The Review of Asset Pricing Studies

The Core, the Periphery, and the Disaster: Corporate-Sovereign Nexus in COVID-19 Times

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We document that the COVID-19 pandemic triggered a surge in the comovement between nonfinancial corporate and sovereign credit default swaps in core European countries, characterized by strong fiscal capacity. In peripheral countries with lower fiscal capacity, the pandemic had essentially no impact on such comovement. We show that this result is primarily explained by a pandemic-induced repricing of widespread government support directed, for the first time, toward nonfinancial corporations. We interpret our findings within an asset pricing framework featuring defaultable corporate and sovereign debts. (*JEL* F65, G01, G15).

Received: November 20, 2024
Editor: Zhiguo He
Authors have furnished an Internet Appendix, which is available on the Oxford University Press Web site next to the link to the final published paper online.

We are particularly indebted to Viral Acharya, Patrick Augustin, Stephen Schaefer, and Marti G. Subrahmanyam for insightful discussions. We thank Giacomo Bezzi for providing excellent research assistance. We also thank Giancarlo Corsetti, Pasquale della Corte, Matteo Crosignani, Marco Di Maggio, Pierre Collin-Dufresne, Denis Gromb, Zhiguo He (the Editor), Alexandre Jeanneret, Yueran Ma, Florian Nagler, Marco Pagano, Christian Schlag, Mark M. Spiegel, and seminar participants at the 8th Bank of England International Conference on Sovereign Bond Markets, the 2021 CEAR-CenFIS Conference, the 48th EFA Annual Meeting, HEC Paris, Goethe University Frankfurt, the 38th International Conference of the French Finance Association, LTI@UniTO, Macquarie University, the National Bank of Belgium, the 2021 New Zealand Finance Meeting, Paris Dauphine, the 19th Paris December Finance Meeting, the University of Naples Federico II, the University of Neuchâtel, the University of New South Wales, the University of St. Gallen, the University of Sydney, the SoFiE 2022 Annual Conference, the Swiss Finance Institute, the 61st Annual Meeting of the SWFA, the University of Verona, and the 2022 WFA Meeting for comments. Send correspondence to Loriana Pelizzon.

The Review of Asset Pricing Studies 00 (2026) 1–69

https://doi.org/10.1093/rapstu/raag003 Advance Access Publication 27 January 2026

How do sovereign credit risk and domestic corporate credit risk interact? Given the soaring level of outstanding sovereign and corporate credit debt in developed economies, a deep understanding of the channels at work in such a relationship is of paramount importance from both an academic and a policy perspective. For financial firms, and most notably banks, a fundamental characterization of the channels at work has been formalized through the so-called "doom loop," which derives from the combination of bank exposures and bailout (see, e.g., Acharya, Drechsler, and Schnabl 2014; Brunnermeier, Garicano, Lane, Pagano, Reis, Santos, Thesmar, Van Nieuwerburgh, and Vayanos 2016; Farhi and Tirole 2018). Some evidence indicates that credit risk spillovers take place between sovereign and domestic nonfinancial sectors (see, e.g., Lee, Naranjo, and Sirmans 2016; Almeida, Cunha, Ferreira, and Restrepo 2017). The sobering message from this literature is that a rise in sovereign risk generates negative externalities on the ability of corporations to service their debt, and hence on their creditworthiness. These externalities are generally deemed to be exacerbated in governments with already-low fiscal space and high credit spreads, for which a further deterioration in credit conditions would raise concerns of future increases in corporate taxes and more generally a disruption in the legal, political, and economic frameworks (Corsetti, Kuester, Meier, and Müller 2013; Augustin, Boustanifar, Breckenfelder, and Schnitzler 2018).

In this paper, we study the response of credit risk markets to the COVID-19 pandemic, when investors swiftly repriced the cost of default insurance. In the cross-section of countries in the European Union, the first Western countries hit by the pandemic, 5-year credit default swap (CDS) spreads on both sovereign and corporate entities experienced a massive surge. This pattern characterizes both core E.U. countries with strong public finances and peripheral E.U. countries, where high public debt levels and elevated financing costs are more concerning. While it is well-known that credit markets often experience sudden run-ups in spreads (Pan and Singleton 2008), the pandemic stands out as a unique environment for testing the drivers of the corporate-sovereign credit risk loop and the role of fiscal space, for at least two reasons. First, the shock was unanticipated and exogenous to preexisting levels of credit risk and public finances, an argument also made by Augustin, Sokolovski, Subrahmanyam, and Tomio (2022). Second, E.U. governments initially responded to the pandemic by imposing widespread halts to economic activity, thereby threatening firms' profitability and even survival. The unprecedented breadth of these interventions and the discussions around foreseeable support measures to businesses that followed have ignited a debate on the asset pricing implications of government support for nonfinancial corporations.[1] Before the pandemic, the pricing of public support was in fact largely confined to claims issued by financial firms.

We offer the following three contributions to advance our understanding of credit markets. First, we document a strengthening of the corporate-sovereign credit risk comovement at the COVID-19 outbreak only in countries with strong fiscal capacity. This evidence is robust to the inclusion of a comprehensive collection of firm and country characteristics. Second, we provide several analyses that strongly point toward the repricing of expected government support as a key driver of the surge in credit risk comovement. Third, we present a tractable asset pricing model of defaultable corporate and sovereign debt that provides a unified interpretation of our results.

In more detail, we begin by documenting that the comovement of CDS spreads referencing nonfinancial corporations with those on the corresponding governments, which we term the "corporate-sovereign nexus," increased in the period after the first Italian lockdown (February 24, 2020) only in the core of the European Union, namely, in countries with *strong* fiscal capacity. For this group of countries—Belgium, Finland, France, Germany, and the Netherlands—the pandemic had a large and statistically significant positive impact on the corporate-sovereign nexus. By contrast, in peripheral E.U. countries—Greece, Italy, Portugal, and Spain—the effect of the pandemic on the nexus was, albeit positive, small and not statistically significant. Considering that our sample covers nonfinancial firms with an overall market capitalization of €3.25 trillion—about 56% of the E.U. market—the economic relevance of this finding cannot be understated.

In the analysis, we adopt a panel regression setup, where we include as controls the firm's equity return, aggregate volatility and fixed effects. The equity return in particular should absorb the effect of aggregate shocks on both firm assets and sovereign creditworthiness that could bias our inference (Acharya, Drechsler, and Schnabl 2014). The focus on the European Union provides us with a set of countries with homogeneous monetary policy and exchange rates and heterogeneous fiscal capacity. We further control for firm-level characteristics that capture sensitivity to the shock—firm profitability, liquidity, and financing structure—and country-level proxies for the resilience to COVID-19, the breadth of the government policy response, and the severity of the shock, such as the importance of the tourism sector and the strength of the healthcare system. Our estimates are not driven by imbalances in the distribution of covariates, firm counts, and industrial structure between core and periphery, and hold consistently at the disaggregated country level: the surge in the nexus is pervasive across all core countries, and muted across all peripheral ones. Numerous robustness tests confirm that, while the

[1] Isabel Schnabel, member of the executive board of the European Central Bank, discusses how the interlinkages between sovereigns and firms resulting from the broad-based fiscal support have grown as a result of the governments' responses to the pandemic. The speech is available at https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210128~8f5dc86601.en.html.

corporate–sovereign nexus was higher in the periphery during normal times, only core countries experienced an increase in the corporate–sovereign nexus during the COVID-19 period.[2]

Next, we examine the economic channels that could explain this reaction. We find strong evidence that the corporate-sovereign nexus during the COVID-19 period is directly linked to a country's fiscal capacity. We begin by showing that corporate CDS correlate with direct measures of the strength of the guarantee. Specifically, announcements of fiscal measures during the pandemic, capturing current and expected government support, were accompanied by a significant decline in corporate spreads and by a strengthening of the nexus, but only in core countries. We then provide evidence that the corporate-sovereign nexus is related to direct metrics of fiscal space, which offer a more granular dimension than the core/periphery classification. During the COVID-19 period, the nexus rises in country-level and time-varying measures of fiscal capacity, such as the debt-to-GDP ratio, interest expenditures on debt, and indicators of government quality. We then test and rule out alternative explanations based on cross-country differences in pandemic exposure. For example, grouping countries by the severity of the pandemic fails to capture the asymmetric response observed under the core/periphery classification. Likewise, controlling for the intensity of the pandemic and the stringency of containment measures does not undermine our findings.

Within the cross-section of firms, the estimates of the nexus in core countries strengthen when we value-weight observations based on company size (i.e., market capitalization), which is commonly viewed as a proxy for the likelihood of benefiting from government support. After the Italian lockdown, we uncover systematic deviations between observed spreads and those implied by a standard structural model of default. These departures are a decreasing function of firm size (in the spirit of Kelly, Lustig, and Van Nieuwerburgh 2016), but only for firms headquartered in core countries. By contrast, size does not explain deviations from fundamentals in the periphery. Notably, the increase in the nexus in response to the shock is statistically and economically significant even for small firms in the core, but not for those in the periphery; hence, we are not merely documenting a "size effect." We also find that the put spread, a measure of tail risk insurance (Kelly, Lustig, and Van Nieuwerburgh 2016), points toward stronger expectations of public support in core firms compared to peripheral ones.

[2] The result persists in the subset of firms whose bonds were not targeted by the ECB's Pandemic Emergency Purchase Programme (a "monetary policy channel"), for firms whose CDS spread was above that of their sovereign counterparts at the inception of the pandemic (an "exodus from sovereign ceiling" channel, as in Lee, Naranjo, and Sirmans 2016), for companies with below-average government ownership (a "direct ownership channel"), and if we restrict the COVID-19 sample to the month after the Italian lockdown, when discussions about the European Recovery Fund were yet to reach the market (a "demand channel").

To gain a historical perspective, we then expand the time-series dimension of the data and present rolling estimates of the corporate-sovereign nexus throughout the period after the Global Financial Crisis. Historically, the nexus has been larger and more volatile in the periphery than in the core. However, when the pandemic hit, the coefficient for core countries surged to unprecedented levels. In other words, as soon as governments imposed economic lockdowns that posed a threat to corporate survival, credit risk spillovers intensified in European countries with strong fiscal capacity. Similar conclusions ensue when measuring credit risk with corporate bond credit spreads, which are available for a larger cross-section of firms and countries.

Altogether, our analysis points toward market participants factoring expectations of pandemic-induced government support into the valuation of corporate claims in countries with strong fiscal capacity. The intuition for this finding is that, in countries with strong fiscal capacity, corporations can rely on government support to service their obligations, but their debt becomes exposed to sovereign credit risk. Thus, a commitment to future government support ties corporate and sovereign credit risk, provided the sovereign entity is expected to have sufficient fiscal capacity when the support is due. We formalize this argument in an asset pricing model that integrates the pricing of corporate and sovereign debts.

Building on the standard structural framework of Merton (1974), we consider a setting in which a sovereign entity and a representative corporate entity are both characterized by stochastic asset values and risky outstanding debt maturing at a terminal date. At debt maturity, the government may experience a credit shortfall and coercively levy taxes on the corporation. These tax extractions are imposed on the value of corporate assets before the satisfaction of corporate debt obligations, thereby raising corporate credit risk, consistent with the literature on sovereign-to-corporate credit risk spillovers (Lee, Naranjo, and Sirmans 2016; Almeida, Cunha, Ferreira, and Restrepo 2017).

As the tax extraction component enters the ex ante pricing of corporate debt claims, it increases the corporate-sovereign nexus: shocks that increase (decrease) sovereign credit risk are associated with a rise (decline) in the likelihood and extent of tax extraction, and in turn with an increase (reduction) in corporate credit risk. This induces a positive comovement between sovereign and corporate credit risk that is stronger in countries with limited fiscal space, where the government is more likely to face a credit shortfall and corporate debtholders require a greater premium to bear the risk of forceful tax extractions. In contrast, for countries that are far from the default boundary, the tax extraction component plays a much smaller role in the pricing of corporate claims and induces a more limited comovement. This mechanism helps explain the relevance of the sovereign risk channel in peripheral countries during normal times.

The outbreak of the COVID-19 pandemic introduces an entirely new channel in the interaction between corporate and sovereign credit risk. The pandemic significantly reshapes market perceptions of government policy, prompting expectations of government support through widespread (implicit or explicit) guarantees directed, for the first time, at nonfinancial corporations. However, these guarantees are honored only if the sovereign has sufficient capacity to meet its own debt obligations first. Thus, the guarantees are contingent on the government's fiscal position at corporate debt maturity, and are therefore exposed to exogenous shocks in government creditworthiness.

In the model, a country fully commits to the provision of government support to domestic corporations. However, the effects of this commitment on the pricing of corporate debt depend on the fiscal capacity of the country and the expectations that it will honor the guarantee at face value at corporate debt maturity. This setup emphasizes that credit markets price investors' expectations about government guarantees, which depend on the fiscal capacity of the sovereign and may thus diverge from the publicly disclosed amount of the support.

As the government support component enters the ex ante pricing of corporate debt claims in the wake of the COVID-19 pandemic, it increases the corporate-sovereign nexus: shocks that increase (decrease) sovereign credit risk are associated with a decline (rise) in the likelihood and extent of government guarantees, and in turn with an increase (reduction) in corporate credit risk. However, unlike the sovereign risk channel that operates in normal times, this rise in comovement is stronger in countries with high fiscal capacity, where guarantees are likely to be honored and therefore priced into corporate credit risk at near face value. By contrast, in peripheral countries with weak fiscal capacity, where markets apply greater discounts to these guarantees, the comovement induced by the pandemic is muted. This mechanism helps explain why the corporate-sovereign nexus increased only in core countries during the COVID-19 period.

Our work builds on the literature that studies the pass-through of risk between corporate and sovereign entities. A large body of literature has focused on the "doom loop" between the sovereign and the banking sector. Acharya, Drechsler, and Schnabl (2014), Bocola (2016), Brunnermeier, Garicano, Lane, Pagano, Reis, Santos, Thesmar, Van Nieuwerburgh, and Vayanos (2016), Mäkinen, Sarno, and Zinna (2020), and Crosignani (2021) provide theoretical and empirical frameworks to understand this relation. By contrast, the relation between the public and nonfinancial corporate sector has received comparably less attention. Credit risk spillovers to domestic nonfinancial firms are discussed, among others, in Almeida, Cunha, Ferreira, and Restrepo (2017), who exploit variation in credit ratings and investigate the real effects of rating agencies' sovereign ceiling policies, and Bevilaqua, Hale, and Tallman (2020), who use bond yields and suggest that the relation might be state-dependent and driven by an information channel.[3] Our interest in a crisis period motivates the focus on CDS spreads, because flight-to-safety and flight-to-liquidity affect the price of treasury bonds (He, Nagel, and Song 2022). Notable contributions in this area that rely on CDS spreads as a measure of credit risk include Bedendo and Colla (2015), Lee, Naranjo, and Sirmans (2016), and Augustin, Boustanifar, Breckenfelder, and Schnitzler (2018). Unlike the focus of their work, our focus is on how the corporate-sovereign nexus changes in the face of a severe economic contraction. Corsetti, Kuester, Meier, and Müller (2013) modify the standard neo-Keynesian framework by allowing sovereign default risk to affect funding costs in the private sector over concern for tax hikes and disruptive strikes and calibrate the model on CDS data. What differentiates our modelling approach from theirs is the analysis of the pricing of government guarantees within a structural credit risk model. Romer and Romer (2018) focus on the relationship between public debt and the size of the fiscal stimulus in response to financial crises. In contrast, we focus on a broad concept of expected government support to nonfinancial corporations over the medium term (which includes solvency measures, liquidity provisions, and tax exemptions) as factored in credit markets.

Our findings tie in well with the growing number of studies on the effects of the pandemic on financial markets. Among others, Augustin, Sokolovski, Subrahmanyam, and Tomio (2022) document that sovereign credit risk in countries with more fiscal space is relatively less sensitive to the COVID-19 pandemic. We provide complementary evidence by investigating the relation between sovereign and corporate debt credit risk, on top of the response of equity returns, and offer a theoretical framework to interpret it. Elenev, Landvoigt, and Van Nieuwerburgh (2022) conduct a quantitative comparison of the impact of direct debt purchases and guarantees on credit provision in mitigating US corporate credit risk during the pandemic through a macroeconomic model with financial frictions. Benmelech and Tzur-Ilan (2020) argue that country credit risk is a strong determinant of countercyclical policies during the COVID-19 crisis, and Fiore, Martin, and Nagler (2024) find that government fiscal constraints influence firms' disaster vulnerability and investment decisions.[4] Our paper emphasizes the market-implied forward-looking aspect of government support to nonfinancial corporations. During the pandemic, market participants priced in expectations about the scale, credibility, and sustainability of government support in real time, under uncertainty. Thereby, we consider the market recognition of the expected effectiveness of government guarantees (which reflect fiscal capacity and

[3] Credit risk spillovers could also run bidirectionally, as in the work of Kwak (2021), where the build-up of debt in the private sector in excess of the welfare-maximizing benchmark subsequently increases sovereign default risk and spreads.

[4] Along similar lines, Greppmair, Jank, and Smajlbegovic (2023) suggest that short sellers made profits on companies located in financially weak countries, anticipating the importance of a country's fiscal space for the resiliency of its domestic firms.

debt sustainability) as priced into credit derivatives. We are not aware of any study other than ours that considers the asset pricing implications of government support for the credit risk relationship between nonfinancial corporations and their sovereign, and provides an international perspective on credit risk spillovers within a monetary union characterized by a common currency but heterogeneous fiscal capacity.

1. Data and Summary Statistics

We focus on how credit default swap (CDS) spreads of major European corporate *nonfinancial* firms relate to spreads referencing their sovereigns. CDS are standardized contracts providing insurance against default of a reference entity in exchange for a premium in basis points (bps) per year as a fraction of the underlying notional (Duffie 1999). If default occurs, the insurance buyer is entitled to sell the underlying at face value to the insurance seller.[5]

Our source for the CDS data is Markit. The working sample consists of daily mid-quotes from January 1, 2019, to September 10, 2020 (443 trading days), and covering the following nine European countries: Belgium, Finland, France, Germany, and the Netherlands, which we label as the core of the European Union, and Greece, Italy, Portugal, and Spain, which we refer to as the periphery of the European Union, following the classification in Ehrmann and Fratzscher (2017). The sample selection follows Ang and Longstaff (2013), conditional on the availability of corporate CDS data.[6] The focus on eurozone countries anchored to a common currency but unable to take independent revaluation or devaluation decisions minimizes concerns about the effect of strategic devaluation on credit risk. The inclusion of other countries, on the other hand, could bias our estimates.[7]

We work on spreads on CDS contracts with 5-year tenor (the most liquid) that reference senior unsecured debt and denominated in euros. For sovereigns, we rely on cum-restructuring (CR 2014 protocol) instruments, which are the standard reference for Western European sovereign CDS contracts. Corporate CDS data availability leads to the selection of the modified-modified restructuring clause (MMR), but our results are robust to the choice

5 Hull (2003) and Duffie and Singleton (2012) are standard textbook references in the literature on credit risk. Determinants and decomposition of sovereign and corporate CDS are discussed, respectively, in Longstaff, Pan, Pedersen, and Singleton (2011) and Berndt and Obreja (2010). For an appraisal of the literature, see Augustin, Subrahmanyam, Tang, and Wang (2014).

6 We only consider firms with at least 300 valid (i.e., not stale) CDS quotes. Two European countries, Ireland and Austria, are omitted as they have only one nonfinancial firm on Markit with valid CDS data.

7 This aspect is confirmed by the results in table 5 of Augustin, Sokolovski, Subrahmanyam, and Tomio (2022), where the effect on sovereign CDS of the interaction between COVID-19 and fiscal space is largely attenuated when including the foreign exchange rate returns for a sample of 13 countries outside the eurozone.

of the clause.[8] To include a company in the analysis, we require the availability of equity data on Refinitiv, from which we also gather credit ratings and balance sheet data (such as market capitalization, leverage, return on equity, and dividend per share) as of the end of 2018 and 2019. The final sample for our baseline analysis consists of a panel of 123 nonfinancial European firms, of which 99 are in the core and 24 in the periphery, and their sovereigns. Table A.1 in the appendix lists the top 100 firms by market capitalization. We also collect data on 43 financial firms, which we use for robustness considerations.

Summary statistics of the spreads over the period are reported in panel A of Table 1, with countries grouped into core and periphery. For the former, France and Germany have the highest number of firms (40 and 33, respectively), while Italy and Spain have the largest representation in the periphery (11 and 9, respectively).[9] As expected, spreads on sovereign debt of core countries have been on average much lower than for peripherals (12 vs. 107 bps, respectively). For both groups, the period has been characterized by substantial fluctuations in the pricing of sovereign credit risk, as testified by the large standard deviations. Interestingly, unlike for sovereigns, the average CDS spreads of corporations in the core over the period is quite closely aligned with that of peripheral corporations (112 vs. 133 bps), and are more volatile over time and in the cross-section (205 vs. 119 bps).

As is standard in the literature, our analysis alleviates statistical concerns by focusing on changes (i.e., first differences) in log CDS spreads. Panel B collects the corresponding statistics. We note that this data transformation largely attenuates differences in moments between the two areas. For example, the standard deviation of the sovereign series is 43 bps in the core versus 46 bps in the periphery, and a variance-comparison Levene's test cannot reject the null hypothesis of equality between groups (p-value: .12). This evidence reassures us that our conclusions are not unduly influenced by the fact that variables in the two areas fluctuate over markedly different ranges, though the results continue to hold if we analyze first differences in spreads.

Lastly, panel C reports means and standard deviations of firm characteristics that capture relevant dimensions of credit risk. Peripheral firms are on average somewhat smaller and more leveraged than the core firms. In our empirical analyses, we account for imbalances in the number of firms and their characteristics across regions by using, respectively, a resampling procedure and an entropy-balanced estimator.

8 Berndt, Jarrow, and Kang (2007) point out that the cheapest to deliver option is less of a concern in contracts issued under the MMR clause compared to the full restructuring clause. Using corporate MMR spreads as dependent variable, the effect of full restructuring sovereign CDS, whose cheapest to deliver option is relatively less costly, is likely to be *underestimated*, as our Table 11 shows.

9 These numbers are comparable to those in Berndt and Obreja (2010) and Bedendo and Colla (2015), considering that we filter out financial companies.

Table 1
Summary statistics

A. CDS spreads

	Corporate					Sovereign		
Country	Obs.	Firms	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Belgium	2,573	6	0.0101	0.0067	0.0078	0.0017	0.0014	0.0006
Finland	3,340	8	0.0113	0.0084	0.0100	0.0010	0.0009	0.0002
France	17,233	40	0.0121	0.0057	0.0270	0.0018	0.0016	0.0006
Germany	13,824	33	0.0120	0.0073	0.0174	0.0008	0.0008	0.0003
Netherlands	5,195	12	0.0064	0.0039	0.0062	0.0009	0.0009	0.0002
Core	42,165	99	0.0112	0.0063	0.0205	0.0012	0.0011	0.0006
Greece	862	2	0.0255	0.0257	0.0178	0.0204	0.0191	0.0092
Italy	4,705	11	0.0156	0.0090	0.0129	0.0134	0.0131	0.0035
Portugal	866	2	0.0085	0.0071	0.0041	0.0049	0.0045	0.0021
Spain	3,897	9	0.0091	0.0064	0.0060	0.0043	0.0038	0.0019
Periphery	10,330	24	0.0133	0.0087	0.0119	0.0107	0.0088	0.0084
Total	52,495	123	0.0116	0.0067	0.0191	0.0054	0.0020	0.0073

B. $\Delta\log$*(CDS spreads)*

	Corporate					Sovereign		
Country	Obs.	Firms	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Belgium	2,567	6	−0.0005	−0.0000	0.0268	−0.0018	−0.0020	0.0481
Finland	3,332	8	−0.0004	−0.0004	0.0304	−0.0005	−0.0002	0.0594
France	17,193	40	−0.0003	−0.0001	0.0391	−0.0018	−0.0033	0.0354
Germany	13,791	33	−0.0003	−0.0002	0.0404	−0.0005	−0.0005	0.0323
Netherlands	5,183	12	−0.0011	−0.0032	0.0401	−0.0003	−0.0002	0.0326
Core	42,066	99	−0.0004	−0.0002	0.0384	−0.0010	−0.0005	0.0426
Greece	860	2	−0.0012	−0.0000	0.0299	−0.0030	−0.0028	0.0549
Italy	4,694	11	−0.0003	−0.0000	0.0317	−0.0012	−0.0028	0.0340
Portugal	864	2	−0.0005	−0.0031	0.0386	−0.0014	−0.0031	0.0455
Spain	3,888	9	−0.0009	−0.0006	0.0345	−0.0011	−0.0020	0.0438
Periphery	10,306	24	−0.0006	−0.0001	0.0332	−0.0017	−0.0027	0.0463
Total	52,372	123	−0.0004	−0.0001	0.0374	−0.0013	−0.0010	0.0442

C. Firm characteristics

	Debt/Assets		Market cap (bn €)		Equity volatility		Equity beta		Rating
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Median
Belgium	33.34	14.53	46.34	58.90	0.2230	0.0420	0.9063	0.5355	AA
Finland	21.11	12.14	10.64	6.71	0.30715	0.0902	1.366	0.5632	AA
France	30.29	11.70	32.37	41.90	0.2453	0.0654	0.9666	0.3521	AA
Germany	29.04	13.29	29.49	27.86	0.2839	0.0683	0.9968	0.3979	AA
Netherlands	31.93	16.97	29.07	25.67	0.2589	0.0789	1.036	0.3576	AA
Core	29.45	13.50	29.71	35.45	0.2642	0.0735	1.0176	0.4137	AA
Greece	34.03	1.66	5.85	2.06	0.3001	0.0959	0.7778	0.2326	AA
Italy	34.56	14.89	21.08	24.55	0.2598	0.0694	0.8420	0.2815	AA
Portugal	36.43	5.71	13.20	0.8456	0.2198	0.0211	0.7694	0.0095	AA
Spain	42.05	10.02	22.67	14.67	0.2085	0.0351	0.6849	0.2267	AA
Periphery	38.09	12.18	20.11	18.77	0.2350	0.0620	0.7601	0.2498	AA
Total	31.04	13.68	27.94	33.22	0.2588	0.0724	0.9702	0.4014	AA

The table presents summary statistics of the sample. Panel A reports statistics of 5-year CDS spreads for our sample of nonfinancial firms and their sovereigns organized by country and region. Core countries are Belgium, Finland, France, Germany, and the Netherlands, while countries in the periphery are Greece, Italy, Portugal, and Spain. The data are daily from January 1, 2019, to September 10, 2020 (443 trading days), and the source is Markit. Panel B presents growth rates of 5-year tenor corporate and sovereign CDS spreads. Panel C outlines country and regional averages of firms' balance sheet characteristics that are used in our analysis, as of fiscal year 2019. Volatility and market beta from Refinitiv refer to a firm's equity return.

Figure A.1 in the appendix presents the evolution of the spreads over the study period. For each country, we plot a corporate CDS index computed as the average CDS spread across firms weighted by market capitalization as of the end of 2019. Spreads were mostly flat to slightly decreasing until the end of February 2020. The onset of the pandemic is marked by a dizzying spike in corporate CDS across all countries, followed by a reversal. As in the summary statistics, we note that corporate spreads in core countries have been on average comparable to, and at times higher than, those of peripheral companies (without controlling for characteristics). Figure A.2 in the appendix displays the time series of the CDS spreads on European sovereign debt. There, we again observe a run-up in spreads until June 2020 and a flattening thereafter. Compared to the corporate sector, there is a distinct fragmentation in the sovereign CDS market, with higher credit risk for peripheral countries.

Following Pagano, Wagner, and Zechner (2023), and spurred by previous figures, we date the beginning of the COVID-19 subsample as February 24, 2020, which corresponds to the first Italian lockdown.[10] To complete the picture of core/periphery classification, Figure 1 displays six proxies for the fiscal space of the countries in our sample. Fiscal space can be broadly defined as the ability of a government to fund its fiscal policy and service its financial obligations (Romer and Romer 2018). Following Augustin, Sokolovski, Subrahmanyam, and Tomio (2022), we account for the multifaceted nature of fiscal space through a battery of variables capturing the amount of outstanding debt, the cost of financing, and the overall quality of the government. Specifically, we report data as of December 2019 on gross government debt as a portion of GDP, interest expenditures on debt, and four indicators of institutional quality.[11] All variables clearly confirm the presence of two clusters in the euro area, with the five countries in the core being less fiscally constrained than those in the periphery.

2. The Corporate-Sovereign Nexus

We aim to investigate the impact of fiscal capacity on credit risk linkages between nonfinancial corporations and governments, which we refer to as "corporate-sovereign nexus" or simply "nexus." We address the general question whether and under which conditions fiscal capacity on average increases or reduces credit risk spillovers between publicly quoted firms and governments.

The main challenge in establishing a direct effect of fiscal capacity on the nexus is that their relation could be influenced by a wealth of confounding factors. As an illustration, credit risk of both governments and corporations

[10] Moving our event date to February 20, 2020, when the first case of COVID-19 was identified in the Italian town of Codogno, does not affect our conclusions.

[11] *Sources*: OECD, ECB, and World Bank.

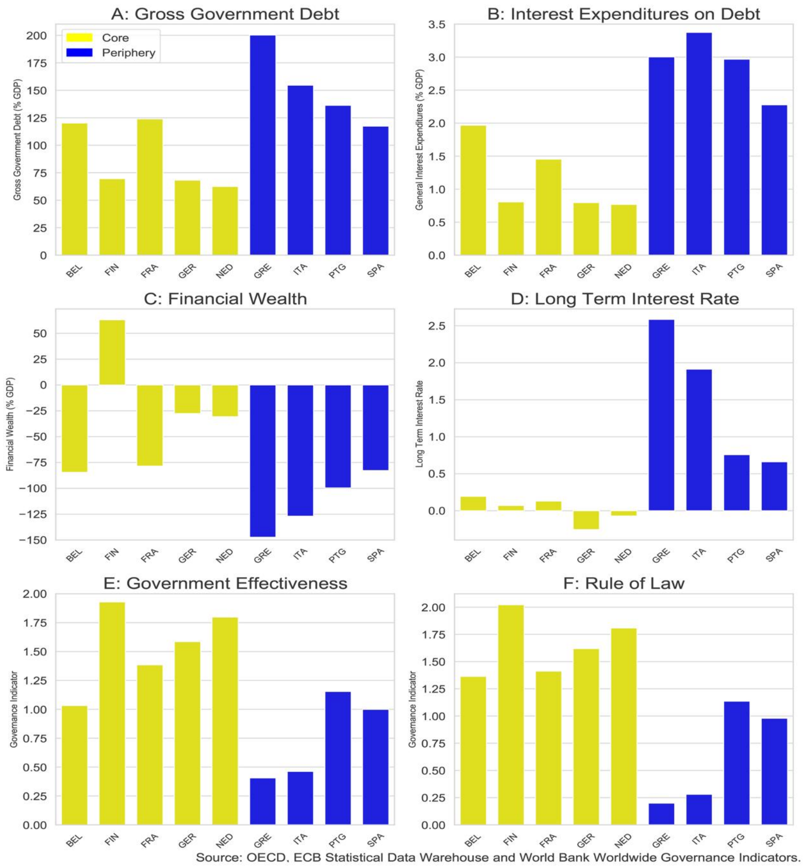

Figure 1
Fiscal capacity measures
This figure plots several measures of fiscal capacity for the nine euro area countries included in the sample as of December 2019. Panel A reports gross government debt over GDP. Panel B considers interest expenditures on debt over GDP. Panel C represents financial wealth, defined as financial assets minus outstanding liabilities. Panel D displays bond implied long-term interest rates. Panels E and F report, respectively, World Bank indexes for government effectiveness, for example, quality of policy, and rule of law, for example, enforcement of property rights.

responds to macroeconomic conditions, such as economic growth and shocks to technology and productivity, and so does their comovement. These fundamentals also have a direct effect on public finances through their impact on revenues and expenditures, albeit at a lower frequency. A cross-sectional approach would therefore suffer from endogeneity concerns. However, a substantial economic contraction that triggers a swift surge in credit risk does not immediately affect fiscal capacity right away. To achieve a good identification, such contraction should in principle be exogenous to both the preexisting structure of the nexus and the fiscal capacity of countries, and affect the entire sample simultaneously.[12] The COVID-19 pandemic clearly meets such requirements, and offers a fruitful context to study how the nexus varies in a cross-section of countries with different fiscal capacities at the outset of the shock, allowing for a clean measurement of the amplifying role, if any, of ex ante public finances on the transfer of sovereign risk to domestic corporate credit risk.

Prior to the pandemic, a broad consensus in the profession viewed the transmission of aggregate demand shocks to domestic firms as being amplified in countries with already high levels of sovereign credit spreads and limited fiscal space. This is a "sovereign risk channel." For these countries, a further deterioration in government creditworthiness could increase credit spreads on the debt of domestic corporations through, for example, the threat of tax hikes and disruptive strikes, as in the model of Corsetti, Kuester, Meier, and Müller (2013). The hazard of an increase in tax burden or expropriation is usually associated with the concept of "sovereign ceiling," which represents a transfer of risk from the sovereign to corporate entities (Almeida, Cunha, Ferreira, and Restrepo 2017). In a similar vein, Lee, Naranjo, and Sirmans (2016) view transmissions of sovereign risk to private sector firms as originating in the threat of expropriation and the transfer of country risks, like corruption and political instability. In our context, the argument that sovereign funding strains exacerbate the severity of the shock and reduce private sector creditworthiness. Thus, credit risk spillovers in the face of the pandemic should be felt more strongly in peripheral E.U. countries that are closer to their fiscal capacity limits.

Nonetheless, COVID-19 brought about profound changes in economic relations. The widespread nature of the shock, along with generalized economic lockdowns imposed by governments, posed a threat to the resilience of the productive system. Under these circumstances, it is conceivable that market participants factored into credit markets the likelihood that the government will also use (at least part of) its fiscal space to rescue the nonfinancial corporate sector. A link between sovereign and corporate credit risk might therefore arise from the pricing of government guarantees. Much of the literature on the pricing of guarantees has thus far focused on financial companies. Acharya, Drechsler, and Schnabl (2014) show that, during the European sovereign debt crisis, government bailouts increased the comovement between sovereign and domestic banks' CDS. In a similar vein, Kelly, Lustig, and Van Nieuwerburgh (2016) document that a collective government guarantee for the financial sector was priced in crash insurance contracts during the 2007–2009 crisis. For banks, credit risk comovement arises from two channels: (1) banks' holding of domestic sovereign bonds, and (2) a backstop option offered by the government to domestic firms. In our context,

[12] Figures A.1 and A.2 show that the jump in credit risk induced by the pandemic is simultaneous in the European market.

the first channel is not present, since nonfinancial firms do not retain significant amounts of sovereign bonds. However, if market participants perceive that a backstop option will also be extended to nonfinancial firms, changes in government risk should affect the spreads of nonfinancial corporations through their effect on the value of such a backstop option. The "government support channel" thus predicts that COVID-19 should have strengthened the corporate-sovereign nexus in core countries, as they were perceived to better sustain firms through ample and credible budgetary measures.

Both the "sovereign risk channel" and the "government support channel" predict that a firm's credit risk sensitivity to its own sovereign should overall become stronger in the face of COVID-19. However, they differ in their predictions regarding the role of fiscal space as captured by the core/periphery classification, with the former implying that the nexus should increase more in the periphery, while the latter sees the nexus increasing in the core of the Union.

It is therefore largely an empirical question which of the two channels prevails in the face of the COVID-19 shock, which we explore in the following sections. Section 2.1 presents our main empirical results. Section 2.2 investigates the economic channels at work. Section 2.3 provides additional analyses and robustness tests. Overall, we find consistent evidence supporting the activation of a government support channel in credit markets in response to the pandemic.

2.1 Main empirical results

2.1.1 Baseline regression model. As a first step in our analysis, Figure 2 illustrates the relation between government and corporate CDS spreads around the COVID-19 pandemic by means of a binned scatterplot. Observations are grouped into equal-width bins, and points in the diagram correspond to within-bin averages of corporate and sovereign spreads. The top plot is for the pre-COVID-19 sample (i.e., from January 1, 2019, until February 23, 2020), while the bottom one refers to the COVID-19 period.[13] By inspecting the graphs, two conclusions emerge. First, two distinct data clusters arise within each plot, coherently with the core/periphery classification. Second, it appears that the pandemic was accompanied by a mild steepening of the relation in peripheral countries, and a much more pronounced one in the core. Thus, this initial evidence suggests that the outbreak had a marked effect on unconditional credit risk comovement in countries with strong fiscal capacity.

[13] Specifically, to obtain Figure 2, we group the values of sovereign CDS spreads into equal-sized bins, compute the mean of the sovereign and corporate CDS spreads within each bin, and create a scatterplot of these data points. We run this procedure separately for core and periphery. For example, we slice the values of the sovereign CDS spreads of 5 core countries recorded over 443 trading days in bins of equal number of observations. We then compute the average of sovereign and corporate CDS spreads within each bin. We also plot the best linear approximation to the conditional expectation function, which is obtained by OLS.

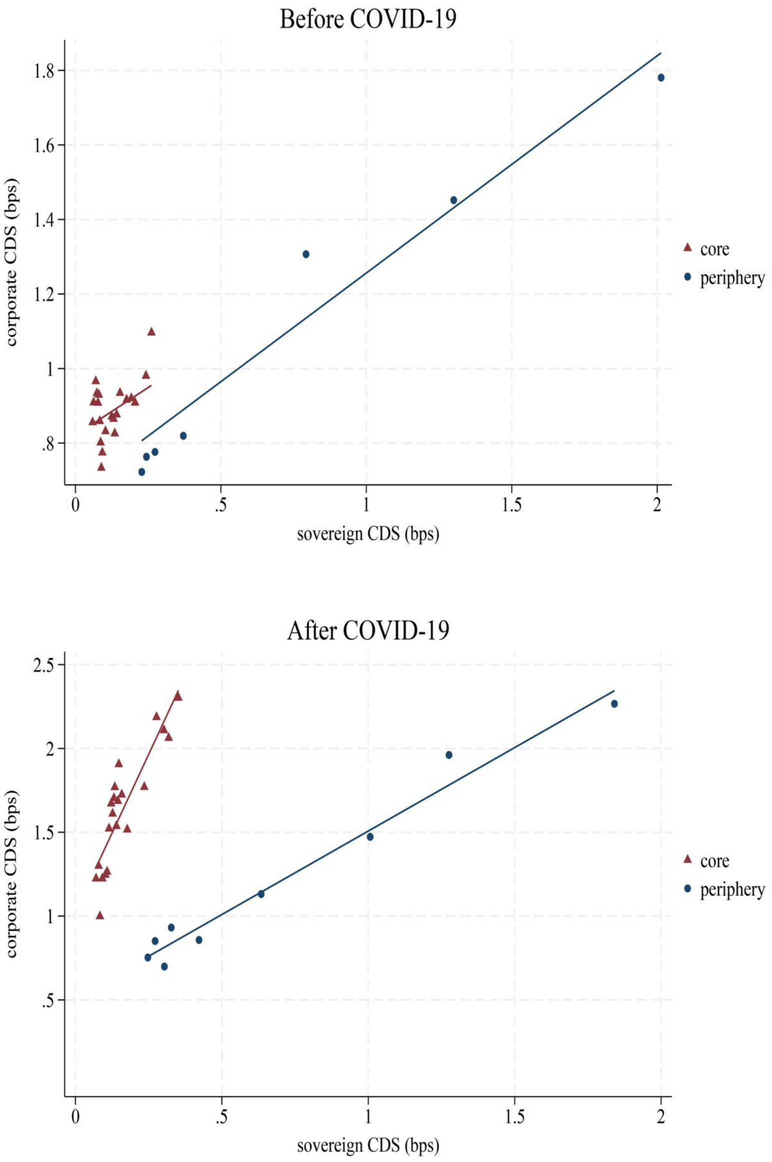

Figure 2
Credit risk comovement
This figure shows a binned scatterplot of sovereign and corporate CDS spreads per unit of notional, before and after the COVID-19 shock (top and bottom panels, respectively). Observations are first grouped into bins at equal-width distance. Data points in the diagram correspond to within-bin averages of the *x*-axis and *y*-axis variables.

To formally test whether this result holds also conditionally on a variety of factors, we resort to a panel regression model with corporate CDS spreads as the dependent variable. This setting allows us to exploit the data's granularity to identify the relation between corporate and government CDS spreads, conditional on aggregate and firm-level controls. In addition, and specific to the evolution of the COVID-19 shock, firm credit risk ultimately reacted to a government decision to impose national lockdowns halting, in part or in full, a number of corporate activities, so it is natural to treat the former as the outcome variable. Following Acharya, Drechsler, and Schnabl (2014) and Augustin, Boustanifar, Breckenfelder, and Schnitzler (2018), we work with daily growth rates in CDS, namely, first differences in log (sovereign and corporate) CDS spreads. This setup improves the stationarity of the data, given the high daily persistence of CDS spreads, and is better suited for a panel of firms and countries with differing spread levels. Moreover, growth rates in CDS spreads approximate well the CDS holding period return (Hilscher, Pollet, and Wilson 2015). We therefore measure the nexus as the sensitivity (i.e., elasticity) of a firm's credit risk to that of its sovereign.

In our empirical approach, we seek to capture two dimensions of the corporate-sovereign nexus. First, in the time series, we interact all variables in the panel regression model with the dummy E that equals one in the days after February 24, 2020, and zero otherwise. The interaction terms reveal how the COVID-19 shock changed preexisting relations. Second, we look for differential effects in the cross-section of countries by estimating the panel regression model separately for core versus periphery, which were characterized by markedly different fiscal capacities at the onset of the crisis (Augustin, Sokolovski, Subrahmanyam, and Tomio 2022). Our panel regression model takes the form

$$\begin{aligned}\Delta \log(\text{CDS Corp})_{ijt} &= \alpha_0 + \alpha_1 \times E + \delta_i + \beta_1 \Delta \log(\text{CDS Sov})_{jt} \\ &\quad + \beta_2 \Delta \log(\text{CDS Sov})_{jt} \times E + \gamma_1 X_{ijt} + \gamma_2 X_{ijt} \times E + \varepsilon_{ijt},\end{aligned} \tag{1}$$

where $\Delta \log(\text{CDS corp})_{ijt}$ is the first difference (between day t and day $t-1$) in the log CDS spread of company i incorporated in country j, and $\Delta \log(\text{CDS Sov})_{jt}$ is the contemporaneous first difference in the log CDS spread on the sovereign debt of country j. The vector X includes: the firm equity return, R_{ijt}, which mirrors the pricing of debt under standard Merton (1974)-type contingent-claim models and should be sufficient (absent guarantees) to absorb the effect of aggregate shocks on both firm's assets and sovereign creditworthiness that could bias our inference (Acharya, Drechsler, and Schnabl 2014); and the CBOE option implied volatility index, VIX_t, which captures aggregate volatility and risk appetite (using VSTOXX as an alternative does not affect our results). The two variables enter the equation both in level and interacted with the COVID-19 period dummy E. The firm fixed effects, δ_i, absorb away any time-invariant attributes, such as

Table 2
Corporate-sovereign nexus, baseline model

	(1) Equally weighted	(2)	(3) Value weighted	(4)	(5) Entropy balanced	(6)
Variables	Core	Periphery	Core	Periphery	Core	Periphery
$\Delta \log(\text{CDS sov})_{jt}$	0.124***	0.222***	0.167***	0.350***	0.123***	0.314***
	(0.013)	(0.040)	(0.015)	(0.038)	(0.013)	(0.044)
$\Delta \log(\text{CDS sov})_{jt} \times E$	0.151***	0.056	0.175***	0.048	0.150***	0.012
	(0.017)	(0.033)	(0.026)	(0.039)	(0.017)	(0.046)
Stock returns$_{it}$	−0.301***	−0.117	−0.412***	−0.225**	−0.309***	−0.104
	(0.035)	(0.071)	(0.047)	(0.090)	(0.036)	(0.097)
Stock returns$_{it} \times E$	−0.174***	−0.163**	−0.086**	−0.270***	−0.176***	−0.287***
	(0.042)	(0.061)	(0.040)	(0.088)	(0.042)	(0.093)
$\Delta \log(\text{VIX})_t$	0.063***	0.053***	0.068***	0.067***	0.062***	0.069***
	(0.004)	(0.008)	(0.006)	(0.009)	(0.004)	(0.010)
$\Delta \log(\text{VIX}_t) \times E$	0.031***	0.001	0.026***	−0.001	0.030***	0.010
	(0.005)	(0.008)	(0.007)	(0.009)	(0.006)	(0.017)
E	0.002***	0.000	0.001***	0.000	0.002***	0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	42,066	10,306	41,634	10,306	40,781	9,442
$\bar{R}^2$	.254	.264	.304	.410	.257	.356
Firms	99	24	98	24	96	22
p-value for $(\beta_2^{Core} = \beta_2^{\text{Periphery}})$	.006		.006		.005	

The table reports estimates from the panel regression in Equation (1), relating changes in log corporate CDS spreads to changes in log CDS spreads of the corresponding sovereigns, the firm's equity return, and changes in the VIX. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Results are reported for the equally weighted model (columns 1 and 2), for the equity market capitalization-weighted model (columns 3 and 4), and for the entropy-balanced model (columns 5 and 6). The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Robust standard errors clustered at the firm level are reported in parentheses. $^*p<.1$; $^{**}p<.05$; $^{***}p<.01$.

country and sector, and arguably—given the relatively short time span of our event window—book leverage.[14]

Columns 1 and 2 in Table 2 present the corresponding OLS estimates for core and periphery, respectively, with associated standard errors clustered at the firm level in parentheses. The coefficient β_1 (first row of the table) measures the corporate-sovereign nexus in the sample preceding the Italian lockdown. In this period, a shock to sovereign credit risk was accompanied by a statistically significant change in corporate risk in the same direction. The effect is about twice as large for nonfinancial corporations in the periphery, for which a 10% increase in sovereign CDS translates into a 2.22% increase in their CDS, compared to firms in the core, for which a shock of the same

[14] In Table A.2 in the appendix, we add as controls standard structural determinants of credit risk, namely, Return Volatility (weekly), Asset Growth (quarterly), and Leverage Growth (quarterly). We also considered additional controls, such as Euroswap rates and the slope of the term structure of sovereign credit risk, and find they do not affect our conclusions. In section 2.3.2, we show that our findings continue to hold using an alternative pooled panel regression model with fully saturated time and sector or country fixed effects.

magnitude generates a more modest 1.24% increase.[15] These estimates are in line with the conventional wisdom that, in normal times, credit risk comovements are amplified in countries with fiscally constrained governments (the "sovereign risk channel").

The second row of the table reveals that the COVID-19 pandemic massively affected the corporate-sovereign nexus for companies in the core, as demonstrated by an economically and statistically significant β_2^{Core} coefficient. The 0.151 estimate implies that the sensitivity of these companies' credit spreads to sovereign shocks effectively doubled during the period, bringing the overall impact ($\beta_1^{Core} + \beta_2^{Core}$) to a level of about 0.27. Thus, a 10% increase in sovereign spreads in the second half of the sample translates into an expected 2.7% increase in spreads for corporate sector debt. In the periphery, the increase in the nexus in the COVID-19 sample β_2^{Peri} is a meager 0.056 (statistically insignificant). The p-value for the F-test of equality between β_2^{Core} (0.151) and β_2^{Peri} (0.056), reported in the last row of the table, confirms that the 0.095 difference (i.e., 0.151 minus 0.056) is not only economically but also statistically significant. Overall, these results point toward the government support channel as the dominant force in the repricing of credit risk markets in the face of the shock: countries that were better positioned to extend government support experienced a tightening in the corporate-sovereign relation.

Among the controls, we note that the loading on stock return is strong and negative and becomes larger in absolute terms during the pandemic for both core and periphery, in line with the intuition from the Merton (1974) model. Option-implied market volatility is positively related to spread changes in the first part of the sample for both groups, and even more so during the COVID-19 period in core countries, thereby highlighting the importance of partialling out changes in the pricing model of corporate credit risk between the two regions unrelated to sovereign risk.

In columns 3 and 4 of Table 2 we perform a value-weighted least squares estimation, where weights are based on equity market capitalization (as of 2019). Intuitively, the larger the company, the stronger its ties with the government, in line with both the government support channel and a coercive taxation motive. This specification strengthens our conclusions, as the difference in the β_2 coefficient between core and periphery widens even further to a full 0.127 (i.e., 0.175 minus 0.048). This evidence is consistent with market participants perceiving and pricing in generous and effective government transfers mostly targeting larger firms in the core. In peripheral countries, with relatively weaker public finances and less resilient structural economic conditions, the COVID-19 shock was accompanied by a very modest increase in corporate-sovereign sensitivity (not statistically significant).

[15] These estimates are comparable to, although generally higher than, those reported in Bedendo and Colla (2015), possibly because of an additional risk transfer taking place during the European sovereign debt crisis that is not in their sample.

In columns 5 and 6, we repeat our baseline analysis using the entropy-based reweighting algorithm of Hainmueller (2012); see Jacob, Michaely, and Müller (2018) for a recent application. Since sample selection is driven by CDS data availability, our estimates could be biased by structural differences in the characteristics of listed firms headquartered across the two eurozone regions. To mitigate this concern, we rely on a reweighting scheme that matches the first three moments of credit-risk-related variables—market capitalization, leverage, market to book ratio, and equity volatility—between the core and the periphery.[16] The results show that accounting for covariate imbalance increases the difference between β_2^{Core} and β_2^{Peri}, both in magnitude and statistical significance.

2.1.2 Firm-level characteristics. We augment our baseline regression model with firm-level characteristics that capture a company's sensitivity to the COVID-19 shock and may also vary systematically between firms in core and peripheral countries. Wenzhi, Levine, Lin, and Xie (2021) show that the pandemic-induced drop in stock prices was milder among firms with larger pre-2020 profitability. We thus control for a firm's profitability, measured as profit before taxes per employee (*PPE*).[17] Fahlenbrach, Rageth, and Stulz (2021) provide evidence that firms with greater financial flexibility exhibited stronger resilience to COVID-19 thanks to their ability to fund the shock-induced revenue shortfall and were therefore less reliant on policy support. We control for this feature by adding *Liquidity*, the ratio of current assets minus stocks to current liabilities. Relatedly, a firm's funding structure and reliance on the banking sector affect its ability to cope with unexpected shortfalls in profitability by temporarily increasing borrowing. Acharya and Steffen (2020) show that firms' ex ante funding structure is priced in the cross-section of stock returns. We capture this effect through *Loans*, the logarithm of a firm's ratio of short-term financial debt to total debt.

We include the three variables in the panel regression model both in level and interacted with $\Delta \log(\text{CDS sovereign})_{jt}$. The corresponding estimates are collected in Table 3, where Z represents each of the three characteristics in turn, all computed in excess of the year-industry median. The overall message from the table is that profitability, liquidity, and bank dependence do not explain the different increases in the intensity of the corporate-sovereign nexus in the two regions.

Furthermore, we use the number of a firm's suppliers (*source*: FactSet) as another proxy for their exposure to the pandemic shock, given that worldwide lockdown policies caused major disruptions in supply chains. Table A.4 in the

[16] Entropy balancing optimally determines weights to achieve exact moment matching while keeping the distribution of observations as close as possible to the data in an entropy sense. Table A.3 in the appendix reports the moments of credit-risk-related variables before and after the reweighting.

[17] We obtain analogous results using net asset turnover (not shown for brevity).

Table 3
Corporate-sovereign nexus, firm-level characteristics

	(1) Core	(2) Periphery	(3) Core	(4) Periphery	(5) Core	(6) Periphery
Variables	$Z=$ PPE		$Z=$ Liquidity		$Z=$ Loans	
$\Delta\log(\text{CDS Sov})_{jt}$	0.141***	0.278***	0.134***	0.236***	0.134***	0.227***
	(0.013)	(0.063)	(0.013)	(0.041)	(0.013)	(0.043)
$\Delta\log(\text{CDS Sov})_{jt}\times E$	0.138***	0.042	0.144***	0.063	0.141***	0.057
	(0.015)	(0.042)	(0.015)	(0.041)	(0.016)	(0.038)
Z_{it}	−0.000	−0.001	0.000	−0.000	−0.004	−0.001
	(0.000)	(0.001)	(0.000)	(0.001)	(0.003)	(0.005)
$Z_{it}\times E$	−0.000	−0.001	−0.000	−0.002*	0.003	0.008
	(0.000)	(0.001)	(0.000)	(0.001)	(0.003)	(0.010)
$\Delta\log(\text{CDS Sov})_{jt}\times Z_{it}$	−0.010***	−0.026	−0.016***	0.029	0.170	−0.397
	(0.003)	(0.031)	(0.002)	(0.030)	(0.184)	(0.413)
$\Delta\log(\text{CDS Sov})_{jt}\times Z_{it}\times E$	0.028	0.153	−0.009***	0.213**	0.090	−0.648
	(0.032)	(0.150)	(0.003)	(0.076)	(0.696)	(1.700)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	35,583	8,500	36,368	8,854	35,504	8,854
$\bar{R}^2$	.267	.300	.266	.306	.264	.306
Firms	85	21	86	21	84	21

The table reports estimates from the panel regression in Equation (1), where the covariates are augmented with firm-specific characteristics that proxy for firm sensitivity to the shock. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Columns 1 and 2 augment the baseline regression with profit per employee (profit before taxes over employees). Columns 3 and 4 control for the liquidity ratio (current assets minus stocks divided by current liabilities). Columns 5 and 6 account for loans (log of loans from financial institutions divided by total debt). Following standard practice, all ratios are industry-year adjusted. The ratios enter the regression both at level and interacted with changes in sovereign CDS spreads. The models are estimated separately for core countries (Belgium, Finland, France, Germany, and the Netherlands) and peripheral countries (Greece, Italy, Portugal, and Spain). Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

appendix repeats the analysis in Table 2 on firms with a number of suppliers below the median computed over the entire distribution. As we can see, the estimates again point to a stronger corporate-sovereign nexus in peripheral countries before COVID, and a strengthening of the nexus for companies in the core only during the pandemic. Finally, our findings are also robust to controlling for timely measures of firm risk constructed from option markets (see Table A.5 in the appendix).

2.1.3 Country-level characteristics. We then consider country-level proxies for the severity of the COVID-19 shock on the country's economy. To incorporate country-level determinants, we follow the empirical setup of Augustin, Sokolovski, Subrahmanyam, and Tomio (2022). To this end, we report in column 1 of Table 4 estimates from a difference-in-differences panel regression with pooled firm-level data across all countries, allowing for a differential loading on sovereign risk in core countries. The coefficient on the triple interaction term—$\text{Core}_j\times\Delta\log(\text{CDS sovereign})_{jt}\times E$—in the second row of the table again confirms that the corporate-sovereign nexus in core

Table 4
Corporate-sovereign nexus, country-level characteristics

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\text{Core}_i \times \Delta \log(\text{CDS Sov})_{jt}$	−0.080*	−0.080*	−0.081*	−0.080*	−0.080*	−0.077*	−0.080*	−0.060	−0.103**
	(0.046)	(0.046)	(0.047)	(0.046)	(0.046)	(0.046)	(0.046)	(0.045)	(0.045)
$\text{Core}_i \times \Delta \log(\text{CDS Sov})_{jt} \times E$	0.142***	0.142***	0.142***	0.142***	0.142***	0.134***	0.142***	0.106***	0.131***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.038)	(0.043)
$\Delta \log(\text{CDS Sov})_{jt}$	0.205***	0.205***	0.206***	0.205***	0.205***	0.203***	0.205***	0.151***	0.195***
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.042)	(0.043)
$\Delta \log(\text{CDS Sov})_{jt} \times E$	0.018	0.017	0.014	0.018	0.018	0.017	0.018	0.059*	0.048
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.034)	(0.037)
$\Delta \log(\text{COVID–19 Cases})_{jt}$		0.001**							
		(0.000)							
$\Delta \log(\text{COVID–19 Deaths})_{jt}$		−0.001**							
		(0.000)							
$\Delta \log(\text{Avg COVID–19 Cases})_t$			0.003***						
			(0.000)						
$\Delta \log(\text{Avg COVID–19 Deaths})_t$			−0.001*						
			(0.000)						
$\text{Trade openness}_{jt}$				0.005					
				(0.014)					
$\text{Hospital beds}_{jt}$					−0.047				
					(0.300)				
$\text{Oxford government response}_{jt}$						−0.027***			
						(0.003)			
Tourism_{jt}							−0.039		
							(0.068)		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week × Sector FE	No	No	No	No	No	No	No	Yes	No
Week × Country FE	No	No	No	No	No	No	No	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs	52,372	52,372	52,372	52,372	52,372	52,372	52,372	52,372	52,372
$\bar{R}^2$	.252	.252	.253	.252	.252	.258	.252	.318	.314
Firms	123	123	123	123	123	123	123	123	123

The table reports estimates from a pooled version of the panel regression in Equation (1), where all countries are included in the estimation and we interact log changes in sovereign CDS with a Core_j dummy that equals one if country j is core (Belgium, Finland, France, Germany, and the Netherlands) and zero otherwise. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Column 1 is the baseline specification, which is then augmented with the following country-specific characteristics (source is the OECD, World Bank, and Oxford COVID-19 Government Response Tracker databases): country-specific growth rate in the number of COVID-19 cases and deaths recorded at the daily frequency in column 2; the growth rate in the daily number of cases and deaths averaged across countries in column 3; trade openness (measured as import plus exports over GDP) in column 4; number of hospital beds per thousand inhabitants in column 5; the Government Response Tracker index in column 6; and the share of GDP generated by tourism per country and year in column 7. Columns 8 and 9 saturate the baseline model with, respectively, week × sector and week × country fixed effects. Robust standard errors clustered at the firm level are reported in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

countries ($\text{Core}_j = 1$) during COVID-19 ($E = 1$) is larger by 0.142 than that in peripheral countries.[18]

In column 2 of the table, we control for the daily number of deaths and COVID-19 cases in a given country. Column 3 includes these variables averaged across Europe, to capture the possibility of a country's reaction in anticipation of foreseeable COVID-19 cases and deaths elsewhere. These variables were under the close scrutiny of the public and investors at the beginning of the pandemic to gauge the severity of the virus and related restrictions; they are also used by Augustin, Sokolovski, Subrahmanyam, and Tomio (2022). Given that national lockdowns caused a severe slowdown or even halt in international trade, we control in column 4 for a country's degree of trade openness (computed as the ratio of exports plus imports to GDP), which measures its reliance on foreign demand and the international supply chain (Ramelli and Wagner 2020).[19] In column 5, we control for the strength of a country's healthcare system, which we measure using the number of hospital beds per thousand inhabitants. The reason is that better-equipped healthcare systems could have mitigated the social and economic consequences of the pandemic. In column 6, we explicitly account for the strictness of government-imposed "lockdown-style" policies through the Oxford COVID-19 Government Response Tracker index.[20] In column 7, we include the country's share of GDP generated by tourism, as this sector was arguably among the most affected by the shock, which in turn triggered a slowdown in related industries. As an alternative modeling approach, we consider a fully saturated fixed effects panel regression model by adding week-by-sector fixed effects in column 8 and week-by-country fixed effects in column 9, in both cases in addition to firm fixed effects.

The table documents that the differential in the nexus between countries classified as core versus periphery remains intact notwithstanding the inclusion of the country-level variables and the alternative fixed effects models. Among the controls, the Oxford Government Response Tracker index is negatively associated with changes in corporate CDS spreads, suggesting that government intervention during the pandemic was generally accompanied by a compression in corporate credit risk.

2.2 Economic channels at work

The surprising result that, among European countries, the pandemic sparked higher credit risk transfers only in those with strong fiscal capacity indicates

18 Columns 1–3 in Table A.6 in the appendix further add to this model firm stock beta and variables structurally correlated with credit risk, which reassures us that the effect we document is not due to structural differences in firm characteristics between core and peripheral European countries.

19 Data on a firm's reliance on international markets—for example, the ratio of foreign to domestic revenues or sales—are insufficiently populated in Refinitiv Eikon for us to carry out this analysis at the firm level.

20 This variable is available on a daily basis. The previous three variables, by contrast, are available at an annual frequency, and we use their values as of the most recent year-end preceding date t to prevent any look-ahead bias.

government support as a strong candidate explanation. However, while public finances are the hallmark of the distinction between core and periphery, countries differ in a number of dimensions that may be at the root of the reaction to the shock, including differences in country policy reactions to the pandemic. In Section 2.2.1, we take on the task of separating potentially coexisting channels at work using granular and timely country-level information from the Oxford COVID-19 Government Response Tracker database. In Section 2.2.2, we move beyond the binary core/periphery classification and rely on various country measures of fiscal health. In Section 2.2.3, we use the approach in Kelly, Lustig, and Van Nieuwerburgh (2016) of looking at deviations from fundamental credit risk to measure government support. Lastly, in Section 2.2.4, we rule out pandemic exposure heterogeneity as an alternative explanation for our results.

2.2.1 Government response policies and the nexus. To gain more direct evidence on the economic drivers of the change in the corporate-sovereign credit risk relation we document above, we leverage the granularity of the Oxford COVID-19 Government Response Tracker database (Hale, Angrist, Goldszmidt, Kira, Petherick, Phillips, Webster, Cameron-Blake, Hallas, Majumdar et al. 2021). The database provides country-level indices at daily frequency covering a wide range of policy responses during the pandemic, grouped into several categories. This wealth of information offers a valuable opportunity to test alternative mechanisms behind the strengthening of the corporate-sovereign nexus. For the purpose of our analysis, we use the Fiscal Measures, Stringency, and Health indices.

The Fiscal Measures index (denoted by E3 in the database) captures announced economic stimulus spending, and reflects a dimension of economic support closely tied to the strength of government guarantees. We scale this variable, reported in USD, by each country's GDP as of December 2019 and express it in percentage points. The Stringency index aggregates all containment and closure measures—from School Closures (C1) to International Travel Controls (C8)—into a single score ranging from 0 (no restrictions) to 100 (maximum stringency). Similarly, the Health index combines all public health measures—from Public Information Campaigns (H1) to Vaccine Policy (H8)—into a single score within the same 0–100 range, with higher values indicating more aggressive health interventions. For ease of comparison with the Fiscal Measures index, we divide both the Health and Stringency indices by 100. We include the three indices in our main analysis both in levels, to test the robustness of our main findings to their inclusion, and interacted with log changes in sovereign CDS spreads, to test for mechanism-specific effects. We demean the indices to facilitate the interpretation of the coefficients.

Table 5
Corporate-sovereign nexus, Oxford COVID-19 Government Response Tracker

Variables	(1) Core	(2) Periphery	(3) Core	(4) Periphery	(5) Core	(6) Periphery
$\Delta \log(\text{CDS Sov})_{jt}$	0.275***	0.278***	0.259***	0.265***	0.235***	0.365***
	(0.023)	(0.047)	(0.022)	(0.045)	(0.022)	(0.060)
Stock returns$_{it}$	−0.473***	−0.278**	−0.460***	−0.278**	−0.463***	−0.277***
	(0.052)	(0.100)	(0.053)	(0.101)	(0.053)	(0.096)
$\Delta \log(\text{VIX})_t$	0.094***	0.054***	0.081***	0.047***	0.081***	0.040***
	(0.007)	(0.012)	(0.007)	(0.012)	(0.007)	(0.011)
Fiscal measures$_{jt}$			−0.086***	−0.053	−0.203***	−0.065*
			(0.023)	(0.037)	(0.066)	(0.037)
Health measures$_{jt}$			−0.074***	−0.063**	−0.069***	−0.003
			(0.013)	(0.029)	(0.013)	(0.033)
Stringency$_{jt}$			0.016*	0.021	0.014*	0.002
			(0.008)	(0.018)	(0.008)	(0.019)
$\Delta \log(\text{CDS sov})_{jt} \times$ Fiscal Measures$_{jt}$					2.100*	−7.294
					(1.079)	(4.858)
$\Delta \log(\text{CDS sov})_{jt} \times$ Health Measures$_{jt}$					−0.220	1.288*
					(0.400)	(0.671)
$\Delta \log(\text{CDS sov})_{jt} \times$ Stringency$_{jt}$					0.016	−1.585***
					(0.277)	(0.468)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	13,856	3,330	13,832	3,330	13,832	3,330
$\bar{R}^2$	.345	.332	.359	.339	.360	.384
Firms	99	24	99	24	99	24

The table reports estimates from panel regression models that relate changes in log corporate CDS spreads to changes in the log CDS spreads of the corresponding sovereigns during the COVID-19 period (defined as the days after February 24, 2020). The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Columns 1 and 2 control for the firm's equity return and changes in the VIX. Columns 3 and 4 additionally control for the following indices from the Oxford COVID-19 Government Response Tracker database: Fiscal Measures, Stringency, and Health Measures. Columns 5 and 6 include these indices both at level and interacted with changes in sovereign log CDS spreads. Robust standard errors clustered at the firm level are reported in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

Since the policy measures were only implemented during the pandemic period, we reestimate in columns 1 and 2 of Table 5 the coefficients from our baseline regression conditional on the COVID-19 shock, that is, during the post February 24, 2020, period. As expected, the coefficients on the nexus in the first row of the table correspond to the sum of the β_1 and β_2 coefficients from the baseline fully interacted model, that is, 0.275 for Core in column 1 of Table 5 equals 0.124 plus 0.151 from Table 2, and similarly for Periphery.

In columns 3 and 4 of Table 5, we augment the baseline panel regression model by adding all the aforementioned policy indices in levels. As we can see, our findings are robust to the inclusion of these indices, with the nexus coefficients similar across specifications. Interestingly, the negative and significant coefficient on Fiscal Measures for core countries implies that ampler fiscal measures were accompanied by a decline in corporate CDS spreads for core firms, with a statistically significant coefficient of -0.086. In peripheral countries, the same fiscal measures had a more modest effect on corporate credit spreads, as the coefficient is smaller in magnitude at -0.053 and not statistically significant.

In columns 5 and 6, we augment the model further by including interaction terms between changes in sovereign CDS spreads and each of the policy indices. This setup provides us a direct test for the economic channel underneath the strengthening of the corporate-sovereign relation in the face of the shock. While the nexus coefficients in the first row are no longer directly comparable with those in the previous models, due to the inclusion of the interaction terms, a few noteworthy results emerge. For core eurozone countries, the interaction between sovereign CDS changes and the Fiscal Measures index is positive and statistically significant (p-value = 5.5%). The remaining interaction terms are not significant. This indicates that, conditional on the sovereign risk shock, the corporate-sovereign nexus in core countries correlates with the strength of fiscal support measures, consistent with a repricing of guarantees. In contrast, for peripheral countries, significant interactions are found with the Health index (positive, p-value = 6.8%) and especially with the Stringency index (negative and highly significant).

We also estimate two variants of the aforementioned regression to address concerns about contemporaneity between sovereign CDS spreads and Fiscal Measures. First, in Table A.7, we replace the sovereign CDS spreads with their residuals from a regression on Fiscal Measures, the VIX, and country fixed effects, and use them both at level and to construct the interaction terms employed in the analysis. As a second check, in Table A.8 we lag Fiscal Measures by 1 week, namely 5 trading days. Given the limited persistence of this variable, such a specification should effectively mitigate contemporaneity concerns by breaking the overlap between fiscal announcements and sovereign CDS spreads. In both tables, our findings remain robust across specifications. In core countries, the interaction effect is positive and economically meaningful, while it is muted in the periphery, suggesting that the result is not mechanical.

This analysis provides direct support to the argument that, conditional on the shock, the comovement between corporate and sovereign credit risk in core countries increased with the strength of government support, primarily operating through fiscal measures. In the periphery, by contrast, the response appears more closely tied to the broader policy and health environment.

2.2.2 Role of fiscal space. Next, we explore more directly the role of fiscal capacity in driving the reaction of credit risk markets to the COVID-19 pandemic. We begin by using the country-level measures of fiscal capacity shown in Figure 1, to which we add the current deficit relative to GDP. These variables capture different facets of public finances in December 2019, right before the outbreak of the pandemic. We then reestimate the pooled panel regression model by replacing the Core_j dummy with such continuous measures, one at a time. To ease the interpretation of the coefficients, we sign the variables so that higher values reflect healthier public finances; that is, we flip the sign of Gross Government Debt over GDP, Interest Expenditures on Debt, and the Long-Term Interest Rate.

The corresponding estimates are reported in columns 1–6 of Table 6. In the pre-COVID-19 sample, the loading on the interaction between log CDS sovereign spreads and each fiscal capacity variable (first row of the table) is consistently negative, confirming the conventional wisdom that the nexus tends to be stronger in countries with weak public finances in "normal times." During the pandemic sample, the relation reverses, as the interaction coefficients with the COVID-19 dummy (second row of the table) are positive and large when compared to the previous ones. With the exception of the Fiscal Wealth measure, the effect is economically and statistically significant for all of the fiscal capacity variables.

We further collect more time-varying measures of fiscal health. Specifically, in the last two columns of Table 6 we include the maturity and (minus) the average interest rate of outstanding public debt, as recorded by the ECB Statistical Data Warehouse at the monthly frequency. The average interest rate on public debt provides a more complete picture of the cost of debt and borrowing capacity in the short run than the long-term rate. Governments with longer debt maturity are less sensitive to rollover risk and their funding costs are less exposed to large unexpected shocks. We incorporate these two monthly variables to more timely reflect the fiscal health of governments. Our result continues to hold, as we observe a statistically significant increase in the nexus for companies headquartered in countries with lower rates on debt and longer debt maturity.

Furthermore, our core-periphery classification aligns well with long-term sovereign credit assessments as measured by Fitch Ratings as of end-2019:[21] Specifically, all core countries have *very high credit quality*: Germany (AAA), Netherlands (AAA), Finland (AA+), France (AA), and Belgium (AA-). In comparison, all peripheral countries—often referred to as GIPS—have *high* or *good credit quality*: Spain (A-), Italy (BBB), Portugal (BBB), and Greece (BB). The correspondence of our core/periphery classification with the forward-looking credit risk assessment by Fitch Ratings reinforces the robustness of our classification as a meaningful proxy for fiscal capacity. In what follows, we retain the binary core/periphery classification for its simplicity as a grouping criterion.

2.2.3 Deviations from fundamental credit risk. Standard models for credit risk predict that in a frictionless world, any shock to a firm's assets would affect its liabilities, with an intensity that depends on leverage. By contrast, in the face of COVID-19, the cost of default risk protection for non-financial corporate debt became more tightly linked to sovereign credit risk,

21 https://www.fitchratings.com/entity/

Table 6
Corporate-sovereign nexus, fiscal capacity measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FiscalCap$_j$ measure							
	– Debt	– Debt exp.	Wealth	-Deficit	Rule of law	Govt. eff.	– Avg. rate	Maturity
$FiscalCap_i \times \Delta \log(\text{CDS sov})_{jt}$	−0.096**	−0.031	−0.088***	−0.015**	−0.068*	−0.070*	−0.076***	0.008
	(0.044)	(0.020)	(0.021)	(0.006)	(0.035)	(0.037)	(0.025)	(0.008)
$FiscalCap_i \times \Delta \log(\text{CDS sov})_{jt} \times E$	0.141**	0.061***	0.038	0.019**	0.101***	0.115***	0.085***	0.028**
	(0.054)	(0.021)	(0.033)	(0.007)	(0.037)	(0.043)	(0.030)	(0.011)
$\Delta \log(\text{CDS Sov})_{jt}$	0.045	0.095***	0.099***	0.041	0.237***	0.237***	−0.020	0.039
	(0.042)	(0.028)	(0.010)	(0.037)	(0.057)	(0.058)	(0.050)	(0.113)
$\Delta \log(\text{CDS Sov})_{jt} \times E$	0.272***	0.222***	0.143***	0.262***	−0.015	−0.030	0.306***	−0.245
	(0.061)	(0.036)	(0.022)	(0.056)	(0.053)	(0.059)	(0.062)	(0.149)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs	52,372	52,372	52,372	52,372	52,372	52,372	52,372	52,372
$\bar{R}^2$	.252	.252	.252	.252	.252	.252	.252	.254
Firms	123	123	123	123	123	123	123	123

The table reports estimates of the pooled panel regression from column 1 of Table 4, where the Core$_j$ dummy is alternatively replaced with fiscal capacity measures from Figure 1 (signed so that higher values reflect healthier government) augmented with the ratio of fiscal deficit to GDP and, in the last two columns, the average interest rate and maturity of the outstanding public debt as recorded by the ECB Statistical Data Warehouse at the monthly frequency. The dependent variable is log changes in corporate CDS credit spreads, and the fiscal capacity measure is reported in the corresponding column header. Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

even after controlling for, among other variables, equity returns. This is consistent with the wedge in the valuation of corporate claims created by the pricing of government guarantees extended to debtholders (Acharya, Drechsler, and Schnabl 2014). A complementary test in Kelly, Lustig, and Van Nieuwerburgh (2016) looks at systematic deviations of actual spreads from those predicted by a standard structural model of default. They document deviations that are a negative function of size for financial firms during the Global Financial Crisis and argue that this fact reflects the pricing of public guarantees. We show that a similar analysis on our sample uncovers wider deviations for large nonfinancial firms during COVID-19 in core countries only.[22]

We compute the model-implied CDS rate from the Merton (1974) model using Bharath and Shumway (2008)'s measure of distance to default.[23] Similar to Kelly, Lustig, and Van Nieuwerburgh (2016), we then estimate cross-sectional weekly regressions of the form

$$\text{CDS}_{it} = a_t + b_{1t}\text{Merton Spread}_{it} + b_{2t}\text{Size}_{it} + b_{3t}\text{Leverage}_{it} + \varepsilon_{it}, \quad (2)$$

separately for observations in the core and periphery. As in Kelly, Lustig, and Van Nieuwerburgh (2016), we define size as the 1-month-lagged logarithm of market value of equity plus book value of debt and leverage as the 1-month-lagged log ratio of book value of assets to market value of equity.

Figure 3 plots the 4-week trailing average of the resultant slope coefficient on size (b_{2t}), along with standard error bands. Controlling for leverage and volatility, the slope of risk-adjusted corporate spreads to firm size in the pre-COVID sample fluctuates in a rather narrow and similar range in both core and peripheral countries. As the shock hits the markets, we observe markedly different behaviors between the two areas. The slope becomes more negative in core countries, and the discount widens to values as much as five times pre-COVID levels. Despite the similarity in the severity of the shock and the relative increase in credit risk, size does not systematically explain departures from fundamentals for CDS referencing firms in peripheral countries. Therefore, at the outbreak of the COVID-19 shock, actual CDS spreads were priced at a discount with respect to predicted spreads only in the case of larger companies located in core E.U. countries; in other words, countries that were perceived to be far from their fiscal capacity limits and whose governments were deemed ready to extend public support.

We gain further evidence supportive of a public support argument from tail risk insurance metrics constructed using equity options data, which

[22] This type of analysis is in line with the approach in Bai, Goldstein, and Yang (2019), who argue that the basket-index put spreads puzzle can be solved by accounting for equity dynamics and the "leverage effect."

[23] As is standard, we take current liabilities plus one half of long-term debt to proxy for face value of debt and close price times amount of ordinary shares as market value of equity. We update the stock's volatility using the RiskMetrics variance model to take into account time variation in risk. Using option-implied volatility diminishes sample size due to data availability but conveys the same message.

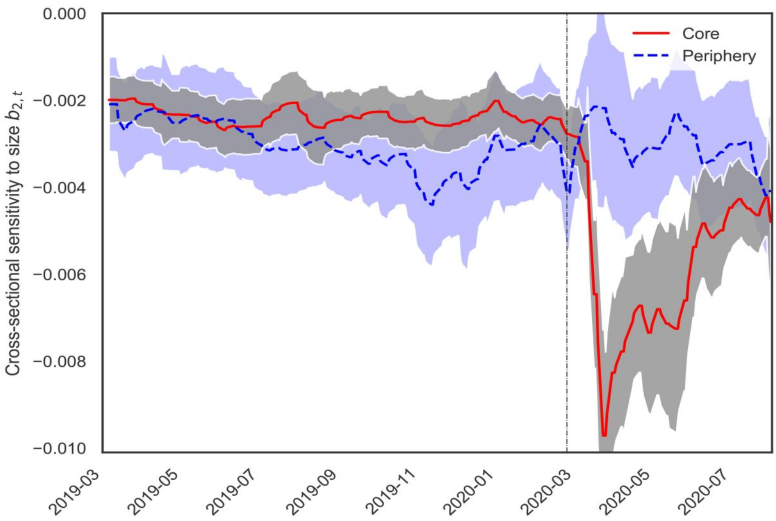

Figure 3
Deviations of CDS from fundamental credit risk as function of size
We calculate the model-implied CDS rate from the Merton (1974) model using Bharath and Shumway's (2008) measure of distance to default (DD). We then estimate cross-sectional weekly regressions of the form $\text{CDS}_{it} = a_t + b_{1t}\text{Merton spread}_{it} + b_{2t}\text{Size}_{it} + b_{3t}\text{Leverage}_{it} + \varepsilon_{it}$, separately for observations in the core and periphery. The plot displays the 4-week trailing average relative to the time series of the resultant coefficient on size, b_{2t}, with shaded areas denoting one-standard-deviation bands. The dash-dot vertical line represents the begin of the COVID-19 sample on February 24, 2020.

complement the paper from a different angle. Kelly, Lustig, and Van Nieuwerburgh (2016) argue that the put spread, computed as the difference in costs between a basket of out-of-the-money put options on individual index constituents P^{basket} and a comparably out-of-the-money put option on the index P^{index}, captures the pricing of sector-wide tail risk insurance. We extend their approach to measure the expectation of public support to nonfinancial firms at the onset of the COVID-19 pandemic. To this end, we retrieve options on European stock market indices and their constituents from Ivy DB Europe to compute the per-euro spread of a country's index as the difference between P^{basket} and P^{index}, scaled by the strike price. Because of data quality and availability issues, we are able to compute the daily put spreads only for the indices of the two largest core countries (the French CAC and the German DAX) and the two largest peripheral countries (the Italian FTSE MIB and the Spanish IBEX).

We average the daily put spreads within each core/periphery group and display in Figure A.3 in the appendix the difference between the core and periphery values. The resultant series can be interpreted as the differential in the market participants' perception of the likelihood of a backstop option to the overall production sector in case of tail risk across the two areas, as priced in equity contingent claims. As we can see from the figure, the series surges during the weeks after the pandemic, with a threefold increase from the 1.4 pre-COVID average level to the 3.3 average thereafter. This pattern is again in agreement with expectations of stronger public support in core firms compared to peripherals, having long-lasting pricing effects.

Additionally, we look at the market reaction to specific forms or mechanisms of government support in response to the pandemic. In Appendix A, we provide institutional details regarding changes in government support policies that took place in the eurozone. Moreover, we document a decline in the difference between corporate CDS spreads and the Merton-implied spreads around a selection of major announcements of public support (see Figure A.4 in the appendix). Finally, Google Trends of worldwide searches for the terms "bailout" and "government support" experience a fivefold rise precisely in concomitance with the sharpest increase in the nexus.

2.2.4 Pandemic intensity. Thus far, our findings provide evidence that the difference in fiscal capacity operating through the repricing of government support is the primary driver of heterogeneity in the corporate-sovereign nexus during the COVID-19 crisis. However, a potential endogeneity concern arises from the fact that countries were differentially exposed to the pandemic, with some experiencing higher case numbers or more severe health impacts than others. In this section, we investigate whether difference in pandemic intensity can offer an alternative explanation for our results.

We begin by considering a placebo country grouping based on pandemic intensity. Specifically, we split the sample into above- and below-median countries using two alternative measures: the case fatality ratio (confirmed deaths relative to confirmed cases) and the case-to-population ratio (confirmed cases relative to population). These ratios are computed using country-level data from the World Health Organization as of the end of our sample period. We reestimate our baseline regression model separately for each group, and report the estimates in Table 7. Across both placebo country splits, we find no evidence of a systematically stronger corporate-sovereign nexus in high-intensity relative to low-intensity countries, either before or after the onset of the pandemic. This suggests that differences in pandemic severity are not driving the observed heterogeneity in the response of the corporate-sovereign nexus during the COVID-19 crisis.

To allay this concern at a more disaggregated level of analysis, we estimate the full panel regression model separately for each country, including time-varying country-level controls for the daily number of COVID-19 cases and public health expenditure. These controls are useful measures of the heterogeneity in evolution of the pandemic and health spending across countries. We report the regression estimates in Table 8. The increase in the corporate-sovereign nexus during the COVID-19 sample remains consistently large and statistically significant in each of the individual core countries, even after

Table 7
Corporate-sovereign nexus, COVID-19 intensity sorts

	(1)	(2)	(3)	(4)
	Case fatality		Cases/Population	
Variables	Low	High	Low	High
$\Delta\log(\text{CDS sov})_{jt}$	0.122***	0.155***	0.129***	0.175***
	(0.022)	(0.015)	(0.014)	(0.032)
$\Delta\log(\text{CDS sov})_{jt}\times E$	0.111***	0.150***	0.141***	0.112***
	(0.025)	(0.019)	(0.019)	(0.027)
Stock returns_{it}	−0.246***	−0.292***	−0.281***	−0.203***
	(0.049)	(0.048)	(0.039)	(0.071)
Stock $\text{returns}_{it}\times E$	−0.150***	−0.181***	−0.189***	−0.110*
	(0.048)	(0.055)	(0.042)	(0.062)
$\Delta\log(\text{VIX})_t$	0.068***	0.057***	0.065***	0.051***
	(0.006)	(0.005)	(0.004)	(0.007)
$\Delta\log(\text{VIX})_t\times E$	0.033***	0.015**	0.032***	−0.004
	(0.007)	(0.006)	(0.006)	(0.006)
E	0.001***	0.002***	0.002***	0.001
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	−0.001***	−0.001***	−0.001***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Firm FE	Yes	Yes	Yes	Yes
No. obs.	22,735	29,637	40,359	12,013
$\bar{R}^2$	.224	.276	.249	.281
Firms	54	69	95	28
p-value for $\beta_1^{Low}=\beta_1^{High}$	.228		.200	
p-value for $\beta_2^{Low}=\beta_2^{High}$	.205		.390	

The table reports estimates from the panel regression in Equation (1), relating changes in log corporate CDS spreads to changes in log CDS spreads of the corresponding sovereigns and firm-specific and aggregate variables. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. The models are estimated separately for countries with above-median and below-median COVID-19 intensity, measured by the case fatality ratio (columns 1 and 2) and by the cases/population ratio (columns 3 and 4). Robust standard errors clustered at the firm level are reported in parentheses. $^*p<.1$; $^{**}p<.05$; $^{***}p<.01$.

accounting for heterogeneous pandemic dynamics and health system capacity. In contrast, none of the peripheral members displays a significant reaction of the nexus to the pandemic. This result confirms that our core/periphery classification has a strong financial backbone, reflected in the country-level repricing of corporate credit risk induced by the shock. Together, these results mitigate concerns that our findings are confounded by cross-country variation in pandemic intensity, effectively ruling out this alternative explanation.

We also use these estimates in a direct cross-sectional test, regressing the average Fiscal Measures on the change in nexus during the pandemic β_2 from Table 8. The resultant coefficient is positive (0.004) and significant at the 10% level. Although statistical power is limited, given that the regression includes only nine observations, the results again point to a positive association between the corporate-sovereign relation and the strength of government support.

Table 8
Corporate-sovereign nexus, analysis by country

	Core					Periphery			
Variables	BEL	FIN	FRA	GER	NED	GRE	ITA	PRT	SPA
$\Delta\log(\text{CDS sovereign})_{jt}$	0.075**	0.015**	0.212***	0.136***	0.123***	0.170	0.167***	0.271**	0.350***
	(0.021)	(0.005)	(0.019)	(0.026)	(0.010)	(0.163)	(0.052)	(0.016)	(0.068)
$\Delta\log(\text{CDS sovereign})_{jt}\times E$	0.140**	0.088***	0.155***	0.193***	0.197***	−0.050	0.056	0.135	−0.009
	(0.050)	(0.021)	(0.026)	(0.036)	(0.012)	(0.096)	(0.035)	(0.080)	(0.031)
$\Delta\log(\text{COVID–19 Cases})_{jt}$	0.001	−0.002	0.002***	−0.002***	−0.007***	0.007	0.008***	−0.006*	0.006**
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.006)	(0.002)	(0.001)	(0.002)
Health Expenditure$_{jt}$	−0.000	−0.004	−0.035***	−0.001	−0.003	0.066	0.628	−0.014	0.016
	(0.004)	(0.010)	(0.010)	(0.003)	(0.005)	(0.065)	(0.371)	(0.090)	(0.011)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	2,567	3,332	17,193	13,791	5,183	860	4,694	864	3,888
$\bar{R}^2$	.257	.213	.301	.231	.285	.133	.255	.524	.309
Firms	6	8	40	33	12	2	11	2	9

The table reports estimates from the panel regression in Equation (1), relating changes in log corporate CDS spreads to changes in log CDS spreads of the corresponding sovereigns, firm-level returns, and aggregate risk factors. The regression model is estimated separately for each of the nine countries in our sample and augmented with the number of COVID-19 cases and the health expenditure. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

2.3 Further analyses and robustness tests

2.3.1 Larger cross-section or longer time series. We resort to CDS data to quantify the corporate-sovereign nexus as they offer a clean and timely measurement of credit risk. This design naturally limits our study to the cross-section of companies—typically large and well-established companies—on which CDS contracts are written. To beef up the representativeness of our sample, while sacrificing some data quality, we repeat our analysis on corporate bonds. We use Refinitiv data on 1898 plain-vanilla bonds issued by non-financial public companies in the considered countries and alive during 2020. We summarize a firm's debt structure by computing daily yield to redemption and modified duration as value-weighted averages across all its available bonds on that day, with weights given by a bond's relative amount issued. After eliminating stale quotes and firms with a high percentage of missing values, the final sample of 255 firms—of which 194 in the core and 61 in the periphery—makes our analysis more representative of the universe of European public firms. As the economic intuition would suggest, the CDS sample includes larger firms than does the bond sample, with the median market capitalization going from €14 bn in the former to €4.6 bn in the latter. On the downside, it is well-known that corporate bonds trade infrequently and that their spreads contain a significant nondefault time-varying component, which relates to bond-specific and marketwide liquidity (Longstaff, Mithal, and Neis 2005; Houweling, Mentink, and Vorst 2005; de Jong and Driessen 2012). Both these issues could potentially contaminate our inference based on the bond sample.

We reestimate the model in Equation (1) by replacing the corporate CDS spreads with bond credit spreads, which we compute by subtracting from the aforementioned yield to maturities the euro area risk-free rate of the nearest modified duration. Columns 1 and 2 of Table 9 use daily data, and show that our main conclusions extend to bond credit spreads. The ex-pandemic loadings on sovereign credit risk in the first row are positive, and much larger in the periphery. During the COVID-19 period, the opposite holds as the 0.172 interaction coefficient in the core far outweighs the 0.048 figure in the periphery (the p-value of the difference is below .01). We also report in columns 3 and 4 the estimates from weekly data, which ameliorate concerns of low trade frequency (but at the cost of fewer observations). Similar conclusions arise, with the corporate-sovereign soaring in fiscally healthy countries during the pandemic.[24]

We further extend our cross-section of countries to include all firms with available corporate bond and equity data from Datastream in the following 16 European countries: Austria, Belgium, Denmark, Finland, France, Germany,

[24] Additionally, columns 4–6 in Table A.6 show that our conclusions continue to hold when estimating the pooled model of Table 4 on the bond sample with an augmented set of regressors that includes firm equity beta and structural determinants of credit risk.

Table 9
Corporate-sovereign nexus, bond sample

	(1)	(2)	(3)	(4)
	Daily		Weekly	
Variables	Core	Periphery	Core	Periphery
$\Delta\log(\text{CDS sov})_{jt}$	0.021	0.093***	0.092***	0.131***
	(0.016)	(0.013)	(0.020)	(0.016)
$\Delta\log(\text{CDS sov})_{jt} \times E$	0.147***	0.054**	0.207***	−0.034
	(0.024)	(0.021)	(0.033)	(0.028)
Firm FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
No. obs	81,612	25,640	16,869	5,306
$\bar{R}^2$	.006	.025	.048	.071
Firms	194	61	194	61

The table reports estimates from running the panel regression in Equation (1) on corporate bonds credit spreads in place of CDS. For each corporate issuer, yield to maturity and modified duration are averages across issues weighted on amount outstanding. We use ECB benchmark rates based on triple A governments nominal spot rates to measure risk-free rates at different horizons. We then compute a firm credit spread "CS" by subtracting from its yield to maturity the risk-free rate corresponding to its modified duration bucket. We then relate changes in log corporate spreads to changes in log CDS spreads of the corresponding sovereign, modified duration, and firm-specific and aggregate variables. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Results are reported at the daily frequency (columns 1 and 2), and at the weekly resolution (columns 3 and 4). The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

Greece, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. The resultant 328 firms offer a comprehensive representation of European corporate debt issuers. To account for cross-country differences in fiscal capacity, we classify countries based on their Fitch Long-Term Issuer ratings as of 2019 year-end, distinguishing between those rated AA or above and those rated below. In Table 10, we estimate the baseline regression separately for each rating group, at both daily and weekly frequencies, and find that our results remain robust in this broader sample.

To put our results into a broader historical perspective, we expand the time series dimension of the CDS data set. Specifically, we estimate the panel regression in Equation (1) separately for core and peripheral countries throughout the period from January 1, 2014, to September 10, 2020. The begin date corresponds to the introduction of the sovereign CR14 clause in the CDS contract, which offers protection from the risk of debt renomination. To appreciate the time variation in the nexus, we run the estimation on 1-year windows of daily data that are rolled forward after one quarter, and we drop the interaction terms with the event dummy, which are redundant in the rolling model. Figure 4 displays the resultant nexus coefficient relating changes in log corporate CDS spreads to those in log CDS spreads of the corresponding sovereign in the two areas. Each coefficient is plotted in

Table 10
Corporate-sovereign nexus, extended bond sample

	(1)	(2)	(3)	(4)
	Daily		Weekly	
Variables	AA and Above	Below AA	AA and Above	Below AA
$\Delta\log(\text{CDS sov})_{jt}$	0.004	0.074***	0.064*	0.119***
	(0.024)	(0.010)	(0.034)	(0.015)
$\Delta\log(\text{CDS sov})_{jt} \times E$	0.148***	0.066***	0.202***	0.005
	(0.033)	(0.017)	(0.044)	(0.025)
Firm FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
No. obs	93,621	32,587	19,347	6,742
$\bar{R}^2$	.003	.021	.028	.053
Firms	250	78	250	78

The table reports estimates from running the panel regression in Equation (1) on corporate bonds credit spreads in place of CDS. For each corporate issuer, yield to maturity and modified duration are averages across issues weighted on amount outstanding. We use ECB benchmark rates based on triple A governments nominal spot rates to measure risk-free rates at different horizons. We then compute a firm credit spread 'CS' by subtracting from its yield to maturity the risk-free rate corresponding to its modified duration bucket. We then relate changes in log corporate spreads to changes in log CDS spreads of the corresponding sovereign, modified duration, and firm-specific and aggregate variables. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Results are reported at the daily frequency (columns 1 and 2), and at the weekly resolution (columns 3 and 4). The sample includes a broader set of 16 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom). The models are estimated separately for countries with a Fitch Long-Term Issuer Rating at the end of 2019 of AA or higher, and for those with a rating below AA. Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

correspondence to the begin date of its estimation window, and the dashed vertical line represents the first sample that includes COVID-19 data.

From the figure, we note that the nexus has been historically higher in peripheral countries, in line with the common wisdom that sovereign spill-overs are normally amplified in countries with low fiscal capacity (Corsetti, Kuester, Meier, and Müller 2013; Lee, Naranjo, and Sirmans 2016; Augustin, Boustanifar, Breckenfelder, and Schnitzler 2018). In the pre-COVID-19 sample, the core coefficient varies in a much more narrow range and does not exhibit economically large swings. The pandemic lead to an unprecedented surge in the nexus for core countries, with a coefficient reaching levels above 0.2. In comparison, the increase has been milder for peripheral countries, to the point that the two coefficients have never been any closer historically.

2.3.2 Robustness checks. We assess the robustness of our finding to a number of econometric concerns and model design choices. The corresponding estimates, which are collected in Table 11, reveal that our conclusions on the effect of the pandemic on the nexus continue to hold or are even reinforced by all these tests.

First, we worry that our findings might be picking up the effect of the ECB's Pandemic Emergency Purchase Programme (PEPP), the temporary asset

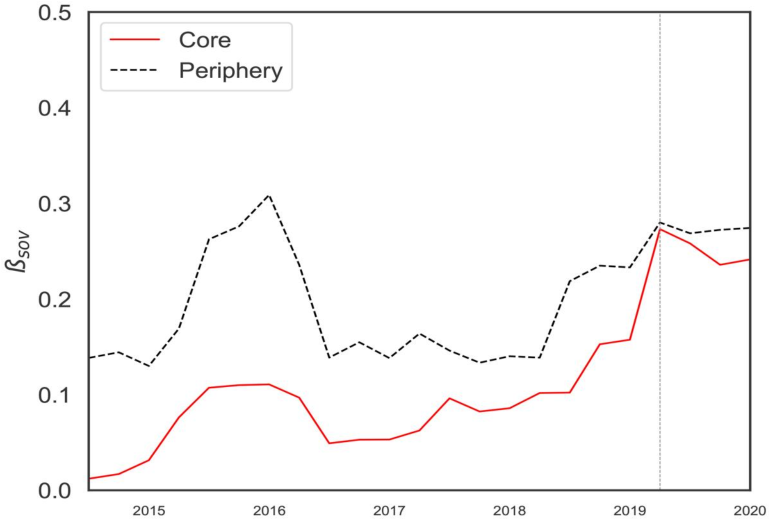

Figure 4
Rolling regressions
We estimate the panel regression in Equation (1), without interaction terms with the *E* dummy, separately for core and peripheral countries on 1-year windows of data that are rolled forward after one quarter over the January 1, 2014, to September 10, 2020, sample period. The figure plots the coefficient relating changes in log corporate CDS spreads to changes in log CDS spreads of the corresponding sovereign by region. Each coefficient is plotted in correspondence to the beginning date of its estimation window, and the dashed vertical line marks the first sample that includes COVID-19 data.

purchase program targeting private and public sector securities.[25] To rule out this concern, in columns 1 and 2 we show that our conclusions extend to the subsample of noneligible PEPP corporate issuers.[26] In a similar vein, in columns 3 and 4 we reestimate our baseline regression model while restricting the COVID-19 sample to only 1 trading month (i.e., through March 24, 2020). By doing so, we minimize concerns that our estimates are capturing the effect of direct government support to local demand and the foreseeable effects of the European Recovery Plan, the implementation of which was not even being discussed. With respect to the timing of the documented effect, we note there are roughly two peaks in CDS spreads after the Italian lockdown.

In columns 5 and 6, we augment our regression with the lagged value of the dependent variable and use the Arellano-Bover/Blundell-Bond system GMM dynamic panel data estimator (Arellano and Bover 1995; Blundell and Bond

[25] The list of eligible PEPP collateral is available at https://www.ecb.europa.eu/paym/coll/assets/html/index.en.html. While the program does not directly target CDS contracts, it might still act as a confounding factor by exerting downward pressure on bond yields with an intensity that depends on market size and thus overlap in part with the core/periphery classification.

[26] This result lines up with evidence from Krishnamurthy, Vissing-Jorgensen, Gilchrist, and Philippon (2011) that QE has a significant effect on CDS spreads of low-rated securities only. Different from that of Krishnamurthy, Vissing-Jorgensen, Gilchrist, and Philippon (2011), our sample comprises high-rated issuers.

Table 11
Corporate-sovereign nexus, robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)
	Non-PEPP		End of March 24, 2020		Arellano–Bover/Blundell–Bond	
Variables	Core	Periphery	Core	Periphery	Core	Periphery
$\Delta \log(\text{CDS Sov})_{jt}$	0.072**	0.200***	0.123***	0.224***	0.135***	0.268***
	(0.030)	(0.052)	(0.012)	(0.040)	(0.013)	(0.037)
$\Delta \log(\text{CDS Sov})_{jt} \times E$	0.139***	0.070	0.177***	0.044	0.159***	−0.013
	(0.048)	(0.052)	(0.021)	(0.040)	(0.021)	(0.031)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	10,607	5,592	30,372	7,504	32,957	8,096
$\bar{R}^2$	0.187	0.226	0.317	0.305	–	–
Firms	25	13	99	24	99	24

	(7)	(8)	(9)	(10)	(11)	(12)
	Weekly aggregation		CR clause		iTraxx	
Variables	Core	Periphery	Core	Periphery	Core	Periphery
$\Delta \log(\text{CDS sov})_{jt}$	0.157***	0.164***	0.132***	0.265***	0.072***	0.172***
	(0.022)	(0.035)	(0.013)	(0.042)	(0.007)	(0.027)
$\Delta \log(\text{CDS sov})_{jt} \times E$	0.196***	0.085*	0.150***	0.006	0.090***	0.013
	(0.030)	(0.048)	(0.015)	(0.035)	(0.025)	(0.041)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	8,557	2,099	35,932	7,336	40,468	10,020

(continued)

Table 11
Continued

	(7)	(8)	(9)	(10)	(11)	(12)
$\bar{R}^2$	.379	.329	.275	.307	.436	.510
Firms	99	24	84	17	98	24
	(13)	(14)	(15)	(16)	(17)	(18)
	EPU		Sovereign ceiling		Cross-spillovers	
Variables	Core	Periphery	Core	Periphery	Core	Periphery
$\Delta \log(\text{CDS Sov})_{jt}$	0.148***	0.222***	0.124***	0.251***	0.125***	0.199***
	(0.013)	(0.043)	(0.013)	(0.053)	(0.013)	(0.037)
$\Delta \log(\text{CDS Sov})_{jt} \times E$	0.176***	0.040	0.151***	0.052	0.086***	0.025
	(0.019)	(0.034)	(0.017)	(0.039)	(0.017)	(0.031)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	38,734	9,442	42,066	6,888	41,177	10,090
$\bar{R}^2$	.263	.243	.254	.269	.199	.205
Firms	91	22	99	16	99	24

The table reports robustness checks from alternative specifications of the panel regression in Equation (1), relating changes in log corporate CDS spreads to changes in log CDS spreads of the corresponding sovereigns and firm-specific and aggregate variables. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Results are reported for the following specifications: restricting the sample to the subset of issuers not eligible for the ECB Pandemic Emergency Purchase Programme (columns 1 and 2); restricting the pandemic sample to 1 month after the Italian lockdown (columns 2 and 3); accounting for Nickell bias through the system GMM procedure of Arellano-Bover/Blundell-Bond (columns 5 and 6); estimating the model on weekly data (columns 7 and 8); selecting the cum-restructuring clause for corporate CDS (columns 9 and 10); controlling for the daily variations in the senior tranche of the iTraxx index of credit risk in the euro area (columns 11 and 12); incorporating the country-level monthly Economic Policy Uncertainty (EPU) index (columns 13 and 14); restricting the cross-section of firms to those with higher average prepandemic credit spreads than that of their sovereign (columns 15 and 16); and adding the first principal component of sovereign CDS spreads of the other region (columns 17 and 18). Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

1998). Using the FGLS as an alternative estimator again confirms our findings (unreported for brevity). In columns 7 and 8, we estimate the model on data aggregated at the weekly frequency to remove any microstructure effects.[27] In columns 9 and 10, we select the cum-restructuring clause for corporate CDS. Additionally, Table A.9 in the appendix reports the estimates of the model augmented with a squared equity term, to account for nonlinearities in the equity-CDS relation, and of the model specified in first differences.[28]

Berndt and Obreja (2010) document a strong factor structure in single-name European CDS contracts, with the first principal component being highly correlated with the senior tranche of the Markit iTraxx Europe index. In columns 11 and 12, we verify that adding this series to the set of controls does not explain away the pricing of sovereign risk spillovers. Sovereign credit risk is priced in single-name CDS contracts above and beyond the strong factor structure, and our coefficient of interest capturing the pandemic-induced reaction remains significant in both statistical and economic terms. In columns 13 and 14 we rely on a more granular cross-sectional proxy for aggregate uncertainty than the VIX, namely, the monthly Economic Policy Uncertainty indicator, which is constructed by Baker, Bloom, and Davis (2016) from newspaper articles and varies at the country level and at the monthly frequency. This index is known to be correlated with both firm-level and country-level indicators of economic conditions.

In columns 15 and 16, we restrict the estimation to firms whose average CDS before the COVID-19 period was higher than that of their government, in the hope to verify that our results are not triggered by asymmetries in the effect of changes in sovereign risk (Almeida, Cunha, Ferreira, and Restrepo 2017). Analogously, we report in Table A.10 in the appendix estimates obtained by splitting the sample of firms between those with zero and positive government ownership, defined as the fraction of a firm's equity that is held by the government (data are quarterly from FactSet). We see that, while government ownership possibly acts as a reinforcing channel of the nexus outside the pandemic, it is not the driving force of the differential core/periphery reaction to the shock. In columns 17 and 18, we control for cross-area spillovers by adding the first principal component of sovereign CDS spreads in the other area (periphery and core, respectively), both at level and interacted with the event dummy E. We carry this analysis to test whether a fiscal unification channel consisting of subsidies across European countries

27 In unreported results, we also confirm that our findings are strongly robust to the inclusion of the number of dealers quoting the credit swaps as a proxy for liquidity.

28 CDS prices may also include a premium for counterparty credit risk. However, several studies suggest that such a premium might be of second-order magnitude. For instance, Arora, Gandhi, and Longstaff (2012) find that counterparty credit risk is priced in CDS, but its effect is economically very small because of the practice of collateralization in the CDS market. In their 2008–2009 sample, a 650-bps increase in the CDS seller's credit spread results in only a 1-bp decrease in the CDS spread charged by the seller. Counterparty risk in the CDS market is covered via collateral requirements for bilateral OTC trades imposed by the EMIR regulation that is effective in Europe since March 1, 2017.

is responsible for the findings documented above. Importantly, the credit risk of core companies remains influenced by their own sovereign even if we include the credit risk of peripheral sovereigns, which suggests that our findings are not capturing cross-area subsidy effects.

In Table A.11 in the appendix we stratify the data by four industrial sectors; namely, energy and utilities, industrial, technology, and goods and services.[29] The effect we document is not concentrated in a single sector but rather pervasive, with β_2 coefficients ranging from 0.055 for tech firms to 0.120 for goods and services. Notably, the sectors for which we find a larger increase in comovement with the sovereign correspond to those classified by Dunn, Hood, and Driessen (2020) as COVID-19 sensitive using credit card transaction data, which is in line with a strong reliance on the pricing of government support. The last column of the panel provides estimates for financial firms, which are excluded from our working sample. The increase in the corporate-sovereign nexus for financials is lower than all other sectors and only marginally significant, despite being the highest before the pandemic. This result is consistent with the nonfinancial nature of the shock and with the pricing of government guarantees extended to the real sector.

Furthermore, we conduct two boostrap exercises. The first simulation aims at controlling for imbalances in the number of firms or industrial composition between core and periphery, while the second one addresses the concern that the reaction just happened to line up with the core/periphery classification “by chance.” Details are provided in Appendix B. Both analyses confirm and extend the evidence in Table 8 which suggests that the effect of the pandemic on the nexus is pervasive across all core countries and muted for all peripheral countries.

We also examine the investor structure and heterogeneity of the CDS markets we study. Given that the market is quite concentrated, one might be concerned that comovements in the corporate and sovereign CDS markets could be due to simultaneous trades from a handful of marginal investors active in both markets, rather than repricing of tail risk.[30] To tackle this concern, we gained access to unique CDS ownership data. The data were made available to us under strict confidentiality requirements, and we cannot disclose their source and the resultant figures. Our analyses of these detailed data do not indicate alterations in the net positions of the groups of financial intermediaries which are relevant to our analyses. Moreover, the COVID-19 pandemic did not induce changes in the concentration of the CDS market, as measured by the Herfindahl-Hirschman index in several segments, at a magnitude or in a direction that could represent a confounding factor to our findings.

[29] The industry classification is based on Refinitiv Eikon.

[30] See Peltonen, Scheicher, and Vuillemey (2014), D’Errico, Battiston, Peltonen, and Scheicher (2018), Siriwardane (2019), and Augustin and Izhakian (2020) for studies of the CDS market structure.

Finally, we carry the following counterfactual experiment. We regress the two nexus series shown in Figure 4 on economic indicators in the eurozone, sovereign ratings in each area, and Eurostoxx returns using data from the prepandemic period only, and use the resultant estimates along with the realization of the covariates during the pandemic to construct a predicted out-of-sample nexus. We find that, while the linear fits track the nexus quite well in both areas before the outbreak of the pandemic, after the outbreak the predicted nexus series for core countries is economically and statistically much lower than its realization in Figure 4. The difference between predicted and realized value is comparably less pronounced for peripheral countries (see Figure A.5 in the appendix). This analysis indicates that, in core countries, preexisting economic relations do not explain the surge in the nexus we observe in the data during the pandemic, which points toward novel channels affecting the pricing relation.

3. Stylized Asset Pricing Model

To rationalize the evidence in the previous section, we develop a simple asset pricing model with defaultable corporate and sovereign debts. The model helps us understand how sovereign fiscal capacity shapes the comovement of corporate and sovereign credit risk. The model highlights a distinction between normal times, when sovereign states can impose forceful taxes, and COVID-19 times, when they can also support corporations. The sovereign risk channel is responsible for the comovement between corporate and sovereign credit risk during normal times. The government support channel is responsible for the increase in the comovement between corporate and sovereign credit risk in countries with large fiscal capacity conditional on the occurrence of the COVID-19 shock.

3.1 Model setup

Consider a two-period framework, with an initial period denoted by $t=0$ and a terminal period denoted by $T=1$. Time evolves continuously between these two periods. A risk-free asset yielding a constant return r_f is available. In this economy, both a sovereign entity and a representative corporate entity have outstanding risky debt maturing at time T. The dynamics of the market value of the corporation's assets are

$$\ln(V_T/V_t) = \mu_V + \sigma_V \varepsilon_T, \tag{3}$$

where the scalars μ_V and σ_V denote, respectively, the growth rate and volatility of the firm's asset market value, and ε_T is a standard Normal random variable with cumulative distribution function N. The dynamics of the market value of the assets of the sovereign are

$$\ln(S_T/S_t) = \mu_S + \sigma_S \eta_T, \tag{4}$$

where the scalars μ_S and σ_S denote, respectively, the growth rate and volatility of the sovereign's assets market value, and η_T is a standard Normal random variable. For simplicity, η_T and ε_T are assumed to be independent. This assumption ensures tractability without affecting the economic mechanisms at work.

3.2 Sovereign debt

The sovereign entity has outstanding public debt with face value B maturing at time T. At maturity, the sovereign uses its own assets to service its debt at face value, if and only if

$$S_T \geq B. \tag{5}$$

Otherwise, the sovereign forcibly extracts taxes from the firm to cover the government credit shortfall, $B - S_T$. If the value of firm's assets is insufficient to service the sovereign debt at face value, the sovereign undergoes debt restructuring. The fiscal capacity of the sovereign is

$$\phi_t = S_t / B. \tag{6}$$

For brevity, we refer to the probability that the government is unable to service its debt using its own assets as the probability of government shortfall.

3.3 Corporate debt

The corporate entity has outstanding debt with face value F maturing at time T. At debt maturity, if the corporate entity lacks sufficient resources to meet this obligation, it defaults and undergoes restructuring. Moreover, the corporate entity faces the risk of forced tax extraction from the government. If the government faces a shortfall, the corporate entity must use its available assets to pay the emergency taxes, $B - S_T$, before servicing its own debt. Clearly, the emergency taxes cannot exceed the value of the firm's assets. Thereby, the payout of corporate debt is:

$$\text{Corporate debt payout} = \min\{F, (V_T - (B - S_T) \cdot \mathbb{1}_{[B > S_T]})^+\}. \tag{7}$$

Equation (7) formalizes the notion that in states of the world where the sovereign experiences a credit shortfall, $\mathbb{1}_{[B > S_T]} = 1$, it will extract from the available corporate assets, V_T, the taxes necessary to service its shortfall, $B - S_T$. The remainder of the payout is standard. The cost of insurance against corporate credit default, denoted by $\mathrm{P}_t^{\mathrm{corp}}$, corresponds to the price of a European put option written on $(V_T - (B - S_T) \cdot \mathbb{1}_{[B > S_T]})^+$, maturing at time T and struck at F.

3.4 Sovereign risk channel

The intuition underlying the sovereign risk channel is illustrated by Equation (7). Consider two governments with differing fiscal capacities. For simplicity, suppose one government has high fiscal capacity ($S_t \gg B$ and high ϕ_t), while the other has much lower fiscal capacity ($S_t \approx B$ and low ϕ_t). Between the two, the government with lower fiscal capacity is more likely to raise emergency taxes in the event of a credit shortfall. This mechanism increases corporate credit risk by capturing the risk of forceful tax extraction (Almeida, Cunha, Ferreira, and Restrepo 2017). Thus, the *level* of corporate credit risk is lower when the government has higher fiscal capacity.

Furthermore, a sovereign with low current fiscal capacity is expected to impose more substantial emergency taxes to cover its shortfall, $B - S_T$, whenever $\mathbb{1}_{[B > S_T]} = 1$. By contrast, even if a high–fiscal capacity sovereign experiences a shortfall, the associated emergency tax burden is expected to be limited. Therefore, as formalized in Proposition 1, the corporate–sovereign credit risk *comovement* is greater for corporations whose sovereign has limited fiscal capacity. In countries with limited fiscal capacity, likely to impose substantial taxes in case of a credit shortfall, changes in sovereign risk increase substantially the discount required by corporate debtholders to bear the risk of a government tax extraction, generating corporate-sovereign credit risk comovement. The sovereign risk channel thus provides a lens to interpret our regression estimates of a stronger corporate–sovereign nexus in peripheral countries in the prepandemic sample.

3.5 COVID-19

COVID-19 corresponds to a scenario in which economic restrictions at time t halt business operations and induce a contraction in V_t, thus increasing corporate credit risk. Sovereign credit risk also rises, as the depressed value of corporate assets lowers the emergency taxes that the sovereign can impose on firms in the event of a sovereign credit shortfall. Sovereign assets, which include natural resources and infrastructure, are less reliant on active business operations than corporate assets; we thus assume their market value, S_t, remains unaffected by the lockdown.[31] This scenario captures key features of COVID-19: it occurs before debt maturity and simultaneously raises corporate and sovereign credit risk. The sovereign's fiscal capacity, ϕ_t, is predetermined at the pandemic's onset.

COVID-19 significantly reshapes market expectations about government policy. In our setting, the pandemic prompts expectations that the government will intervene to ensure that the corporate entity will be able to service its debt at time T. That is, financial markets have full faith that the

[31] The COVID-19 pandemic imposed direct costs on the sovereign through increased healthcare expenditures. However, Table 8 documents that healthcare spending does not drive our results. For tractability, we therefore abstract from this aspect in the model.

government will guarantee the face value of corporate debt using the resources available after meeting its own obligations, $S_T - B$. Accordingly, the existing sovereign debtholders are senior to the guarantees, so that guarantees do not affect sovereign debt payout.[32] This setup highlights that market expectations of government guarantees may differ from the amounts officially announced or implemented, instead reflecting the fiscal capacity of the sovereign.

Government guarantees reduce corporate credit risk, as in Acharya, Drechsler, and Schnabl (2014). However, these guarantees are contingent on the government avoiding a credit shortfall. In other words, government bailout guarantees are worth $S_T - B$ if and only if the government has enough assets to service its own debt, and become worthless otherwise. Everything else remains as in the absence of COVID-19, namely, a government facing a credit shortfall forcibly extracts emergency taxes. Thus, the payout of corporate debt protected by the risky government guarantees, $\text{Corporate debt payout}_g$, becomes

$$\begin{aligned}\text{Corporate debt payout}_g &= \min\{F, (V_T - \overbrace{(B - S_T)\cdot \mathbb{1}_{[B>S_T]}}^{\text{Sovereign Risk}} + \overbrace{(S_T - B)\cdot \mathbb{1}_{[B\le S_T]}}^{\text{Government Support}})^+\} \\ &= \min\{F, (V_T + S_T - B)^+\}.\end{aligned} \tag{8}$$

Equation (8) formalizes the notion that in states of nature where the sovereign experiences a credit shortfall, $\mathbb{1}_{[B>S_T]} = 1$, it will extract from the available corporate assets, V_T, the taxes necessary to service its shortfall, $B - S_T$. In states of the world where the sovereign is solvent, $\mathbb{1}_{[B\le S_T]} = 1$, it will pledge its resources, $S_T - B$, in support of corporate debt. The cost of insurance against corporate credit default is now the price of a European put option written on $(V_T + S_T - B)^+$, maturing at time T and struck at F.

3.6 Government support channel

The intuition underlying the government support channel is illustrated by Equation (8). Government guarantees only affect corporate credit risk in states of nature where the sovereign does not experience a credit shortfall, and have no effect when the sovereign itself is distressed. Conversely, forceful tax extractions only affect corporate credit risk in states of nature where the sovereign is distressed, and have no effect when the sovereign is in good standing. Thereby, the two policy interventions are mutually exclusive, and their likelihood depends on the sovereign's fiscal capacity.

[32] Guarantees are typically treated as off-balance sheet items until they are called, especially when they are implicit. Sovereign restructurings have often resulted in guarantees being *de facto* subordinated to bondholders, not least because bondholders affect the approval of restructuring plans.

Consider again the example of two governments with differing fiscal capacities: one with a high fiscal capacity, and the other with a low fiscal capacity. Both governments face the same contraction in economic activity induced by COVID-19, and both fully commit to supporting the domestic economy. This mechanism mitigates the increase in corporate credit risk, capturing the effect of government support. Between the two governments, the one with higher fiscal capacity is less likely to experience a credit shortfall. Thus, the *level* of corporate credit risk containment achieved by the government is higher if the government has a higher fiscal capacity.

Furthermore, a sovereign entity with high current fiscal capacity is expected to have more resources available, $S_T - B$, to honor its guarantee, provided it does not experience a credit shortfall, $\mathbb{1}_{[S_T > B]} = 1$. In stark contrast, even if a government with low fiscal capacity manages to honor its guarantee, the associated resources available are expected to be limited. As we will formalize in Proposition 2, the corporate-sovereign credit risk *comovement* is greater for corporations whose sovereign state has a strong fiscal capacity. In countries with strong fiscal capacity, more likely to provide a substantial guarantee at corporate debt maturity, changes in sovereign risk affect strongly the premium to corporate debtholders resulting from the uncertain provision of the government guarantee, generating corporate-sovereign credit risk comovement. The government support channel provides a lens to interpret our regression estimates of a stronger increase in the corporate-sovereign nexus in core countries in the COVID-19 sample.

3.7 Credit risk comovement

After qualitatively illustrating the mechanisms at work, we now proceed to formalize them. Below, we consider simple measures of credit risk to analyze the *ex ante* comovement between corporate and sovereign credit risk. Corporate credit risk can be measured by the price of the corporate default insurance, $\mathrm{P}_t^{\mathrm{corp}}$. Sovereign credit risk can be measured by the probability of a government shortfall, $N(-d_2^{\mathrm{sov}})$, where

$$d_2^{\mathrm{sov}} = \frac{\ln(\phi_t) + r_f - \frac{\sigma_S^2}{2}}{\sigma_S}.$$

These measures, while different from CDS spreads, are directly proportional to them under standard assumptions and help maintain tractability. Below, we will measure the corporate-sovereign credit risk comovement as the partial derivative of the cost of default insurance with respect to the probability of a sovereign shortfall.[33]

[33] Given the model's two-period time horizon, the comovement between any two variables coincides with the comovement in their changes.

$$\text{Credit risk comovement}_t = \frac{\partial \mathrm{P}_t^{\mathrm{corp}}}{\partial N(-d_2^{\mathrm{sov}})}. \tag{9}$$

This sensitivity reflects how strongly the cost of corporate credit insurance responds to the likelihood of a sovereign credit event.

Proposition 1. Sovereign risk channel. During normal times, Credit risk comovement$_t$ is higher in countries with lower fiscal capacity, ϕ_t.
Proof. See Appendix C. ■

As the tax extraction component enters the ex ante pricing of corporate debt claims, it increases the corporate-sovereign nexus: shocks that increase (decrease) sovereign credit risk (η_t) are associated with a rise (decline) in the likelihood and extent of tax extraction, and in turn with an increase (reduction) in corporate credit risk. Proposition 1 establishes that the rise in the nexus is stronger in countries with limited fiscal space, where the government is more likely to face a credit shortfall and corporate debtholders require a greater premium to bear the risk of forceful tax extractions. In countries with stronger fiscal capacity, the risk of forceful tax extraction is less pronounced. This result helps us to interpret our regression estimates of a strong corporate-sovereign nexus for countries in the periphery of the euro area before the COVID-19 pandemic.

Proposition 2. Government support channel. As the government support component enters the pricing of corporate debt, it induces a rise in Credit risk comovement$_t$ relative to Proposition 1 that is higher in countries with greater fiscal capacity, ϕ_t.
Proof. See Appendix D. ■

As the government support component enters the ex ante pricing of corporate debt claims in the wake of the COVID-19 pandemic, it increases the corporate-sovereign nexus: shocks that increase (decrease) sovereign credit risk are associated with a decline (rise) in the likelihood and extent of government guarantees, and in turn with an increase (reduction) in corporate credit risk. Proposition 2 establishes that, unlike the sovereign risk channel that operates in normal times, this rise in comovement is stronger in countries with high fiscal capacity, where guarantees are likely to be honored and therefore priced into corporate credit risk at near face value. By contrast, in peripheral countries with weak fiscal capacity, where markets apply greater discounts to these guarantees, the comovement induced by the pandemic is muted. This mechanism helps explain why the corporate-sovereign nexus increased only in core countries during the COVID-19 period.

In summary, the activation of both the sovereign risk and government support channels increases the comovement between corporate and sovereign credit risk. The sovereign risk channel operates in normal times, raising comovement in countries with low fiscal capacity. By contrast, the government support channel, activated by the market recognition that governments would extend their support to nonfinancial corporates in COVID-19 times (and potentially in other future tail events), raises comovement in countries with high fiscal capacity.

4. Conclusion

This work investigates the effect of fiscal capacity on credit risk spillovers between governments and domestic nonfinancial corporations in the euro area using the exogenous variation prompted by the COVID-19 pandemic. These spillovers are commonly attributed to a sovereign risk channel, which views spillovers as originating from the amplification of a negative demand shock caused by fiscal strains and the threat of tax hikes. And indeed, before the diffusion of the coronavirus, the data are consistent with this interpretation.

However, the pandemic triggered a significant increase in the elasticity of firms' credit default swaps to their sovereign only in countries with wide fiscal capacity, and the effect of the outbreak on the corporate-sovereign nexus increases in direct measures of fiscal capacity. This result is highly robust to a wealth of compelling economic and econometric sensitivity checks and its magnitude dominates the one of alternative channels. In the cross-section of firms, the increased sensitivity to government risk is more pronounced for larger firms and size systematically explains discounts over a standard credit risk model for larger firms at the core of the euro area, consistent with perceived sovereign fiscal capacity playing a key role when systemic tail risk materializes. These findings suggest that the government support channel is a major determinant of the corporate-sovereign nexus in the wake of the pandemic, which which attributes spillovers to the pricing of anticipated government support.

To illustrate the mechanisms at work, we present an asset pricing model with risky corporate and sovereign debts. The model helps us to emphasize a distinction between normal times, when the sovereign entity can impose forceful taxes, and COVID-19 times, when it can also support domestic corporations. A sovereign risk channel is responsible for the comovement between corporate and sovereign credit risk in countries with low fiscal capacity during normal times (Almeida, Cunha, Ferreira, and Restrepo 2017). A government support channel is responsible for the increase in the comovement between corporate and sovereign credit risk in countries with high fiscal capacity conditional on the COVID-19 shock uncovered by our empirical results. In a nutshell, evidence and theoretical arguments concur that, in the wake of the pandemic, credit risk transfers between corporations and their sovereign reflect the pricing of public supports in countries with strong fiscal capacity.

A broader message of our analysis is that the corporate-sovereign nexus is not necessarily a concerning indicator of debt (credit risk) markets. Rather, credit risk comovement between corporate and sovereign debt in countries with high levels of fiscal capacity could reflect the pricing of public support, whose likelihood is reassessed when a tail event materializes. As emphasized by the model, government fiscal capacity influences the pricing of corporate credit risk, thereby lowering corporate credit spreads, and hence the cost of capital, for companies headquartered in fiscally sound countries, where government support is credible and priced into corporate debt. This insight has far-reaching implications in light of the debate around the benefits of fiscal capacity. Recently, Blanchard (2019) argues that in a low-interest-rate environment, high public debt may not imply large fiscal costs. However, our analysis uncovers a positive effect originating from sovereign fiscal space, as spending capacity buffers directly spill over into corporate credit risk after the extension of government guarantees.

Code Availability: The replication code is available in the Harvard Dataverse at https://doi.org/10.7910/DVN/UCJZWR.

Appendix A: Government Announcements and Market Reactions

On March 13, 2020, the Commission adopted a Communication on a Coordinated economic response to the COVID-19 outbreak setting out the possibility of government support to domestic corporations, previously limited by competition law.[34] The extract of the announcement that we report below provides an illustration of the measures that could *now* be put in place (and subsequently were, with various intensity) in the eurozone:

> The Temporary Framework [. . .] provides for the following types of aid, which can be granted by Member States: (i) Direct grants, equity injections, selective tax advantages and advance payments; (ii) State guarantees for loans taken by companies; (iii) Subsidised public loans to companies, including subordinated loans; (iv) Safeguards for banks that channel State aid to the real economy; (v) Public short-term export credit insurance; (vi) Support for coronavirus related research and development (R&D); (vii) Support for the construction and upscaling of testing facilities; (viii) Support for the production of products relevant to tackle the coronavirus outbreak; (ix) Targeted support in the form of deferral of tax payments and/or suspensions of social security contributions; (x) Targeted support in the form of wage subsidies for employees; (xi) Targeted support in the form of equity and/or hybrid capital instruments.

To appreciate the effects of repricing around these announcements, we conduct an event study analysis following Kelly, Lustig, and Van Nieuwerburgh (2016), who look at the pricing of guarantees to banks during the Global Financial Crisis. The goal is to zoom in on the market reaction to government fiscal stimuli announcements. We focus on the first announcement of supportive

[34] The official communication is at https://ec.europa.eu/commission/presscorner/detail/en/ip_20_459.

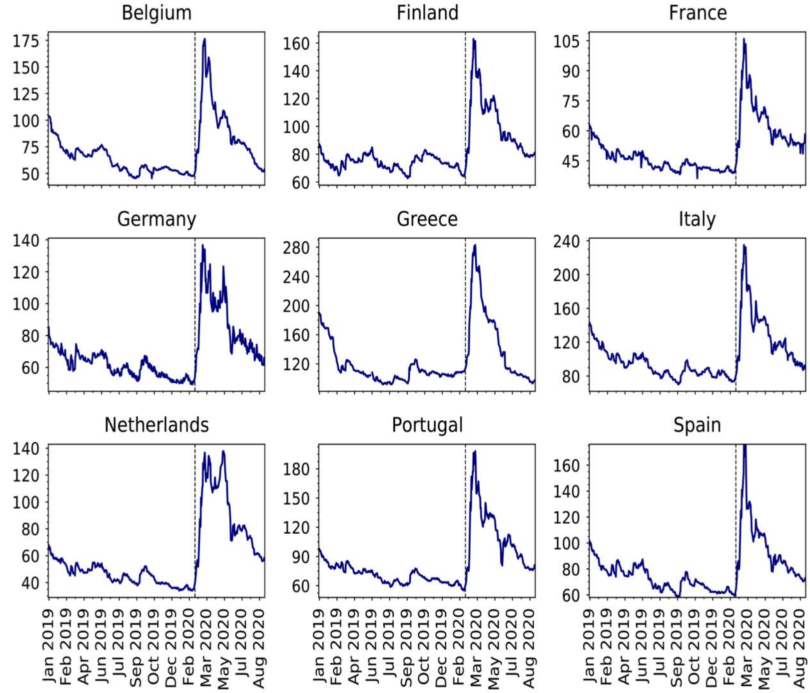

Figure A.1
Euro area corporate CDS
This figure plots the value-weighted average corporate CDS spread in basis points for firms headquartered in the nine countries in our sample over the period from January 1, 2019, to September 10, 2020 (443 trading days). The dashed vertical line represents the beginning of the first Italian lockdown on February 24, 2020.

fiscal policy.[35] The list of events is (*sources*: IMF policy tracker and local financial press): Greece was the first country to announce fiscal support in a press conference on March 9, 2020, without specifying the size of the intervention; on March 13, 2020, Germany announced a €460 bn package to rescue the domestic economy; on the same date, Italy and Portugal announced a stimulus of the size of €55 bn and €13 bn, respectively; on 14 March, France followed through announcing a package of €100 bn; Spain announced a €100 Bn intervention on March 17; Finland discussed €15 bn fiscal measures in response to the pandemic on March 20; Belgium announced the rollout of a guarantee scheme for corporations of €50 bn on March 22; the Netherlands announced on 20 May 20, 2020, a €65 bn aid scheme to domestic corporations. Kelly, Lustig, and Van Nieuwerburgh (2016) also identify events that are likely to reduce the probability of bailouts to financial institutions during the GFC. Differently, we cannot find any such event for domestic corporations in our sample.

In Figure A.4, we present the cumulative average percentage difference between actual corporate CDS spreads and Merton-implied, as a function of event time. As the figure shows, observed CDS trade at a significant discount with respect to the Merton model predicted value in the days surrounding the announcement. The difference in the pre- and post-stimulus difference again

[35] Haddad, Moreira, and Muir (2025) show that the repricing reaction to new types of policies is mostly concentrated in the first announcement.

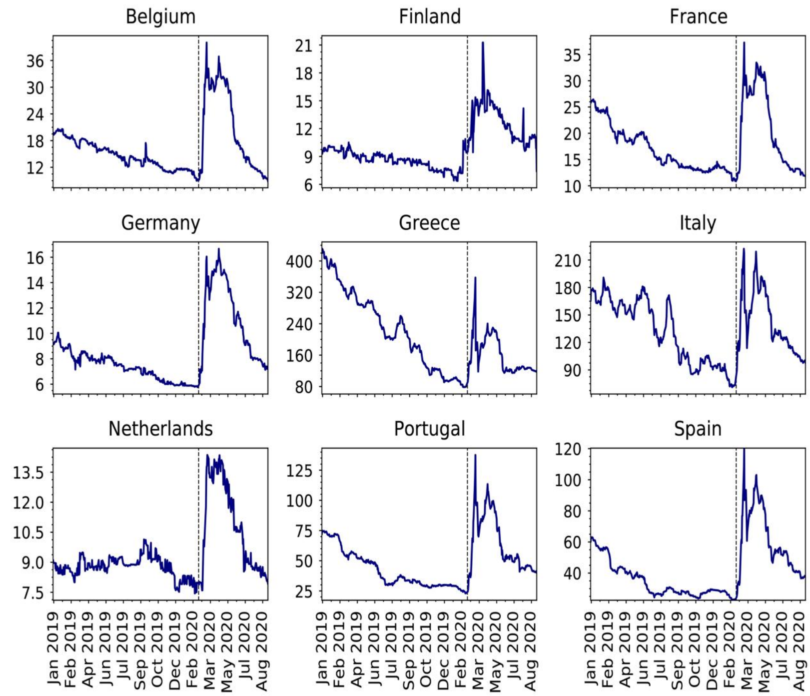

Figure A.2
Euro area sovereign CDS
This figure plots sovereign CDS spreads in basis points for the nine countries in our sample over the period from January 1, 2019, to September 10, 2020 (443 trading days). The dashed vertical line represents the beginning of the first Italian lockdown on February 24, 2020.

points toward repricing of government support to nonfinancial corporations, which ultimately reduced corporate credit spreads.

Further suggestive evidence comes from the evolution of Google Trends of worldwide searches for the terms "bailout" and "government support" during our sample period, which we report in Figure A.6. The maximum (normalized at 100 in the plot) coincides with the first peak in CDS prices, when searches were about five times more numerous than in the pre-COVID period. While these patterns are clearly to be interpreted with grain of salt, they align quite well with those from market data and lend further support to the view that the repricing in credit markets was accompanied with revamped attention toward government intervention.

Appendix B: Bootstrap Exercises

We carry the following two simulation exercises. The first resampling experiment aims at controlling for imbalances in the number of firms or industrial composition between core and periphery. In every bootstrap run, we match each firm in the periphery with a random core firm in the same industry classification. We then estimate our baseline panel regression on this randomized sample of core firms, whose size and industrial composition match (by design) those in the periphery, store the resultant coefficients and standard errors, and repeat the procedure 1,000 times. Figure A.7 plots the distributions of the β_2 coefficient (left panels) and its t-statistic (right panels) for the equally weighted (top panels) and market cap-weighted (bottom panels)

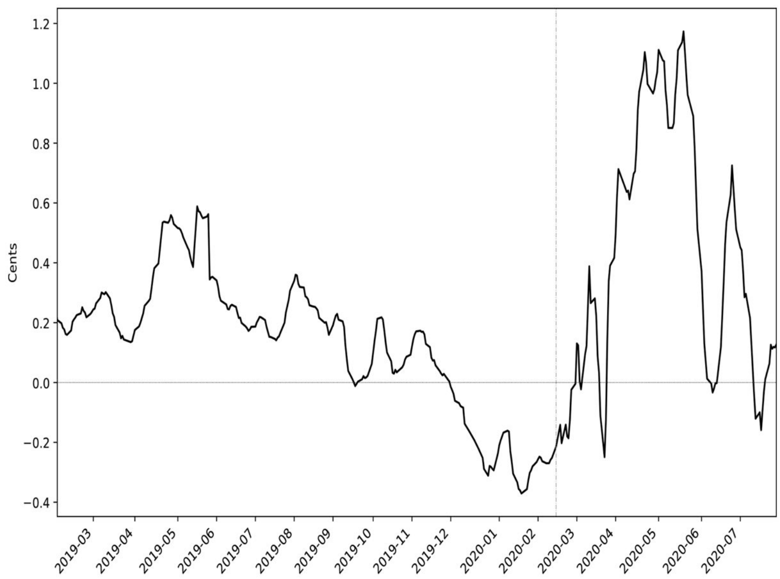

Figure A.3
Put Spread of core minus periphery
The figure shows the trailing weekly average of the difference between the basket-index put spreads of core and that of periphery. The daily per euro put spread of a country's index is computed as the difference between P^{basket} and P^{index}, scaled by the strike price. For core, the series is the average of the spreads of France (CAC) and Germany (DAX); for periphery, it is the average of Italy (FTSEMIB) and Spain (Ibex). The dash-dot vertical line represents the begin of the COVID-19 sample on February 24, 2020.

models across the 1,000 randomized core samples. If our results were driven by CDS data in the periphery being available only for fewer firms or firms operating in sectors with low sensitivity to the COVID-19 shock, we should observe no effect in balanced sets of Core firms in the same sectors. By contrast, none of these artificial samples deliver estimates that are lower than those obtained in Table 2 for the actual periphery (which are marked in each panel by a vertical dotted line).

In the second experiment, we address the concern that the reaction just happened to line up with the core/periphery classification "by chance" using a block bootstrap. In each bootstrap sample, we randomly assign countries (and firms therein) to one of two groups, core and periphery, and reestimate the baseline model separately for the two resultant random samples. For each random sample, we then store (a) the fraction of (firm-month) observations that are misclassified with respect to the actual classification, and (b) the estimated difference in the nexus between the randomly assigned core and periphery, $\widehat{\beta}_2^{Core} - \widehat{\beta}_2^{Peri}$. We iterate over all possible country random assignments, and display the outcome in Figure A.8.[36] The figure plots the difference in the nexus for a given random sample against its distance from the actual sample. When the distance is zero, we obtain the actual sample estimate of the nexus, which equals 0.073 (i.e., 0.125 minus 0.052, from the second row of Table 2), marked by the diamond.

[36] To fix ideas, one of such random draws could put German firms in the periphery and Italian and Spanish firms in the core, another draw could simply move Portugal to the core, etc. We cannot have corner cases in which all firms are moved to either of the groups. The total number of combinations is thus $2^9 - 2$.

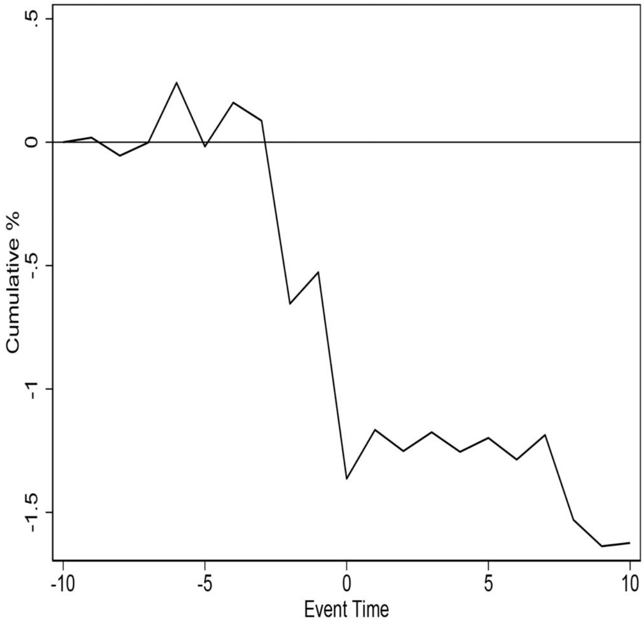

Figure A.4
Credit Spreads around Government Announcements
The figure shows the cumulative average percentage difference between actual corporate CDS spreads and Merton-implied, as a function of event time. The event time is in days, and the CDS tenor is 5 years.

We observe a strong negative relation between the distance from actual classification and the difference in the nexus. In other words, the more we arbitrarily move core firms to the periphery, and viceversa, the more we make the distance between coefficient estimates in the core and periphery smaller, or even negative. The fraction of points to the right of the actual estimate is only 0.057, indicating that is very unlikely that random assignments deliver a higher nexus than the observed one. These few samples are in correspondence to a small distance from the core/periphery classification based on fiscal capacity commonly used in the literature, which means that they are associated to a small shift of firms across areas. This finding confirms and extends the evidence from Table 8, which shows that the effect of the pandemic of the nexus is pervasive across all core countries and muted for all peripheral countries.

Furthermore, the middle plot of Figure A.8 repeats the bootstrap exercise focusing on Large firms (i.e, those in the top 30% of the market cap distribution in each area), while the leftmost plot collects analogous estimates for Small firms (the remaining ones). As we can see, focusing on Large firms widens the difference in the nexus, which is now 0.107 (again, red diamond corresponding to distance of zero), and the evidence becomes statistically more compelling, as the *p*-value is only .015. This result implies that we are not simply documenting a size effect, as there is a differential impact of the nexus for large core firms versus large peripheral firms. Our finding also extends to smaller firms, where the difference in the nexus between actual core and periphery is still a large 0.069, and the fraction of random assignments that would have delivered a larger value is below 10% (9.4%).

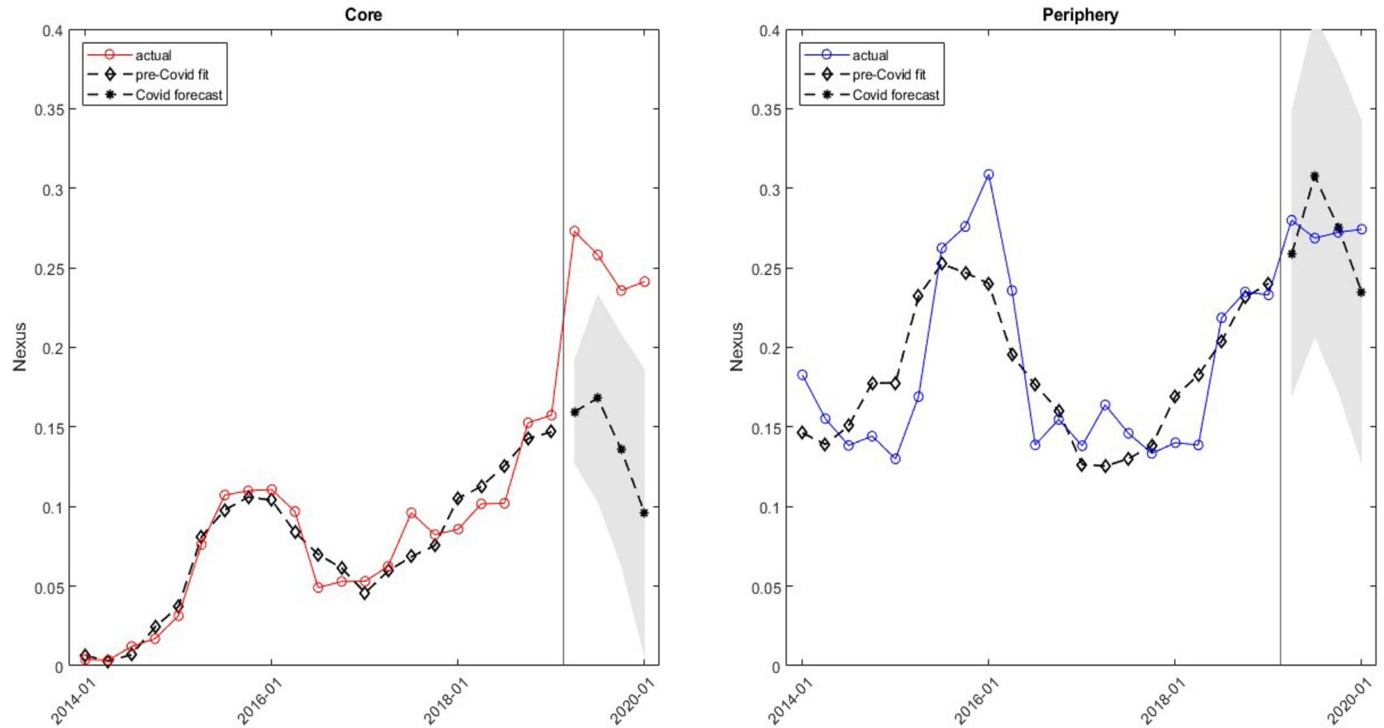

Figure A.5
Counterfactual nexus
The solid line, represented by circles, is the nexus series over the 2014:Q1-2020:Q4 period, estimated over 4-quarter moving windows. We regress this series on: the economic sentiment indicator (ESI) and industrial confidence indicator (ICI), both seasonally adjusted, compiled by the ECB for the eurozone; the average rating of sovereign debt in a given area, Rating; and the Eurostoxx return, StockRet. We estimate the model using data until the window commencing in 2019:Q1, the pre-COVID sample. The dotted line marked with diamonds displays the corresponding fitted values. The dotted line marked with asterisks reports the predicted nexus during the COVID sample, using the pre-COVID coefficients and the value of the explanatory variables during the COVID period, and its 95% confidence interval in the gray-shaded area.

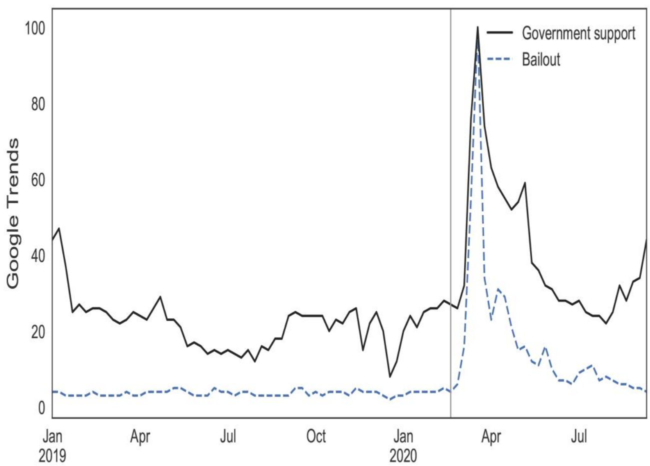

Figure A.6
Google Trends
Number of worldwide searches for "bailout" and "government support" terms during the sample period, on a 0-100 scale where 100 corresponds to the maximum.

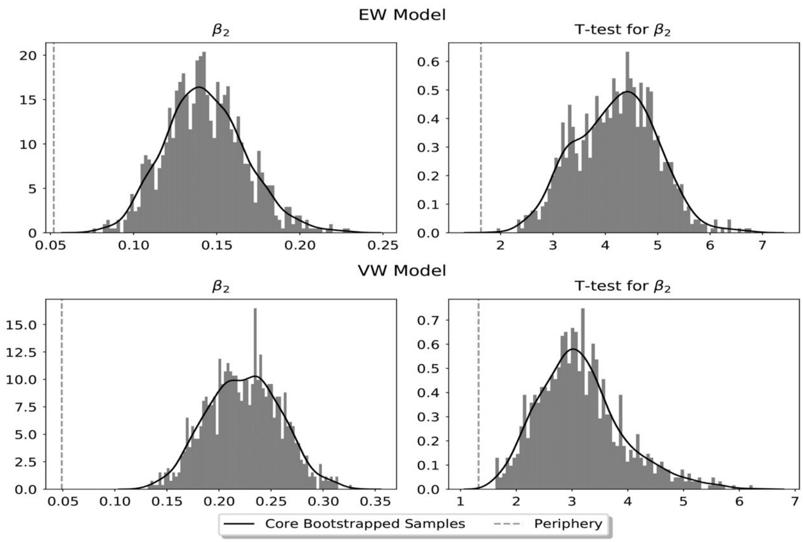

Figure A.7
Bootstrapped samples
In each bootstrap run, we match every firm in the periphery with a random firm in the core in same sector classification. We then estimate our baseline panel regression on this randomized sample of core firms, whose size and industrial composition match (by design) those in the periphery, store the resultant coefficients and standard errors, and repeat the procedure 1,000 times. The figure plots the distributions of the β_2 coefficient (left panels) and its *t*-statistic (right panels) for the equally weighted (top panels) and market cap-weighted models across the 1,000 randomized core samples. The dotted line in each panel represents the corresponding estimate for the actual periphery from Table 2.

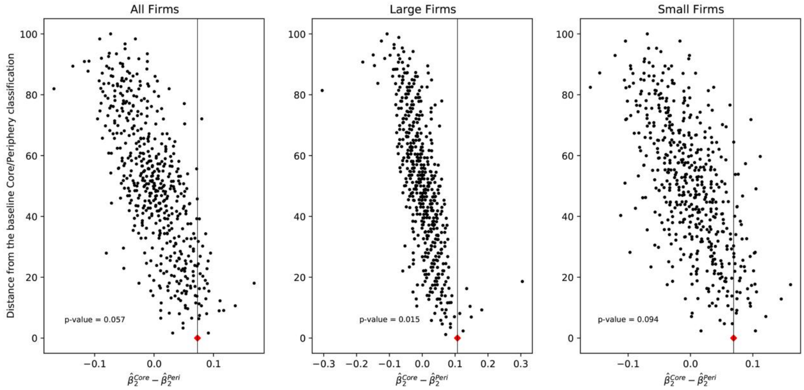

Figure A.8
Block bootstrap
We run a block bootstrap exercise where, in each bootstrap sample, we randomly assign countries (and firms therein) to one of two groups, core and periphery, and re-estimate the baseline model separately for the two resultant random samples. For each random sample, we then store the fraction of observations that are misclassified with respect to the actual classification, and the estimated difference in the nexus between the randomly assigned core and periphery, $\widehat{\beta_2}^{Core} - \widehat{\beta_2}^{Peri}$. We iterate over all possible country random assignments, and plot the difference in the nexus for a given random sample against its distance from the actual sample. When the distance is zero, we obtain the actual sample estimate of the nexus, marked by the red diamond. The leftmost plot is for the whole sample, the middle plot restricts the boostrap to Large firms (i.e, those in the top 30% of the market cap distribution in each area), while the rightmost plot collects analogous estimates for Small firms (the remaining ones).

Appendix C: Proof of Proposition 1

The payoff of a put option that protects from corporate credit risk is

$$\max\{F - (V_T + (B - S_T) \cdot \mathbb{1}_{[B > S_T]})^+, 0\}. \tag{C.1}$$

As ε_T and η_T are independent, the price of this option admits a contingent representation based on the occurrence of a sovereign shortfall.

$$\mathrm{P}_t^{\mathrm{corp}} = N(d_2^{\mathrm{sov}})\mathrm{P}_t^{\mathrm{corp}}(B \leq S_T) + N(-d_2^{\mathrm{sov}})\mathrm{P}_t^{\mathrm{corp}}(B > S_T). \tag{C.2}$$

In the above expression, $\mathrm{P}_t^{\mathrm{corp}}(B > S_T)$ and $\mathrm{P}_t^{\mathrm{corp}}(B \leq S_T)$ denote the price of this put option conditional on whether sovereign credit shortfall occurs or not. Moreover, the probability that the sovereign does not experience a credit shortfall (and thus does not impose taxes on corporations) is given by $1 - N(-d_2^{\mathrm{sov}}) = N(d_2^{\mathrm{sov}})$. The corporate-sovereign credit risk comovement is given by

$$\text{Credit risk comovement}_t = \frac{\partial \mathrm{P}_t^{\mathrm{corp}}}{\partial N(-d_2^{\mathrm{sov}})} = [\mathrm{P}_t^{\mathrm{corp}}(B > S_T) - \mathrm{P}_t^{\mathrm{corp}}(B \leq S_T)]. \tag{C.3}$$

We are interested in the effect of fiscal capacity, ϕ_t, on the corporate-sovereign credit risk comovement (Equation (9)). It can be observed that as ϕ_t rises, the expected sovereign credit shortfall, $E_t[S_T - B | B > S_T]$, falls. Intuitively, when the sovereign has more fiscal capacity, the expected severity of emergency taxes during a sovereign shortfall diminishes. Thereby, $\mathrm{P}_t^{\mathrm{corp}}(B > S_T)$ falls in the current fiscal capacity of the sovereign, ϕ_t. This property follows from the observation that the payoff of such option, in Equation (C.1), rises in S_T and falls in B, and thus its risk-neutral expectation rises in $\phi_t = S_t/B$. The remaining term of the expression is given by

Table A.1
Top 100 nonfinancial firms

Name	Country	Rank
LVMH	France	1
L'Oréal	France	2
SAP SE	Germany	3
Anheuser-Busch InBev	Belgium	4
Total SE	France	5
Sanofi	France	6
Airbus Group	Netherlands	7
Volkswagen Group	Germany	8
Siemens AG	Germany	9
Kering	France	10
Enel S.p.A.	Italy	11
Bayer AG	Germany	12
Deutsche Telekom AG	Germany	13
BASF SE	Germany	14
Air Liquide	France	15
Iberdrola	Spain	16
Adidas AG	Germany	17
Vinci SA	France	18
Heineken N.V.	Netherlands	19
Daimler AG	Germany	20
Schneider Electric SE	France	21
Eni S.p.A.	Italy	22
BMW Group	Germany	23
Danone	France	24
Merck KGaA	Germany	25
Pernod Ricard	France	26
Deutsche Post AG	Germany	27
Henkel AG & Co. KGaA	Germany	28
Koninklijke Philips N.V.	Netherlands	29
Orange	France	30
Engie	France	31
Telefónica	Spain	32
Électricité de France	France	33
Vivendi	France	34
Fresenius SE & Co. KGaA	Germany	35
Fiat Chrysler Automobiles N.V.	Netherlands	36
Endesa S.A.	Spain	37
E.ON SE	Germany	38
Koninklijke Ahold Delhaize N.V.	Netherlands	39
Continental AG	Germany	40
Naturgy Energy Group S.A	Spain	41
Grifols S.A.	Spain	42
STMicroelectronics N.V.	Netherlands	43
Porsche Automobil Holding SE	Germany	44
Repsol S.A.	Spain	45
Koninklijke DSM N.V.	Netherlands	46
Compagnie de Saint-Gobain S.A.	France	47
Thales Group	France	48
Fresenius Medical Care AG & Co. KGaA	Germany	49
Fortum Oyj	Finland	50
Michelin	France	51
Legrand	France	52
Peugeot S.A	France	53
Nokia Oyj	Finland	54
Capgemini SE	France	55
Akzo Nobel N.V.	Netherlands	56
Wolters Kluwer N.V.	Netherlands	57
Atlantia S.p.A.	Italy	58
UPM-Kymmene Oyj	Finland	59

(continued)

Table A.1
Continued

Name	Country	Rank
Sodexo	France	60
Cellnex Telecom SA	Spain	61
Bouygues	France	62
EDP - Energias de Portugal	Portugal	63
EnBW Energie Baden-Württemberg AG	Germany	64
Hapag-Lloyd AG	Germany	65
UCB	Belgium	66
CNH Industrial N.V.	Netherlands	67
Veolia Environnement S.A.	France	68
HeidelbergCement AG	Germany	69
Galp Energia SGPS S.A.	Portugal	70
Groupe Renault	France	71
Terna - Rete Elettrica Nazionale S.p.A.	Italy	72
Carrefour S.A.	France	73
Telecom Italia S.p.A.	Italy	74
Accor S.A.	France	75
Koninklijke KPN N.V.	Netherlands	76
Solvay S.A.	Belgium	77
Stora Enso Oyj	Finland	78
Red Eléctrica de España	Spain	79
Publicis Groupe	France	80
Alstom SA	France	81
Proximus	Belgium	82
Hochtief AG	Germany	83
ThyssenKrupp AG	Germany	84
Elisa Oyj	Finland	85
Deutsche Lufthansa AG	Germany	86
Valeo	France	87
Hellenic Telecommunications Organization S.A.	Greece	88
Faurecia	France	89
Schaeffler Group	Germany	90
MAN SE	Germany	91
TUI Group	Germany	92
Leonardo S.p.A.	Italy	93
Rémy Cointreau	France	94
Edison S.p.A.	Italy	95
Elia System Operator	Belgium	96
Metso	Finland	97
Pirelli & C. S.p.A.	Italy	98
Lanxess AG	Germany	99
Casino Guichard-Perrachon	France	100

This table reports the top 100 nonfinancial firms by market capitalization (as of the end of 2019) in our sample.
Sources: Markit and Refinitiv.

Table A.2
Corporate-sovereign nexus, structural determinants of credit risk

	(1) Core	(2) Periphery	(3) Core	(4) Periphery	(5) Core	(6) Periphery	(7) Core	(8) Periphery
$\Delta log(\text{CDS Sov})_{jt}$	0.127***	0.208***	0.126***	0.232***	0.126***	0.232***	0.126***	0.232***
	(0.013)	(0.036)	(0.013)	(0.042)	(0.013)	(0.042)	(0.013)	(0.042)
$\Delta log(\text{CDS Sov})_{jt} \times E$	0.124***	0.050	0.131***	0.063*	0.131***	0.063*	0.132***	0.061*
	(0.017)	(0.031)	(0.016)	(0.035)	(0.016)	(0.036)	(0.016)	(0.035)
Return Volatility$_{it}$	0.102***	0.069*					0.083***	0.057*
	(0.033)	(0.036)					(0.024)	(0.030)
Return Volatility$_{it} \times E$	−0.079**	−0.006					−0.114***	0.037
	(0.035)	(0.050)					(0.035)	(0.040)
Asset Growth$_{it}$			0.000	0.001			0.001	0.001
			(0.003)	(0.001)			(0.003)	(0.001)
Asset Growth$_{it} \times E$			0.002	−0.013***			0.002	−0.011***
			(0.006)	(0.003)			(0.007)	(0.004)
Leverage$_{it}$					−0.003**	0.001	−0.003**	0.000
					(0.001)	(0.001)	(0.001)	(0.001)
Leverage$_{it} \times E$					0.001	0.004	0.002	0.006
					(0.001)	(0.005)	(0.001)	(0.006)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	41,967	10,282	37,706	8,576	37,706	8,576	37,706	8,576
$\bar{R}^2$	.274	.285	.269	.322	.269	.322	.269	.323
Firms	99	24	89	20	89	20	89	20

The table reports an alternative specifications of the panel regression in Equation (1), relating changes in log corporate CDS spreads to changes in log CDS spreads of the corresponding sovereigns and firm-specific and aggregate variables. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. We further control for Return Volatility (the weekly trailing volatility of firm-level stock returns), Asset Growth (the quarterly change in Total Assets), and Leverage (the ratio of Total Debt to Total Assets).

Table A.3
Entropy-balancing covariates

A. Unweighted sample

	Core			Periphery		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Market Capitalization	3.03×10^7	1.40×10^{15}	2.332	1.90×10^7	$3.34e \times 10^{14}$	1.538
Total Debt to Total Assets	30.64	237	1.184	40.15	108.9	−0.318
Equity Volatility (5-yr)	0.264	0.005	0.853	0.245	0.006	1.964
Market to Book	2.100	2.535	1.076	2.095	2.321	2.039

B. Weighted sample

	Core			Periphery		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Market Capitalization	3.03×10^7	1.40×10^{15}	2.332	3.03×10^7	6.30×10^{14}	0.4907
Total Debt to Total Assets	30.64	237	1.184	30.66	84.82	0.4818
Equity Volatility (5-yr)	0.264	0.005	0.853	0.264	0.012	1.230
Market to Book	2.100	2.535	1.076	2.099	3.217	1.915

The table reports the first three moments of credit risk-relevant variables stratified by region of the euro area. Panel A presents unweighted summary statistics. Panel B shows the corresponding moments when each observation is reweighted, following Hainmueller (2012). Entropy balancing optimally determines weights to achieve exact moment matching while keeping the distribution of observations as close as possible to the data in an entropy sense.

Table A.4:
Corporate-sovereign nexus, supply chain exposure

	(1)	(2)	(3)	(4)	(5)	(6)
	Equally Weighted		Value Weighted		Entropy Balanced	
Variables	Core	Periphery	Core	Periphery	Core	Periphery
$\Delta log(\text{CDS sovereign})_{jt}$	0.078**	0.141**	0.133**	0.226**	0.074**	0.181*
	(0.017)	(0.038)	(0.028)	(0.052)	(0.018)	(0.069)
$\Delta log(\text{CDS sovereign})_{jt} \times E$	0.100**	0.063	0.125**	0.065	0.099***	0.035
	(0.022)	(0.039)	(0.019)	(0.052)	(0.023)	(0.034)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	19,007	6,834	18,576	6,834	17,725	5,972
$\bar{R}^2$	.221	.186	.282	.289	.229	.209
Firms	45	16	44	16	42	14

The table repeats the analysis in Table 2 on firms with a number of suppliers below the median computed over the entire distribution. Results are reported for the equally weighted model (columns 1 and 2), for the equity market capitalization-weighted model (columns 3 and 4), and for the entropy-balanced model (columns 5 and 6). The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

Table A.5
Corporate-sovereign nexus, firm-level characteristics from options data

	(1) Equally Weighted	(2)	(3) Value Weighted	(4)	(5) Entropy Balanced	(6)
Variables	Core	Periphery	Core	Periphery	Core	Periphery
$\Delta log(\text{CDS sovereign})_{jt}$	0.129***	0.215***	0.179***	0.350***	0.129***	0.318***
	(0.015)	(0.042)	(0.019)	(0.047)	(0.016)	(0.046)
$\Delta log(\text{CDS sovereign})_{jt} \times E$	0.134***	0.058	0.138***	0.037	0.133***	0.018
	(0.017)	(0.036)	(0.019)	(0.048)	(0.017)	(0.046)
$\Delta log(\text{IVOL})_{ijt}$	0.029***	0.029***	0.032***	0.031***	0.028***	0.036***
	(0.004)	(0.007)	(0.006)	(0.008)	(0.004)	(0.010)
$\Delta log(\text{SKEW})_{ijt}$	0.000	0.000	0.001	−0.001	0.000	0.000
	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)
$\Delta log(\text{KURT})_{ijt}$	0.005	0.002	0.006**	0.003	0.004	−0.001
	(0.004)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)
$\Delta log(\text{Smirk Slope})_{ijt}$	−0.001*	−0.000	−0.001	−0.000	−0.001*	−0.001**
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
$\Delta log(\text{Put/Call Ratio})_{ijt}$	0.001	0.010	−0.015	0.004	0.000	0.003
	(0.004)	(0.007)	(0.015)	(0.009)	(0.004)	(0.007)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	34,802	8,018	34,386	8,018	33,575	7,171
R-squared	.244	.283	.272	.426	.249	.393
No. firms	88	21	87	21	85	19

The table reports estimates from the panel regression in Equation (1), where the covariates are augmented with firm-specific option-implied metrics that proxy for the price attached to different notions of risk at the firm level and daily resolution. These are: the implied volatility IVOL, implied skewness SKEW, and implied kurtosis KURT of the risk-neutral distribution, following the procedure in Bakshi, Kapadia, and Madan (2003); the slope of the implied volatility smirk for out-of-the-money put options; the Put/Call ratio $\frac{P}{C+P}$, where P and C are the open interest weighted by moneyness of put and call options, respectively. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. Results are reported for the equally weighted model (columns 1 and 2), for the equity market capitalization-weighted model (columns 3 and 4), and for the entropy-balanced model (columns 5 and 6). The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

Table A.6
Corporate-sovereign nexus, additional DIDID checks

	(1)	(2) CDS sample	(3)	(4)	(5) Bond sample	(6)
$Core_i \times \Delta log(\text{CDS Sov})_{jt}$	−0.057	−0.090*	−0.085*	−0.107***	−0.103***	−0.109***
	(0.043)	(0.048)	(0.048)	(0.017)	(0.017)	(0.018)
$Core_i \times \Delta log(\text{CDS Sov})_{jt} \times E$	0.098**	0.105**	0.087*	0.141***	0.125***	0.130***
	(0.044)	(0.044)	(0.051)	(0.033)	(0.032)	(0.033)
$\Delta log(\text{CDS Sov})_{jt}$	0.185***	0.216***	0.212***	0.114***	0.105***	0.111***
	(0.041)	(0.046)	(0.045)	(0.014)	(0.013)	(0.014)
$\Delta log(\text{CDS Sov})_{jt} \times E$	0.032	0.032	0.049	0.053**	0.053**	0.045*
	(0.040)	(0.041)	(0.047)	(0.023)	(0.023)	(0.024)
Return Volatility$_{it}$		0.081***	0.082***		0.087*	0.081
		(0.020)	(0.020)		(0.048)	(0.050)
Return Volatility$_{it} \times E$		−0.088***	−0.112***		0.077	0.082
		(0.029)	(0.029)		(0.071)	(0.073)
Asset Growth$_{it}$		0.001	0.001		−0.004	−0.005*
		(0.002)	(0.002)		(0.002)	(0.003)
Asset Growth$_{it} \times E$		−0.001	−0.000		0.007	0.009*
		(0.006)	(0.006)		(0.005)	(0.005)
Leverage$_{it}$		−0.001	−0.002		−0.004	−0.005
		(0.001)	(0.002)		(0.006)	(0.007)
Leverage$_{it} \times E$		0.002	0.003**		−0.001	−0.001
		(0.001)	(0.001)		(0.003)	(0.003)
Equity Beta$_{it}$	0.001		−0.001	−0.000		−0.004***
	(0.001)		(0.001)	(0.002)		(0.001)
Equity Beta$_{it} \times E$	0.001		0.002**	0.000		−0.001
	(0.001)		(0.001)	(0.001)		(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	50,144	46,282	45,066	90,927	88,078	83,537
$\bar{R}^2$	.269	.275	.272	.052	.058	.058
Firms	120	109	108	228	214	210

The table reports estimates from a pooled version of the panel regression in Equation (1), where all countries are included in the estimation and we interact log changes in sovereign CDS with a $Core_j$ dummy that equals one if country j is core (Belgium, Finland, France, Germany, and the Netherlands) and zero otherwise. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. We augment the baseline specification with either firm-specific daily Equity Beta with respect to the market; the stock return weekly trailing volatility, quarterly growth in Total Assets, and Leverage (the ratio of Total Debt to Total Assets or both. Columns 1–3 use the CDS sample, while columns 4–6 use the bond sample. Robust standard errors clustered at the firm level are reported in parentheses. $^*p < .1$; $^{**}p < .05$; $^{***}p < .01$.

Table A.7

Corporate-sovereign nexus, Oxford COVID-19 Government Response Tracker, Two-step estimation

Variables	(1) Core	(2) Periphery	(3) Core	(4) Periphery	(5) Core	(6) Periphery
$\Delta\log(\tilde{\text{CDS}}\ \text{Sov})_{jt}$	0.276***	0.279***	0.259***	0.265***	0.268***	0.367***
	(0.023)	(0.047)	(0.022)	(0.045)	(0.021)	(0.059)
Stock Returns$_{it}$	−0.474***	−0.278**	−0.459***	−0.278**	−0.456***	−0.271***
	(0.052)	(0.099)	(0.053)	(0.101)	(0.053)	(0.095)
$\Delta\log(\text{VIX})_t$	0.136***	0.096***	0.120***	0.087***	0.122***	0.093***
	(0.009)	(0.017)	(0.008)	(0.016)	(0.009)	(0.018)
Fiscal Measures$_{jt}$			−0.045**	−0.011	−0.129***	−0.214
			(0.023)	(0.037)	(0.024)	(0.160)
Health Measures$_{jt}$			−0.074***	−0.063**	−0.068***	−0.010
			(0.013)	(0.029)	(0.013)	(0.031)
Stringency$_{jt}$			0.016*	0.021	0.012	0.003
			(0.008)	(0.018)	(0.008)	(0.018)
$\Delta\log(\tilde{\text{CDS}}\ \text{Sov})_{jt} \times$ Fiscal Measures$_{jt}$					8.999***	−5.897
					(1.564)	(4.884)
$\Delta\log(\tilde{\text{CDS}}\ \text{Sov})_{jt} \times$ Health Measures$_{jt}$					0.312	1.342**
					(0.294)	(0.625)
$\Delta\log(\tilde{\text{CDS}}\ \text{Sov})_{jt} \times$ Stringency$_{jt}$					−0.278	−1.658***
					(0.214)	(0.442)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	13,832	3,330	13,832	3,330	13,832	3,330
$\bar{R}^2$	.346	.333	.359	.339	.360	.384
Firms	99	24	99	24	99	24

The table reports estimates from panel regression models that relate changes in log corporate CDS spreads to changes in the log CDS spreads of the corresponding sovereigns during the COVID-19 period (defined as the days after February 24, 2020). To address concerns about simultaneity in sovereign CDS and fiscal measures, we implement a two-step procedure. In the first step, sovereign CDS changes are regressed onto fiscal measures, changes in the VIX, and country fixed effects:

$$\Delta\log(\text{CDS Sov})_{jt} = \underset{(0.0001)}{-0.0009^{***}} + \underset{(0.0415)}{0.1578^{***}}\ \text{Fiscal Measures}_{jt} + \underset{(0.0214)}{0.1513^{***}}\ \Delta\log(\text{VIX})_t + \text{Country FE} + \varepsilon_{jt}.$$

The residuals from this regression are orthogonal to fiscal measures and used as a dependent variable in the second-step regressions reported in the table below; formally, $\Delta\log(\tilde{\text{CDS}}\ \text{Sov})_{jt} \equiv \varepsilon_{jt}$. The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Columns 1 and 2 control for the firm's equity return and changes in the VIX. Columns 3 and 4 additionally control for the following indices from the Oxford COVID-19 Government Response Tracker database: Fiscal Measures, Stringency, and Health Measures. Columns 5 and 6 include these indices both at level and interacted with changes in sovereign log CDS spreads. Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

Table A.8

Corporate-sovereign nexus, Oxford COVID-19 Government Response Tracker, Lagged Fiscal Measures

Variables	(1) Core	(2) Periphery	(3) Core	(4) Periphery	(5) Core	(6) Periphery
$\Delta\log(\text{CDS Sov})_{jt}$	0.275***	0.278***	0.255***	0.261***	0.246***	0.391***
	(0.023)	(0.047)	(0.023)	(0.046)	(0.024)	(0.061)
Stock Returns_{it}	−0.473***	−0.278**	−0.460***	−0.279***	−0.462***	−0.274***
	(0.052)	(0.100)	(0.052)	(0.099)	(0.053)	(0.094)
$\Delta\log(\text{VIX})_t$	0.094***	0.054***	0.081***	0.061***	0.081***	0.055***
	(0.007)	(0.012)	(0.007)	(0.012)	(0.007)	(0.011)
Fiscal $\text{Measures}_{j,t-5}$			−0.121***	−0.088***	−0.743***	−0.263
			(0.019)	(0.031)	(0.094)	(0.257)
Health Measures_{jt}			−0.058***	−0.076**	−0.053***	−0.029
			(0.015)	(0.031)	(0.015)	(0.033)
Stringency_{jt}			0.012	0.029*	0.010	0.015
			(0.009)	(0.017)	(0.009)	(0.018)
$\Delta\log(\text{CDS Sov})_{jt} \times \text{Fiscal Measures}_{j,t-5}$					12.305***	1.408
					(1.684)	(2.239)
$\Delta\log(\text{CDS Sov})_{jt} \times \text{Health Measures}_{jt}$					−0.164	1.636**
					(0.382)	(0.586)
$\Delta\log(\text{CDS Sov})_{jt} \times \text{Stringency}_{jt}$					−0.006	−1.941***
					(0.262)	(0.430)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	13,856	3,330	13,337	3,210	13,337	3,210
$\bar{R}^2$	.345	.332	.335	.328	.337	.377
Firms	99	24	99	24	99	24

The table reports estimates from panel regression models that relate changes in log corporate CDS spreads to changes in the log CDS spreads of the corresponding sovereigns during the COVID-19 period (defined as the days following February 24, 2020). The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Columns 1 and 2 control for the firm's equity return and changes in the VIX. Columns 3 and 4 additionally control for the following indices from the Oxford COVID-19 Government Response Tracker database: Fiscal Measures, Stringency, and Health Measures. To address concerns about simultaneity in sovereign CDS and Fiscal Measures, Fiscal Measures are lagged by 1 week, namely, 5 trading days. Columns 5 and 6 include these indices both at level and interacted with changes in sovereign log CDS spreads. Robust standard errors clustered at the firm level are reported in parentheses. $^*p<.1$; $^{**}p<.05$; $^{***}p<.01$.

Table A.9
Additional robustness checks

	(1)	(2)		(3)	(4)
	Squared Equity Returns			First Differences	
Variables	Core	Periphery		Core	Periphery
$\Delta log(\text{CDS Sov})_{jt}$	0.127***	0.208***	$\Delta\text{CDS Sov}_{jt}$	0.818***	0.136***
	(0.013)	(0.036)		(0.158)	(0.047)
$\Delta log(\text{CDS Sov})_{jt} \times E$	0.115***	0.042	$\Delta\text{CDS Sov}_{jt} \times E$	1.814**	0.004
	(0.016)	(0.029)		(0.908)	(0.054)
Controls	Yes	Yes		Yes	Yes
Firm FE	Yes	Yes		Yes	Yes
Observations	41,967	10,282		24,158	5,942
$\bar{R}^2$	0.285	0.294		0.040	0.125
Firms	99	24		99	24

The table reports estimates from the baseline panel regression, including a quadratic term in firm-level stock returns (columns 1 and 2), and estimating the model in first differences (columns 3 and 4), that is, relating changes in corporate CDS spreads to changes in CDS spreads of the corresponding sovereigns and firm-specific and aggregate variables. Robust standard errors clustered at the firm level are in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

Table A.10
Corporate-sovereign nexus, government ownership

	A. CDS sample				*B. Bond sample*			
	Govt. own. $=0$		Govt. own. >0		Govt. own. $=0$		Govt. Own. >0	
	Core	Periphery	Core	Periphery	Core	Periphery	Core	Periphery
$\Delta \log(\text{CDS Sov})_{jt}$	0.126***	0.184***	0.132***	0.269***	0.020	0.104***	0.038**	0.086*
	(0.013)	(0.044)	(0.037)	(0.050)	(0.012)	(0.012)	(0.015)	(0.039)
$\Delta \log(\text{CDS Sov})_{jt} \times E$	0.130***	0.076**	0.097***	−0.010	0.184***	0.042*	0.089***	0.068
	(0.018)	(0.031)	(0.030)	(0.075)	(0.026)	(0.022)	(0.028)	(0.035)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	36,767	7,700	5,200	2,582	72,954	22,568	8,379	3,003
$\bar{R}^2$	.269	.246	.322	.382	.079	.048	.027	.074

The table reports estimates from the panel regression in Equation (1), relating changes in log corporate credit spreads to changes in log credit spreads of the corresponding sovereign and firm-specific and aggregate variables. We split the sample between firm-day observations where the government ownership is equal to zero and those where government ownership is positive. We measure government ownership as the government percentage of shares outstanding using quarterly holdings data from FactSet. The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. The estimation is conducted on the CDS sample in the top panel and on the Bond sample in the bottom panel. The models are estimated separately for countries in the core (Belgium, Finland, France, Germany, and the Netherlands) and the periphery (Greece, Italy, Portugal, and Spain). Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

Table A.11
Corporate-sovereign nexus, analysis by sector

Variables	Energy and Utilities	Industrial	Technology	Goods and Services	Financials
$\Delta \log(\text{CDS sovereign})_{jt}$	0.174***	0.110***	0.132***	0.145***	0.172***
	(0.041)	(0.024)	(0.044)	(0.015)	(0.037)
$\Delta \log(\text{CDS sovereign})_{jt} \times E$	0.113***	0.130***	0.066**	0.152***	0.059**
	(0.033)	(0.031)	(0.024)	(0.027)	(0.028)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
No. obs.	9,177	14,739	6,286	19,010	17,991
R-squared	.304	.237	.196	.261	.212
Firms	22	36	16	47	43

The table reports estimates from the panel regression in Equation (1), relating changes in log corporate CDS spreads to changes in log CDS spreads of the corresponding sovereigns and firm-specific and aggregate variables separately for each sector (including financials, which are excluded from the analysis in Table 2). The dummy E equals one during the COVID-19 period (defined as the days after February 24, 2020) and zero otherwise. The industry classification follows Refinitiv Eikon. Robust standard errors clustered at the firm level are reported in parentheses. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

$$P_t^{\text{corp}}(B \le S_T) = Fe^{-r}N(-c_2) - V_t N(-c_1), \tag{C.4}$$

where

$$c_1 = \frac{\ln(V_t/F) + r_f + \frac{\sigma_V^2}{2}}{\sigma_V},$$
$$c_2 = c_1 - \sigma_V.$$

Thus, it can be concluded that $P_t^{\text{corp}}(B \le S_T)$ in Equation (C.4) does not depend on sovereign fiscal capacity, ϕ_t. Intuitively, when the government does not experience a shortfall, its fiscal capacity does not affect corporate credit risk. Overall, as fiscal capacity rises, the credit risk comovement originated by the sovereign risk channel falls.

In the two-country example, the corporate-sovereign credit risk comovement is higher in the country with lower fiscal capacity, where expected emergency taxes are higher and so is $P_t^{\text{corp}}(B > S_T)$. In general, absent government guarantees on corporate debt, the corporate-sovereign credit risk comovement falls with the fiscal capacity of the sovereign, ϕ_t. Thus, the higher the fiscal capacity, the lower the credit risk comovement induced by the sovereign risk channel. ■

Appendix D: Proof of Proposition 2

In the presence of a government guarantee, a government that does not experience a credit shortfall intervenes to support the firm, whereas a government facing a credit shortfall resorts to extracting emergency taxes from the firm. The payoff of a put option that protects from corporate credit risk becomes

$$\max\{F - (V_T + (B - S_T)^+, 0\}. \tag{D.1}$$

We denote the price of the put option covered by the sovereign guarantee by $P_t^{\text{corp, g}}$. Again, as ε_T and η_T are independent, the price of this option admits a contingent representation based on the occurrence of a sovereign shortfall.

$$\mathrm{P}_t^{\mathrm{corp,\ g}} = N(d_2^{\mathrm{sov}})\mathrm{P}_t^{\mathrm{corp,\ g}}\ (B \le S_T) + N(-d_2^{\mathrm{sov}})\mathrm{P}_t^{\mathrm{corp,\ g}}(B > S_T). \tag{D.2}$$

$\mathrm{P}_t^{\mathrm{corp,g}}(B > S_T)$ and $\mathrm{P}_t^{\mathrm{corp,g}}(B \le S_T)$ denote the price of this put option, which now incorporates a government guarantee, conditional on whether sovereign credit shortfall occurs or not. The corporate-sovereign credit risk comovement is then the derivative of Equation (D.2) with respect to the probability of a government shortfall, $N(-d_2^{\mathrm{sov}})$; namely,

$$\text{Credit risk comovement}_t = \frac{\partial \mathrm{P}_t^{\mathrm{corp,g}}}{\partial N(-d_2^{\mathrm{sov}})} = [\mathrm{P}_t^{\mathrm{corp,g}}(B > S_T) - \ \mathrm{P}_t^{\mathrm{corp,g}}(B \le S_T)]. \tag{D.3}$$

It is observed that COVID-19 does not affect the economic mechanism at work for the pricing of corporate credit risk in states of nature where the sovereign experiences a credit shortfall. That is, $\mathrm{P}_t^{\mathrm{corp,g}}(B > S_T) = \mathrm{P}_t^{\mathrm{corp}}(B > S_T)$. By contrast, COVID-19 affects the pricing of corporate credit risk in states where the sovereign does not experience a credit shortfall. As ϕ_t rises, the expected support provided by a sovereign that does not experience a credit shortfall to the corporation, $E_t[S_T - B | B \le S_T]$, rises. Intuitively, when the sovereign has more fiscal capacity, the expected amount of resources available to support corporate debt rises. As a result, $\mathrm{P}_t^{\mathrm{corp,g}}(B \le S_T)$ falls in the current fiscal capacity of the sovereign, ϕ_t. This property follows from the observation that Equation (D.1) rises in S_T and falls in B, and thus its risk-neutral expectation rises in $\phi_t = S_t/B$.

In the two-countries example, the activation of bailout guarantees leads to a larger increase in the corporate-sovereign nexus in the country with higher fiscal capacity, where expected government support is higher and thus $\mathrm{P}_t^{\mathrm{corp,g}}(B \le S_T)$ is lower. In general, the activation of government guarantees on corporate debt increases the corporate-sovereign nexus relative to the benchmark of Proposition 1, with the magnitude of the increase rising in the sovereign's fiscal capacity, ϕ_t. Thus, the higher the fiscal capacity, the greater the credit risk comovement induced by the COVID-19 pandemic through the government support channel. ■

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Review of Asset Pricing Studies, 2026, 00, 1–69
https://doi.org/10.1093/rapstu/raag003
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