovereign country's default threshold z^* as given,[9] the realized value of the bank's assets at date 1 is given by the random variable $\omega(Y)$ where

$$\omega(Y) = B^b \cdot \Pr(z \geq z^* | Y) = B^b \Phi\left(\frac{\rho Y - z^*}{\sigma_y}\right). \tag{6}$$

The bank keeps its probability of default to $\alpha > 0$ according to the VaR constraint:

$$P_r\left(\omega(Y) < \left(1 + r_f\right)L\right) \geq \alpha. \tag{7}$$

Following Adrian and Shin (2011), we assume the bank takes its equity E as given and adjusts the size of its sovereign lending B^b and funding L. Its balance sheet is $qB^b = E + L$. Because the bank is risk-neutral and maximizes profit, the VaR constraint binds when the expected profit to buying sovereign bonds is positive. Hence, we can derive the condition that B^b must satisfy:

$$\Phi\left(\frac{\sigma_y \Phi^{-1}\left(\left(1 + r_f\right)L/B^b\right) + z^*}{\rho \sigma_Y}\right) = \alpha. \tag{8}$$

[7] In the sovereign debt literature, the cost of default includes the direct economic cost and the indirect cost due to the loss of access to the international financial markets. Because of the two-period model setup, the country does not borrow in period 2, and thus a direct output cost is the only penalty imposed on defaulting countries.

[8] Adrian and Shin (2013) provide a possible microfoundation for the VaR constraint as a solution to the optimal contracting problem.

[9] Note that the bank takes the sovereign default probability as given. In Shin (2012), the bank diversifies its loan book, taking as given the failure rate of the ultimate borrower's projects. In our case, we endogenize the default probability in an equilibrium model of sovereign debt. Yet, for the bank, the default set is taken as given. Since conditional on Y, defaults are independent, the bank can diversify the sovereign bond lending and remove the idiosyncratic default risk. In the limit, the realized value of bank assets is a function of Y only.

Denote the ratio of notional liabilities to notional assets in period 1 by φ, which is given by

$$\varphi \equiv \frac{\left(1+r_f\right)L}{B^b} = \Phi\left(\frac{\rho\sigma_Y\Phi^{-1}(\alpha)-z^*}{\sigma_y}\right). \tag{9}$$

Note that the normalized leverage ratio φ is between zero and one.

Therefore, we can solve for the amount of sovereign bond holdings by the bank and the demand for deposit funding L. That is,

$$\begin{aligned} B^b &= \frac{\left(1+r_f\right)E}{\left(1+r_f\right)q-\varphi}, \\ L &= \frac{\varphi E}{\left(1+r_f\right)q-\varphi}. \end{aligned}$$

Given the default probability, the bank credit supply B^b is a function of the bond price q. It is easy to show that the bank credit supply decreases with the sovereign bond price q as long as $(1+r_f)q>0$.

4.3. Bond investors

The other source of demand for sovereign bonds is individual bond investors. We assume that households are mean-variance investors with identical risk aversion γ. This assumption is akin to assuming a CARA utility function for the households and simplifies the solution. The main mechanism holds under a more general preference.

As in Shin (2012), households hold a portfolio consisting of three component assets: risky bonds, cash, and deposits in the bank. We assume that households have sufficient endowments and that they purchase a diversified portfolio of sovereign bonds that diversified away idiosyncratic sovereign default risk.

Therefore, the household's optimization problem is

$$\max_x E[W] - \frac{\gamma}{2}\mathrm{Var}[W], \tag{10}$$

where

$$\begin{aligned} E[W] &= \frac{1-x}{q_0} + \frac{x}{q}(1-E[\widetilde{p}]), \\ \mathrm{Var}[W] &= \left(\frac{x}{q}\right)^2 \mathrm{Var}[\widetilde{p}], \end{aligned}$$

and q_0 is the risk-free bond price, q is the sovereign bond price, and $\widetilde{p}$ is the probability of default on the sovereign bond portfolio. If there is measure N of the mean-variance investors with identical risk aversion, the total demand for sovereign bonds is given by

$$B^h = \mathrm{Nx} = N\frac{(1-E[\widetilde{p}])-\left(1+r_f\right)q}{\gamma \mathrm{Var}[\widetilde{p}](1/q)}.$$

4.4. Market clearing condition

In the model, sovereign borrowing is from the direct credit and intermediated credit. The default risk of sovereign bonds depends on the equilibrium level of sovereign borrowing. The sovereign debt market clears such that $B^b + B^h = b$.

4.5. A numerical example

In the baseline model, given b,

$$\frac{\left(1+r_f\right)E}{\left(1+r_f\right)q^b(b)-\Phi(\rho\Phi^{-1}(\alpha)-\ln(b/\phi))} + N\frac{(1-E[\widetilde{p}])-\left(1+r_f\right)q(b)}{\gamma \mathrm{Var}[\widetilde{p}](1/q(b))} = b.$$

From the model, we can solve for the allocation of credit supply between direct and intermediated credit for any level of sovereign bond b.

Table 8
Summary of model calibration.

Parameter	Symbol	Value
Aggregate volatility	σ_Y	0.100
Idiosyncratic volatility	σ_y	0.100
Sensitivity of country's income to aggregate risk	ρ	0.900
Default penalty	ϕ	0.200
Risk-free rate	r_f	0.050
Time discount factor	β	0.950
Risk aversion	γ	2.000
Mass of households	N	0.100
Value-at-risk parameter	α	0.001
Net equity	E	0.010

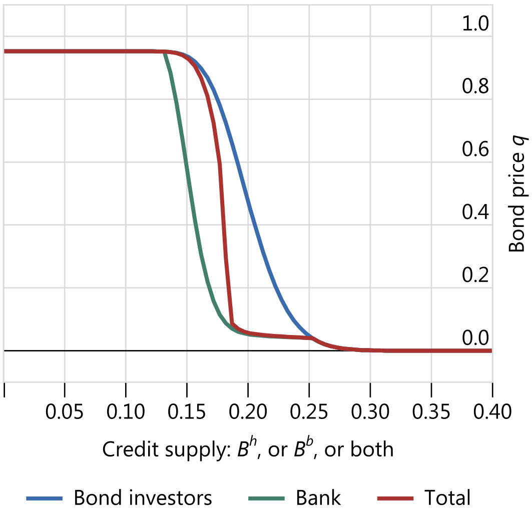


Fig. 8. Sovereign bond price function. Note: The lines in the figure depicts the sovereign bond price ($q(b)$) as a function of credit supply. The blue line corresponds to the case where bond investors (B^h) are the sole buyers of sovereign debt; the green line corresponds to the case where banks (B^b) are the sole buyers of sovereign debt; and the red line corresponds to the baseline case in which both types of agents participate in the sovereign bond market.

For illustrative purposes, Table 8 gives the parameter values we use to numerically solve the two cases and the baseline model. We pick 0.1 as the standard deviation of the two income shocks. The loading of country income on the aggregate shock is 0.9. The default cost parameter is 0.2. The risk-free rate is 0.05. The discount factor for all of countries is 0.95. Their preference is given by a CRRA utility function with a risk aversion of 2. The risk attitude of the mean-variance bond investors is given by the parameter $\gamma = 2$, and there is measure $N = 0.1$ of bond investors. Finally, the bank's equity is assumed to be 0.01, and the failure probability in its VaR constraint is $\alpha = 0.001$. All of these parameters are set in order to learn about the model's properties.

Fig. 8 compares the bond price function from the three cases, where bank and bond investors are the sole source of credit supply, respectively, as well as when both sources of credit supply are at work on the sovereign bond market. The blue line shows the bond price function $q^h(b)$ if the bond investors are the only buyers of sovereign bond portfolios. The green line shows the bond price function $q^b(b)$ if the banks are the only buyers of sovereign bonds. The red line shows the equilibrium bond price function in our baseline model. This figure depicts that the credit supply in these cases is a decreasing function of bond prices. Thus, the higher the interest rate on sovereign bonds, the greater the credit supply. However, the bank credit supply is more sensitive to the bond prices. Banks in our model are risk neutral. Yet, the VaR constraint limits the bank's probability of failure and thus introduces an effective aversion to risk.

Table 9 shows the equilibrium level of total debt, allocation of credit supply, average default probability, and average risk premium. The first column shows the results using the baseline parameterization. The total level of debt is around 16% of average national income. The default probability on average is 3.5%. There is a sizable risk premium even though the risk aversion parameter for the households is very small. The average risk premium is about 2.2%. The reason is that banks require a risk premium to invest in sovereign bonds because of their VaR constraint. The bank's notional leverage is the ratio of notional liabilities and national assets. The period-0 bank leverage (i.e., qB^b/E) is 1.64.

Now we can compare the baseline case with a few cases to show how the bank's risk-bearing capacity is linked to sovereign spreads and the risk premium. We conduct three comparative statics to illustrate the impact of global financial shocks and global volatility in general in the economy. Column (2) shows the impact when the aggregate shock is more volatile. In this riskier

Table 9
Model results.

	Calibration			
	Baseline	$\sigma_Y = 0.15$	$\alpha = 0.005$	$\rho = 0.95$
	(1)	(2)	(3)	(4)
Debt level (b)	0.156	0.146	0.157	0.157
Intermediated credit (B^b)	0.018	0.013	0.026	0.017
Direct credit (B^h)	0.138	0.133	0.131	0.140
Average default probability ($E[\tilde{p}]$)	0.035	0.033	0.035	0.039
Sovereign spread ($s = 1/q-(1+r_f)$)	0.057	0.067	0.055	0.066
Risk premium ($s-E[\tilde{p}]$)	0.022	0.034	0.020	0.027
Notional leverage (φ)	0.369	0.145	0.552	0.313
Bank leverage (qB^b/E)	1.638	1.183	2.386	1.500

Note: The entries in column (1) of the table denote the equilibrium solution of the model under the baseline calibration (see Table 8). The entries in columns (2)–(4) denote the corresponding equilibrium solutions for alternative values of the specified parameter, with all other parameters at their baseline values.

environment, the sovereign bond price function shifts in. The sovereign countries borrow less in equilibrium. Both the direct and intermediated credit supply shrink. Because of the general equilibrium effect, the average default probability is slightly smaller as a result of the smaller debt burden on the sovereign country. However, the average sovereign bond spreads are higher. In particular, the risk premium increases by about 50%. Now, although the bank credit supply is a smaller fraction of the total debt market, a comparison of the first two columns shows that the bank's leverage is substantially lower, implying a smaller risk-bearing capacity for the bank.

Column (3) shows the case in which the bank allows a bigger failure probability. Therefore, the bank faces a more lax VaR constraint and can bear more risk. We can interpret this case as a positive global financial risk shock. Now the big change relative to the baseline case is in the fraction of intermediated credit. As the banks are more tolerant in bearing risk, they take on more sovereign bonds and significantly increase their leverage. Although the average default probability is roughly unchanged, the sovereign spreads and the risk premium both drop, reflecting the spillover from global financial risk to sovereign bond markets.

The previous two examples illustrate the impact of global volatility and global financial shocks. For comparison purposes, we also consider the case in which the aggregate shocks are more important for sovereign borrowers. Column (4) shows the implications of a more synchronized economy in which the loading on the aggregate shock increases to 0.95. Now the investors and the banks face more non-diversifiable risk and thus reduce their supply of credit. Therefore, sovereign debt financing is more expensive with a higher default probability, sovereign spreads, and a risk premium. In terms of the intermediate credit, the banks cut back on sovereign lending and reduce their leverage.

Overall, this model shows that the sovereign bond pricing is closely related to the financial intermediary's risk bearing capacity in a general equilibrium setup, especially through the changes in the risk premium.

5. Conclusion

In this paper, we study the interplay between sovereign risk and global financial risk. We show that a substantial portion of the comovement among sovereign spreads is accounted for by changes in global financial risk. Through panel regressions and local projection analysis, we find that global financial risk has a persistent and significant impact on sovereign bond spreads. Sovereign bond spreads are wider at times when aggregate uncertainty or risk aversion is higher, or when there is a reduced risk-bearing capacity of financial intermediaries. The spillover effects of global financial risk are more pronounced for speculative-grade sovereign bonds. These spillover effects are also more pronounced and more persistent in response to fluctuations in the risk-bearing capacity of U.S. financial intermediaries, as measured by movements in the excess bond premium.

The empirical results provide evidence for the pass-through of financial risk to sovereign risk. We illustrate this channel using a theoretical model in which the financial risk that arises from a reduced risk capacity of financial intermediaries or a higher level of aggregate uncertainty or risk aversion may force banks to deleverage and reduce their investment in sovereign bonds, which in turn increases financing costs for sovereign governments, resulting in increased sovereign risk and larger sovereign bond spreads.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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