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The COVID-19 Pandemic and Sovereign Bond Risk

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ABSTRACT

Governments around the world are tackling the COVID-19 pandemic with a mix of public health, fiscal, macroprudential, monetary, and/or market-based policies. We assess the impact of the pandemic in Europe on sovereign CDS spreads using an event study methodology. We find that a higher number of cases and deaths and public health containment responses significantly increase the uncertainty among investors in European government bonds. Other governmental policies magnify the effect in the short run as supply chains are disrupted. Moreover, an increased debt-to-GDP ratio significantly boosts the cumulative abnormal change of CDS spreads, which indicates that investors are concerned about countries that are too indebted and thus have a limited capacity to intervene and provide fiscal stimuli and emergency fiscal packages to businesses and households.

1. Introduction

The pandemic of the novel coronavirus, i.e., COVID-19, is administering a shock to the global economy, triggering an unprecedented economic sudden stop. This time is truly different for at least two reasons. First, the macroeconomic impact of the novel coronavirus is larger than those of any catastrophic episodes that have occurred in the past forty years (Ludvigson et al., 2020) as the containment measures taken to curtail the spread of the virus have put the global economy into a synchronized standstill. Second, the economic responses of governments around the world rely on a mix of strategies and policy measures, including but are not limited to public health, fiscal, macroprudential, monetary, or market-based measures, in an “whatever it takes” approach to save businesses and jobs.¹ Additionally, the current health crisis, which is an exogenous shock, i.e., a pandemic-induced shock originating outside the financial sector, stands in sharp contrast with the global financial crisis from 2007 to 2009, which was an endogenous shock due to the

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¹ “There are no limits to our commitment to the euro” (Christine Lagarde, President of the ECB - <https://www.ecb.europa.eu/home/search/coronavirus/html/index.en.html>) and “The Federal Reserve is committed to using its full range of tools” (Board of Governors of the Federal Reserve System - <https://www.federalreserve.gov/newsevents/pressreleases/monetary20200323b.htm>). See the IMF policy tracker that summarizes the key economic responses governments are taking to limit the human and economic impacts of the COVID-19 pandemic - <https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19>.

Fig. 1. The evolution of the volatility indices between January 1st, 2020 and April 30th, 2020. The red vertical line represents March 9th, 2020.

build-up of imbalances in the financial sector.² The markets reacted to the pandemic and the policy frenzy with steep declines, and investors' uncertainty skyrocketed to levels last seen during the global financial crisis of 2007–2009, as measured by the CBOE Volatility Index (VIX), which is a real-time market index representing the market's expectations for volatility over the coming 30 days, the EURO STOXX 50 index options (VSTOXX) or the newspaper-derived Equity Market Volatility (EMV) index of Baker et al. (2020). The data show that the COVID-19 shock had a sizeable impact on stock market volatility compared to the effects of other similar infectious diseases (Fig. 1).

In this paper, we explore the impact of the pandemic and the policy measures taken by governments on European sovereign CDS spreads using an event study approach. Our analysis extends the previous studies that study the impact of the pandemic on sovereign bond risk (see, e.g., Cevik and Öztürk, 2020; Daehler et al., 2020; Augustin et al., 2021). We find that investors in European government bonds reacted in a negative manner when the pandemic was in Europe, resulting in enhanced abnormal changes in the CDS spreads. Moreover, the increased number of cases and deaths and the nonpharmaceutical interventions significantly increase the uncertainty among investors, both in the short and long terms. In addition, we investigate whether policies with a monetary stance adopted by European governments mitigate or augment the negative effect and find that in the short run, the mix of policies tends to amplify the effect as countries incur significant losses due to disruptions in the supply chain. In the early stage of the pandemic, lockdown measures tend to slow economic activity that relies on social interactions through both supply and demand channels. Thus, as government measures become more stringent, investors penalize those countries by requiring higher premia to invest in the bonds issued by these European sovereigns. In terms of indebtedness, increased public debt-to-GDP ratios significantly increase the abnormal change in the CDS spreads, which indicates that investors are concerned about the creditworthiness of countries that are fiscally constrained and thus have a limited capacity to intervene and provide fiscal stimuli and emergency fiscal packages to businesses and households.³

Fig. 2 exhibits the evolution of average European, European Union and Euro Area sovereign 5-year CDS spreads for the debt denominated in EUR together with the Datastream Europe Sovereign CDS 5-year Index from January 1, 2020 to April 30, 2020. We can note a sharp increase starting March 9, 2020. The most affected countries in terms of the absolute increase in CDS spreads 30 days before the event (January 27, 2020) compared with 30 days after the event (April 20, 2020) were Turkey (+325.87 basis points), Italy

² Another striking difference stated by He et al. (2020) is that the prices of long-term Treasury securities fell sharply in March 2020, creating an unusual positive correlation between equity and bond returns, thus contradicting the theory stating that during market turmoil when the prices of risky assets decline, the price of Treasury securities typically increases (e.g., Adrian et al., 2019).

³ In the same vein, Benmelech and Tzur-Ilan (2020) use an empirical setting including 35 advanced and 50 emerging and developing countries to derive that the most important factor that affects a country's fiscal spending during the current pandemic is its precrisis sovereign credit rating.

Fig. 2. The evolution of the 5-year average CDS spreads for European, European Union and Euro Area countries and the Datastream Europe Sovereign 5-year CDS Index between January 1st, 2020 and April 30th, 2020. The red vertical line represents March 9th, 2020.

(+102.76 basis points) and Russia (+99.25 basis points); the least affected countries were Bulgaria (−28.69 basis points), Estonia (−8.84 basis points) and the Czech Republic (+1.29 basis points) (Fig. 3).

We contribute to the extant literature in at least three ways. First, we assess how investors in European sovereign bonds reacted to the institutional quarantine imposed in Italy, which is associated with the arrival of the COVID-19 pandemic in Europe. Contrary to the large strand of literature analyzing the impact of the pandemic on stock markets, there are only a few studies that investigate sovereign credit risk. Additionally, we extend the analysis by exploring several other dates related to the pandemic's intensity, such as the specific day when a country's number of cases reached 100, the growth rate climbed to 30 cases a day, or the death rate surpassed 10, or a set of dates more related to the stringency of the containment measures, such as the restrictions on internal movement and general workplace closings.

Second, we examine what factors drive the abnormal performance of sovereign CDS besides the event *per se* using a similar approach to Andries, Nistor, Ongena, & Sprincean (2020). The factors we study are pandemic-related (Daehler et al., 2020; Cevik and Öztürk, 2020) and other local, regional and global factors that are found to be connected with sovereign spreads (e.g., Hilscher and Nosbusch, 2010; Galarotis et al., 2016; Cepni et al., 2017; Augustin, 2018; Chen and Chen, 2018; Augustin et al., 2021).

Third, we compare the actual health crisis with the European sovereign debt crisis from 2009 to 2010 considering the event day to be the date when Greek government debt was downgraded to junk by Standard and Poor's.

We differentiate from other studies that assess the impact of the COVID-19 pandemic on sovereign credit risk by analyzing the abnormal behavior of CDS spreads in an event study framework and by investigating the determinants of the abnormal performance besides the event *per se*. In addition, we compare the actual health crisis with the European sovereign debt crisis from 2009 to 2010 in terms of the magnitude of CDS spreads abnormal behavior and examine the interconnectedness in the sovereign CDS spread markets as a channel of risk spillover during the health and sovereign debt crises.

Our work relates to the literature investigating the impact of the COVID-19 pandemic on financial markets, which is still nascent but is developing at a rapid pace. These studies assess the effects of the pandemic for different asset classes, such as equity (Acharya and Steffen, 2020; Albuquerque et al., 2020; Alfaro et al., 2020; Arteaga-Garavito et al., 2020; Ding et al., 2020; Ramelli and Wagner, 2020; Schoenfeld, 2020; Heyden and Heyden, 2021; Zaremba et al., 2021), corporate fixed income (Boyarchenko et al., 2020; Ettmeier et al., 2020b; Fahlenbrach et al., 2020; Falato et al., 2020; Haddad et al., 2020; Kargar et al., 2020; O'Hara and Zhou, 2020), sovereign fixed income (Augustin et al., 2021; Cevik and Öztürk, 2020; Daehler et al., 2020; Esteves and Sussman, 2020; He et al., 2020; Schrimpf et al., 2020), foreign exchange (Arteaga-Garavito et al., 2020; Bahaj and Reis, 2020; Njindan Iyke, 2020), commodities (Bakas and Triantafyllou, 2020; Corbet et al., 2020) or cryptocurrencies (Conlon and McGee, 2020; Corbet et al., 2020).

For example, analyzing a sample of 67 countries, Zaremba et al. (2021) document that stock markets where companies pursue conservative investment policies have low valuations relative to future earnings and countries that have a low unemployment rate are

Fig. 3. Absolute change in the CDS spreads for countries from our sample 30 days before the event (January 27th, 2020) and 30 days after the event (April 20th, 2020).

more resilient to adverse consequences of the COVID-19 shock. [Alfaro et al. \(2020\)](#) show that unanticipated changes in the trajectory of COVID-19 predict aggregate US stock market returns, and [Heyden and Heyden \(2021\)](#) and [Ramelli and Wagner \(2020\)](#) focus on equity markets in Europe and the US and find that news about COVID-19 developments and monetary and fiscal policy measures negatively impacted stock prices.

On the corporate debt side, [O'Hara and Zhou \(2020\)](#) and [Kargar et al. \(2020\)](#) study the liquidity conditions in the corporate bond market during the pandemic and find a substantial deterioration at the height of the crisis; [Falato et al. \(2020\)](#) document evidence of major outflows from nonbank financial intermediaries, especially from those that were illiquid and vulnerable to fire sales.

[Augustin et al. \(2021\)](#) use a well-documented approach and assess how public debt affects sovereign credit risk for a sample of 30 developed economies. Their findings indicate a positive and significant impact of sovereign default risk on the intensity of the COVID-19 disease for countries that are too indebted. Additionally, the increase in daily cases of infections increases the dynamics of sovereign CDS spreads. In the same vein, [Arrelano et al. \(2020\)](#) find an increased likelihood not only of a health and economic crisis induced by the virus's spread but also of a lengthy debt crisis in emerging markets, and [Cevik and Öztürkcal \(2020\)](#) show for a sample of 77 advanced and developing economies that the pandemic has had a significant impact on sovereign CDS spreads across all countries and that stringent containment measures have a positive effect on lowering sovereign bond risk. [Daehler et al. \(2020\)](#), however, find that sovereign CDS spreads in emerging markets are not driven by COVID-19-related factors (such as the number of infections, mortalities or containment measures), but rather they are driven by traditional determinants of sovereign debt risk such as fiscal space, monetary policy or global factors. Additionally, a growing number of studies analyze the macroeconomic effects of the COVID-19 pandemic ([Auerbach et al., 2020](#), [Baqaee and Farhi, 2020](#), [Barro et al., 2020](#), [Bigio et al., 2020](#), [Eichenbaum et al., 2020](#); [Guerrieri et al., 2020](#)).

In line with the previous results that document major asset price movements and a significant rise in volatility in March 2020, we expect a significant increase in European sovereign CDS abnormal change following the general lockdown imposed in Italy when many realized that the pandemic was in Europe ([Ettmeier et al., 2020a](#)). As reported by [Cevik and Öztürkcal \(2020\)](#), who use daily data for 77 advanced and developing countries, the COVID-19 pandemic severely impacted the sovereign CDS markets. Moreover, this adverse effect seems to be more noticeable in developed countries, which may be a sign of a greater severity of the pandemic and thus of the subsequent economic crisis.

Hypothesis 1. The arrival of the COVID-19 pandemic in Europe is associated with a significant hike in the sovereign CDS abnormal change.

[Cevik and Öztürkcal \(2020\)](#) suggest that more stringent domestic containment measures are associated with lower sovereign CDS spreads. Contrary to these findings, [Daehler et al. \(2020\)](#) infer that traditional drivers of sovereign spreads are more important in explaining sovereign CDS spread dynamics. [Augustin et al. \(2021\)](#) identify countries' fiscal capacity as the main channel that drives

sovereign credit risk for advanced economies, along with the daily increase in COVID-19 cases. Thus, we expect mixed findings in the following [Hypothesis 2](#).

Hypothesis 2. The abnormal behavior of sovereign CDS spread changes can also be explained by pandemic-related, country-specific, regional and global factors.

2. Data

2.1. Sample

We follow [Borri \(2019\)](#) and employ the European daily 5-yr sovereign credit default swap (CDS) spreads denominated in EUR, which are the most traded and liquid contracts in the CDS market. Although both the bond yield spreads and the spread on a sovereign CDS contract can be considered indicators of the default risk of a country, using sovereign CDS data provides more accurate estimates of credit spreads and returns due to the higher liquidity of the sovereign CDS market ([Longstaff et al., 2011](#)). Moreover, the bond yield spreads can reflect other factors that are not related to default risk ([Jorion and Zhang, 2007](#)). Additionally, as [Blanco et al. \(2005\)](#) states, CDS spreads have the advantage of revealing information in a timelier manner than bond spreads or credit ratings. The source of our data is Thomson Reuters Datastream, and we consider all European countries for which we have available information to compute the indicators described in the next sections.

2.2. Event dates

We consider March 9, 2020 as the main event date for all European countries. On this day, a general lockdown was imposed in Italy, and many realized that the pandemic was in Europe ([Ettmeier et al., 2020a](#)). Additionally, we extend the analysis by exploring several other dates related to pandemic intensity, such as the specific day when a country's number of cases reached 100, the growth rate climbed to 30 cases a day, or the death rate surpassed 10, or a set of dates more related to the stringency of the containment measures, such as the restrictions on internal movement and general workplace closings. Thus, we undertake a comprehensive assessment of how the perception of investors in European government bonds has changed given the intensity of the disease and the national lockdown measures specific to every country.

3. Methodology

3.1. Abnormal change computation

In order to quantify the impact of the pandemic risk on sovereign CDS spreads, we apply the event study technique (see [MacKinlay, 1997](#) for details).⁴ To compute the expected or normal change, we follow previous studies (see, e.g., [Andries, Nistor, Ongena, & Sprincean, 2020](#); [Binici, Hutchison, & Miao, 2020](#); [Drago & Gallo, 2016](#); [Sahin & de Haan, 2016](#); [Micu et al., 2006](#)) and employ the market model as our main estimation model.⁵ One of the main advantage of the market model used in our study is that it takes into account market-wide systematic factors that could influence all CDS spreads simultaneously ([Micu et al., 2006](#); [Drago and Gallo, 2016](#)). The model is described by the following equation:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

where R_{it} is the log-change in the CDS spread of country i at time t ,⁶ α_i is the constant term, β_i is the slope, R_{mt} is the market portfolio log-change at time t , and ε_{it} is an *i.i.d.* error term. The market index used to compute the abnormal performance and the β s for all events is the Datastream Europe Sovereign 5-year CDS Index. The abnormal change (AC) for each country i and time t is determined based on Eq. (1) as follows:

$$AC_{it} = R_{it} - (\alpha_i + \beta_i R_{mt}) \quad (2)$$

A positive value of abnormal change means that the actual change in CDS spreads is greater than the predicted change, i.e., the investors reacted in a negative manner following the event and deemed it to be harmful, whereas a negative abnormal change implies a reduction in the cost of default protection.

Following [Brown and Warner \(1985\)](#), we compute the average abnormal change (AAC) across all countries from our sample:

⁴ Throughout this paper, we employ the term “change” when referring to change in CDS spreads from t to $t+1$. The term is analogous to “return” from equity prices.

⁵ To check the robustness of our findings and the appropriateness of the market model, we employ several alternative models. The results are very similar and thus we consider that the choice of the model does not alter the main conclusions of our paper. See [Section 4.5](#) for details.

⁶ Both absolute (e.g., [Hull et al., 2004](#)) and relative changes (e.g., [Shivakumar et al., 2011](#)) are employed in the CDS event study literature. By comparing these two methods in corporate event studies involving CDS spreads, [Andres et al. \(2016\)](#) recommends the use of the relative change as a more adequate choice.

$$AAC_t = \frac{1}{N} \sum_{i=1}^N AC_{it} \quad (3)$$

where N is the number of countries.

Furthermore, to assess the reaction over a longer period, we sum all the abnormal changes obtained using Eq. (2) over any interval in the event window ($[t_1; t_2]$) around the event date to obtain the cumulative abnormal change (CAC), similar to Morgan et al. (2014):

$$CAC_i[t_1; t_2] = \sum_{t=t_1}^{t_2} AC_{it} \quad (4)$$

To study the aggregate effect over specific event windows and time periods, following MacKinlay (1997), we compute the cumulative average abnormal change (CAAC) given by:

$$CAAC[t_1; t_2] = \quad (5)$$

The event study is performed over an estimation window of 250 trading days, i.e., $[-260; -11]$, where $T = 0$ is the event day. Similar to Andries, Nistor, Ongena, and Sprincean (2020); Sahin and de Haan (2016), we consider a 10-d period before the event to reduce contamination risk.⁷

In order to measure abnormal performance, we consider a 3-d event window length to study the effect in the short run, similar to Imailescu and Kazemi (2010), and longer event windows to assess the impact for larger periods. Thus, we consider four sets of event windows: $[0; 0]$, $[-1; 1]$, $[-5; 5]$, and $[0; 30]$.

3.2. Significance tests

To test the statistical significance of CAACs, we employ two parametric and two nonparametric tests. The parametric tests are the adjusted Patell test of the standardized residuals proposed by Patell (1976) and modified by Kolari and Pynnönen (2010) to account for cross-sectional dependence in the data and the BMP test introduced by Boehmer et al. (1991) corrected for event-induced changes in volatility. The nonparametric tests are the generalized sign test according to Cowan (1992), which is robust in the presence of skewed changes and is well specified when cross-sectional abnormal changes are not symmetric; the GRANK test proposed by Kolari and Pynnönen (2011), which is robust to abnormal change serial correlation and event-induced volatility. All the tests have the null hypothesis that the CAAC is equal to zero and the alternative hypothesis that the CAAC is different from zero.

3.3. Determinants of cumulative abnormal change

To study whether the national policies adopted by the governments in response to the risk induced by the pandemic mitigate or amplify the negative effect in the short run, we run a Panel-Corrected Standard Errors (PCSE) regression,⁸ with the cumulative abnormal change (CAC) from day 0 (March 9, 2020) to day 30 (i.e., April 20, 2020) as the dependent variable:

$$CAC_i[t_1; t_2] = \beta_0 + \beta_1 \times Policymeasures_{it} + \beta_2 \times Nationalfactors_{it} + \beta_3 \times Globalfactor_t + \beta_4 \times Europeanfactor_t + \varepsilon_{it} \quad (6)$$

where $CAC[t_1; t_2]$ represents the cumulative abnormal change of country i during the event window ($[0; 30]$); β_0 is the intercept; $Policymeasures_{it}$ is a vector of policy measures taken by the governments to sustain public welfare in response to the health risk posed by the pandemic; $Nationalfactors_{it}$ is a vector of country-specific variables including the debt/GDP ratio (Cepni et al., 2017), national stock market return and the exchange rate against USD (Chen and Chen, 2018); $Globalfactor_t$ is the volatility index (VIX) at time t to control for global uncertainty of equity market; $Europeanfactor_t$ is the spread between the 3-mon Euribor and Eonia rates as a proxy for both credit risk and market liquidity in Europe (Galariotis et al., 2016); and ε_{it} is an error term corresponding to country i in day t .⁹ With the exception of the debt/GDP ratio, which is available at a lower frequency – thus, we take the value at the end of 2019 – all other independent variables are from the $[0; 30]$ window period and have a daily frequency.

For policy measures, we use the database from the European Systemic Risk Board (ESRB) to construct an intervention index based on the date of adoption of specific measures, grouped as fiscal with financial stability relevance, macroprudential, microprudential, market-based, monetary and other. For instance, Austria first adopted the following policies: fiscal with financial stability relevance (tax deferrals) on March 15, 2020 with the beneficiaries being nonfinancial corporations; macroprudential (use of systemic risk buffer to maintain the supply of credit to companies and households) on March 25, 2020 for the banking sector; microprudential (extending reporting requirements) on March 19, 2020 for all financial sectors; market-based (the Austrian Financial Market Authority enabled employees to conduct an online identification of customers at the place of residence of the employees in a separate locked room (online

⁷ In an alternative specification, we consider a 30-d period before the event, similar to Augustin et al. (2019).

⁸ We employ the PCSE technique because the number of time periods (31 days) is greater than the number of individuals (22 countries). Under this specification, standard error estimates are robust to disturbances being heteroscedastic, contemporaneously cross-sectionally correlated, and autocorrelated of type AR(1).

⁹ Because VIX and the 3-mon Euribor-Eonia spread are not stationary as indicated by the Phillips-Perron test, which accounts for potential serial correlation and heteroskedasticity in the residuals, we use their first difference in the regression equation.

Table 1

Descriptive statistics of the CDS spreads.

	Mean	St. dev.	p25	Median	p75	Min	Max	Obs.
Europe	70.99	94.58	26.9	52.24	72.81	5.33	600.56	804
European Union	48.32	30.48	21.26	49.91	60.62	5.33	169.35	682
Euro Area	49.51	31.85	21.26	52.1	59.75	6.53	169.35	434

Note: This table presents the descriptive statistics of the CDS spreads used in the event study from day 0 to day 30 (March 9th, 2020–April 20th, 2020).

Table 2

Market reaction to the general lockdown measures imposed in Italy.

Event window	CDS CAACs 9 March 2020 (b. p.)			
	[0; 0]	[−1; 1]	[−5; 5]	[0; 30]
Europe (26)	503.85	2149.31	4159.07	4901.43
European Union (22)	456.98	2051.69	4071.69	4800.72
Euro Area (14)	443.04	2645.15	5584.05	5300.95
Significance tests: Europe				
Adjusted-Patell test	5.08***	12.80***	14.10***	23.28***
BMP test	2.29**	4.26***	4.78***	6.30***
Generalized sign test	−0.71	2.10**	2.90***	3.68***
GRANK test	0.84	3.11***	3.42***	3.97***
Significance tests: European Union				
Adjusted-Patell test	4.52***	10.60***	13.21***	21.05***
BMP test	1.88*	3.83***	4.28***	5.48***
Generalized sign test	−0.97	1.65*	2.52**	3.39***
GRANK test	0.45	2.58**	2.94***	3.73***
Significance tests: Euro Area				
Adjusted-Patell test	4.18***	12.35***	16.03***	21.07***
BMP test	1.40	3.69***	4.59***	4.47***
Generalized sign test	−1.03	1.66*	2.74**	2.74**
GRANK test	0.09	2.71***	3.28***	3.31***

Note: This table shows the cumulative average abnormal changes (CAACs) of countries CDS spreads for European countries, the European Union and Euro Area subsamples, considering the following event windows: [0; 0], [−1; 1], [−5; 5], and [0; 30]. The event refers to 9 March 2020. The estimation window is 250 days and the model employed to compute the expected change is the market model described in Eq. (2). The table also reports the statistics of the tests used to assess the significance of CAACs described in Section 3.2. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. The number of countries are shown between parentheses.

identification while working from home)) to prevent the spread of COVID-19) on February 21, 2020 for all financial sectors; other type of measures (temporarily waiving the requirement for members to be personally present at meetings of the supervisory board and of the supervisory board's committees) on March 19, 2020 for all financial sectors. Additionally, at the Euro area level, the European Central Bank adopted credit facilities and asset purchase programs on March 12, 2020 to provide immediate liquidity support to banks and to safeguard money market conditions. Thus, starting with the date of the adoption of each type of policy, we construct time-varying indices taking the value of one on or after the policy is adopted and zero before adoption. By summing all these policies, we build the intervention index, which takes a minimum value of one (no policy adopted) and a maximum value of six (all types of policy adopted).¹⁰ In addition, we use three additional indices computed by Hale et al. (2020), which capture income support and debt/contract relief for households (economic support index); government responses to the pandemic including containment, closure, economic and health policies (government response index); and variation in containment, closure and health system policies (stringency index). The indices vary from 0 to 100 with higher values being associated with more stringent actions. A complete description of the variables can be found in Table A3 in the Annexes. We employ cumulative abnormal change and normal change because a policy response taken at time t will already be incorporated in the abnormal change at time $t + 1$; thus, we investigate the cumulative effect.

4. Empirical evidence

4.1. Descriptive statistics

Table 1 presents the descriptive statistics of the CDS spreads from March 9, 2020 (event day) to April 20, 2020 (30 days after the event). The highest average values in this timeframe occurred for European countries (70.99 basis points with a standard deviation of

¹⁰ In the Annexes, Table A1 shows the first day when specific policies were adopted in countries from our sample, and Table A2 shows the type of measures for each type of policy.

Table 3

Market reaction to pandemic intensity and stringency of the measures.

Pandemic intensity			Stringency		
Event window	[0; 0]	[-1; 1]	Event window	[0; 0]	[-1; 1]
100th case (26)	517.19	1584.65	Restrictions (22)	183.74	962.09
30 cases a day (26)	714.90	927.13	Workplace (19)	332.13	624.94
10th death (25)	387.98	835.27	SI $\geq$ 20 (26)	451.46	1241.70
Significance tests: 100th case			Significance tests: Restrictions		
Adjusted-Patell test	4.85***	15.45***	Adjusted-Patell test	1.74*	7.83***
BMP test	1.65*	5.23***	BMP test	1.34	2.56**
Generalized sign test	0.08	3.29***	Generalized sign test	-0.32	1.41
GRANKT test	1.85*	6.83***	GRANKT test	0.90	3.09***
Significance tests: 30 cases a day			Significance tests: Workplace		
Adjusted-Patell test	9.93***	9.07***	Adjusted-Patell test	3.72***	4.17***
BMP test	2.88***	2.99***	BMP test	1.73*	1.99**
Generalized sign test	2.13**	1.73*	Generalized sign test	-0.06	0.86
GRANKT test	4.20***	4.08***	GRANKT test	1.02	1.19
Significance tests: 10th death			Significance tests: SI $\geq$ 20		
Adjusted-Patell test	4.28***	5.81***	Adjusted-Patell test	4.71***	9.91***
BMP test	2.01**	2.31**	BMP test	2.54**	3.29***
Generalized sign test	0.22	0.22	Generalized sign test	0.38	1.19
GRANKT test	1.38	1.99**	GRANKT test	2.61**	3.18***

Note: This table shows the cumulative average abnormal changes (CAACs) of countries CDS spreads for European countries, considering the following event windows: [0; 0] and [-1; 1]. The events refer to specific national days, i.e. the day when the number of cases reached 100, the first day with 30 cases a day, and the day when the total number of deaths surpassed 10 (pandemic intensity) and the days when were imposed restrictions on internal movement, general workplace closing and the Stringency index was grater or equal than 20 (stringency of containment measures). The estimation window is 250 days and the model employed to compute the expected change is the market model described in Eq. (2). The table also reports the statistics of the tests used to assess the significance of CAACs described in Section 3.2. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. The number of countries are shown between parentheses.

94.58 basis points) whereas European Union and Euro Area members registered lower values. As Fig. 3 shows, Turkey and Russia were two of the most affected economies between January 27, 2020 and April 20, 2020.

4.2. Abnormal performance of CDS spreads: March 9, 2020

Table 2 shows the estimated results for the cumulative average abnormal change of CDS spreads for the four intervals for which we assess the abnormal performance, i.e., [0; 0], [-1; 1], [-5; 5] and [0; 30], considering the full sample (European countries) and two subsets of European Union (EU) countries and Euro Area (EA) members. When Italy imposed the general lockdown measures ([0; 0] window), European markets reacted negatively,¹¹ resulting in an increased CAAC of 503.85 basis points,¹² which is statistically significant according to parametric tests, controlling for both cross-correlation and event-induced changes in volatility. The effect does not differ between the EU and EA countries, with the same trend in both cases, although with a smaller magnitude. For longer event windows, the effect is even more pronounced with all four tests showing statistical significance. Therefore, overall, investors in sovereign bonds further acknowledged the default risk they faced on the day Italy went into its lockdown.¹³

4.3. Abnormal performance of CDS spreads: Pandemic intensity and stringency of measures

Next, we assess how investors in government bonds reacted to different intensities of the pandemic specific to every country and the stringency of the public health interventions, such as attempts to reduce the interactions among people in order to limit the spread of the virus. We evaluated the intensity of the pandemic from three standpoints: the day when the number of cases reached 100, the first day with 30 cases a day, and the day when the total number of deaths surpassed 10. The stringency of government responses index was developed by Hale et al. (2020) based on several criteria, such as school or workplace closings. We select two criteria: the first day when a workplace closing policy was imposed and the first day of nationwide restrictions on internal movement. Moreover, based on the distribution of the index, we chose the first day when the value of the index was greater than or equal to 20. The findings for the [0;

¹¹ Because of the possibility of confounding events, we run different estimations with different event dates. The first date is February 24 since Ibikunle and Rzaev (2020) find that the volatility in the European market increased substantially on this day. The second date is March 5 when markets experienced a severe stock sell-off (Aldasoro et al., 2020). The third date is March 11 when the World Health Organization declared COVID-19 as pandemic (the results for this event are presented in Section 4.4). In all cases, we do not find statistically significant CAACs on the event day.

¹² Note that this is a relative change and not an absolute one because we employ the logarithmic change of CDS spreads.

¹³ The results remain consistent when considering a 30-day period before the event, similar to Augustin et al. (2019). These results are available upon request.

0] and $[-1; 1]$ windows are presented in Table 3. For pandemic intensity, we note that the CAACs are positive and statistically significant for all three measures of intensity with a larger magnitude for the first day when 30 cases a day occurred. Hence, the rapid increase in the number of confirmed cases per day brings the highest uncertainty among investors in government bonds and, accordingly, an enhanced country risk.

In terms of the stringency of government responses, all national containment policies increase sovereign risk. In the early stage of the pandemic, lockdown measures tended to be excessive (Beck and Wagner, 2020) and slow, especially economic activity that relies on social interactions (Correia et al., 2020) through both supply and demand channels (Eichenbaum et al., 2020). Thus, as government measures become more stringent, investors respond by requiring higher credit risk insurance premia to invest in their sovereign bonds. Hence, according to CDS investors, the economic channel of nonpharmaceutical interventions (reducing economic activity and therefore taxation) dominates that of coordination (with a theoretically positive impact) where people deliberately reduce their consumption and labor supply to lower the transmission of the disease and the risks associated with the pandemic (for details, see Correia et al., 2020).

4.4. Determinants of abnormal performance

Besides the event *per se*, we are interested in whether other factors, especially policy measures adopted in response to the pandemic, such as fiscal, microprudential, macroprudential, market-based, monetary or other types of policy measures, affect the abnormal performance of sovereign CDS spreads.¹⁴

The empirical evidence in Table 4 reveals that all policy measures¹⁵ significantly increase the abnormal performance of CDS spreads (Models (1)–(6)). Comparing policy measures, we see that the fiscal measures of financial stability relevance and the monetary policy measure display the highest impacts on the abnormal performance of CDS spreads. A possible explanation is related to the fact that fiscal measures create significant fiscal risks that will impact public finances directly in terms of higher fiscal deficits and debt. Moreover, the monetary policy measures adopted are in addition to the monetary stimulus implemented during the global financial crisis of 2008 and hence may be deemed excessive by investors.

The same findings result from the intervention index (Model (8)) that is constructed based on all types of policy interventions with a monetary stance, as discussed in Section 3.3. Additionally, we include the economic support index (Model (9)), the government response index (Model (10)) and the stringency index (Model (11)) of Hale et al. (2020) as regressors. The economic support index captures income support and debt/contract relief for households. The government response index includes containment, closure, economic and health policies; the stringency index is derived from social distancing measures introduced to contain the spread of the virus (i.e., nonpharmaceutical interventions). The positive and statistically significant effect is also maintained in these cases. The effect of policy interventions on cumulative abnormal changes in CDS spreads is also economically significant. A one standard deviation increase in the intervention index leads to a 14.39 percent enhancement in the CAC of the CDS spread relative to the sample average; whereas in terms of elasticity, a 1 percent increase in the intervention index results in a 54.61 percent increase in the CAC of the CDS spread relative to the sample average. Regarding the stringency index, the semielasticity is 1.02 percent, and the elasticity is 71.19 percent. Thus, monetary and nonpharmaceutical interventions tend to exacerbate the effect on abnormal performance of European sovereign CDS spreads in the short run as these measures significantly disrupt the demand and supply chains of countries, which lead to a sharp fall in real economic activity. In summation, while these measures may have had partial helpful effects on those treated, overall, investors were either more frightened and/or deemed the measures to jeopardize the creditworthiness of sovereign CDS spreads even further.

In terms of other control variables, an increased debt/GDP ratio significantly increases the cumulative abnormal change in CDS spreads (more positive CAACs), which indicates that investors are concerned about countries that are too indebted and thus have a limited capacity to intervene and provide fiscal stimuli and emergency fiscal packages to businesses and households. Our results are in line with those of Augustin et al. (2021) who find that fiscal channels are an amplification mechanism of sovereign credit risk.

Because our dependent variable has an overlapping structure, we test the robustness of our findings,¹⁶ by employing a regression with Driscoll and Kraay standard errors (Driscoll and Kraay, 1998). In this setting, the error structure is assumed to be heteroskedastic, autocorrelated up to a lag of 30, correlated between panels, and robust to general forms of cross-sectional and temporal dependence. As Driscoll and Kraay (1998) note, their estimator applies a Newey-West-type correction (see Hoechle, 2007 for details). The results for the intervention index (Model (1)), economic support index (Model (2)), government support index (Model (3)) and stringency index (Model (4)) are shown in Table 5. We note that the results are robust and similar to the benchmark model (Table 4, Models (8)–(11)). We also investigate what drives the abnormal performance of CDS spreads when considering the country-specific event dates, i.e., the day when a country's number of COVID-19 cases reached 100, growth rate climbed to 30 cases a day, or death rate surpassed 10. The empirical results are presented in Table 5, Models (5)–(16). Again, in all instances, the measures taken by national governments to help households and businesses recover and to limit the transmission of the virus increase the abnormal performance of CDS spreads in the

¹⁴ Table A1 from the Annexes shows the descriptive statistics of our variables employed in the empirical analysis.

¹⁵ Details regarding the categorization of these measures can be found at this web address: <https://www.esrb.europa.eu/home/coronavirus/html/index.en.html>.

¹⁶ We thank an anonymous referee for stating this issue.

Table 4

Determinants of CDS spreads cumulative abnormal change (CAC) – official event.

Dependent: CAC	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Fiscal	0.175*** (0.019)						0.002*** (0.000)				
Macroeconomic		0.075*** (0.023)					0.385* (0.214)				
Microeconomic			0.144*** (0.022)				0.821 (0.613)				
Market-based				0.155*** (0.043)			0.000 (0.001)				
Monetary					0.212*** (0.029)		−0.476 (0.302)				
Other						0.160*** (0.027)	0.067*** (0.021)				
Intervention index								0.051*** (0.006)			
Economic support index									0.002*** (0.000)		
Government response index										0.005*** (0.001)	
Stringency index											0.004*** (0.000)
Public Debt/GDP	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.002*** (0.000)	0.003*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.003*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Equity index return	0.473* (0.272)	0.624* (0.324)	0.431 (0.280)	0.579* (0.308)	0.524** (0.236)	0.425 (0.278)	0.315 (0.229)	0.355 (0.243)	0.313 (0.263)	0.215 (0.231)	0.259 (0.233)
Exchange rate	1.404* (0.782)	1.181 (0.973)	1.352 (0.834)	0.832 (0.953)	0.621 (0.662)	0.986 (0.841)	1.223* (0.681)	1.332* (0.731)	1.204 (0.778)	0.958 (0.659)	0.903 (0.664)
ΔVIX	0.001 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
ΔEuribor 3M-Eonia	−0.500 (0.404)	−0.619 (0.525)	−0.570 (0.427)	−0.703 (0.520)	−0.523 (0.349)	−0.579 (0.440)	−0.479 (0.329)	−0.469 (0.351)	−0.430 (0.389)	−0.475 (0.309)	−0.530* (0.316)
Constant	−0.233*** (0.033)	−0.132*** (0.024)	−0.190*** (0.033)	−0.096*** (0.020)	−0.300*** (0.038)	−0.123*** (0.027)	−0.319*** (0.042)	−0.194*** (0.031)	−0.259*** (0.028)	−0.334*** (0.040)	−0.326*** (0.041)
Number of countries	22	22	22	22	22	22	22	22	22	22	22
Observations	682	682	682	682	682	682	682	682	682	682	682
R-squared	0.781	0.763	0.776	0.762	0.789	0.767	0.808	0.782	0.788	0.785	0.783
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table presents the empirical output regarding the determinants of CDS spreads cumulative abnormal change using the estimation technique presented in Eq. (6). The event day refers to March 9th, 2020 (official event day). Coefficients are rescaled by dividing them to 10,000. Description of variables can be found in [Table A4 from the Annexes](#). Panel-corrected standard errors in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Table 5
Determinants of CDS spreads cumulative average abnormal change (CAC) – national events.

Dependent: CAC	Driscoll and Kraay SEs				100th case				30 cases a day				10 death			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)	(15)	(16)
Intervention index	0.052*** (0.006)				0.079*** (0.010)				0.073*** (0.010)				0.060*** (0.012)			
Economic support index		0.003*** (0.000)				0.003*** (0.000)				0.003*** (0.000)				0.003*** (0.000)		
Government response index			0.005*** (0.000)				0.009*** (0.001)				0.008*** (0.001)				0.007*** (0.001)	
Stringency index				0.004*** (0.000)				0.007*** (0.001)				0.006*** (0.001)				0.005*** (0.001)
Public Debt/ GDP	0.002*** (0.001)	0.003*** (0.000)	0.002*** (0.000)	0.002*** (0.001)	0.012*** (0.001)	0.013*** (0.001)	0.010*** (0.001)	0.009*** (0.001)	0.013*** (0.001)	0.014*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.008*** (0.001)	0.009*** (0.001)	0.007*** (0.001)	0.007*** (0.001)
Equity index return	0.641*** (0.170)	0.730*** (0.241)	0.580*** (0.218)	0.644*** (0.203)	0.281 (0.296)	0.174 (0.303)	0.121 (0.299)	0.194 (0.294)	0.198 (0.283)	0.104 (0.291)	0.116 (0.299)	0.185 (0.285)	0.118 (0.270)	0.065 (0.239)	0.019 (0.240)	0.057 (0.258)
Exchange rate return	2.128*** (0.661)	1.974** (0.812)	1.959*** (0.574)	1.791*** (0.511)	1.728* (0.955)	1.532 (0.967)	1.492 (0.949)	1.632* (0.940)	1.663* (0.870)	1.682* (0.891)	1.745* (0.919)	1.692* (0.889)	1.613** (0.762)	1.577** (0.673)	1.409** (0.685)	1.555** (0.744)
ΔVIX	0.001* (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.000 (0.001)	−0.000 (0.001)	0.000 (0.001)	0.001 (0.001)	−0.000 (0.001)	−0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	−0.000 (0.002)	−0.000 (0.001)	−0.000 (0.001)	−0.000 (0.001)
ΔEuribor 3M-Eonia	−0.383** (0.154)	−0.297 (0.203)	−0.360** (0.135)	−0.428*** (0.131)	−0.180 (0.331)	−0.133 (0.349)	−0.129 (0.345)	−0.208 (0.333)	−0.344 (0.303)	−0.269 (0.305)	−0.256 (0.318)	−0.319 (0.312)	−0.351 (0.254)	−0.258 (0.210)	−0.289 (0.215)	−0.360 (0.248)
Constant	−0.238*** (0.057)	−0.262*** (0.023)	−0.328*** (0.055)	−0.322*** (0.059)	−1.147*** (0.070)	−1.069*** (0.082)	−1.193*** (0.083)	−1.131*** (0.078)	−1.367*** (0.078)	−1.299*** (0.083)	−1.372*** (0.084)	−1.292*** (0.080)	−0.765*** (0.093)	−0.737*** (0.080)	−0.881*** (0.102)	−0.742*** (0.093)
Number of countries	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Observations	682	682	682	682	682	682	682	682	682	682	682	682	682	682	682	682
R-squared	0.845	0.840	0.846	0.842	0.804	0.785	0.805	0.807	0.844	0.836	0.844	0.837	0.876	0.869	0.864	0.863
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table presents the empirical output regarding the determinants of CDS spreads cumulative abnormal change using the estimation technique presented in Eq. (6). The event day refers to March 9th, 2020 (official event day) for Models (1)–(4). For Models (5)–(8) the event day refers to the country-specific event when the when the number of cases reached 100, Models (9)–(12) - the growth rate of infections climbed to 30 cases a day, and Models (13)–(16) - the death rate surpassed 10. Coefficients are rescaled by dividing them to 10,000. Description of variables can be found in [Table A4 from the Annexes](#). Driscoll and Kraay standard errors in parentheses for Models (1)–(4) and panel-corrected standard errors in parentheses for Models (5)–(16). *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Table 6

Robustness checks for market reaction to the pandemic.

Event window	[0; 0]	CDS CAACs (b. p.)		
		[-1; 1]	[-5; 5]	[0; 30]
WHO pandemic (11 March 2020)	87.03	2041.51	4884.63	3277.06
Equally-weighted portfolio (market model)	528.41	2138.54	3792.95	4327.43
150 days estimation window (market model)	504.53	2152.82	4180.60	4996.08
CAPM	589.25	2386.11	4902.57	6276.63
Constant mean model	587.04	2328.07	4399.38	5118.60
Adjusted spread change (market-adjusted model)	372.20	1634.71	2174.05	2237.17
Two-factor model	551.66	2287.79	4561.75	4818.64
Significance tests: WHO pandemic				
Adjusted-Patell test	0.84	14.05***	17.80***	14.58***
BMP test	1.15	3.56***	4.52***	6.75***
Generalized sign test	0.36	2.38**	2.67**	3.16***
GRANK test	0.89	0.77	0.33	3.83***
Significance tests: Equally-weighted portfolio				
Adjusted-Patell test	5.69***	13.69***	13.02***	21.64***
BMP test	2.31**	3.93***	3.73***	4.66***
Generalized sign test	-0.37	1.24	0.83	2.47**
GRANK test	0.40	1.98**	2.04**	2.83***
Significance tests: 150 days estimation window				
Adjusted-Patell test	7.52***	16.68***	18.54***	29.95***
BMP test	2.19**	3.91***	4.35***	5.74***
Generalized sign test	-1.61	1.61	2.42**	3.40***
GRANK test	0.58	3.68**	3.22***	4.26***
Significance tests: CAPM				
Adjusted-Patell test	5.91***	14.52***	17.87***	28.04***
BMP test	2.75**	5.10***	6.48***	8.06***
Generalized sign test	0.11	2.40**	2.86***	2.39**
GRANK test	1.15	2.70**	3.02***	3.25***
Significance tests: Constant mean model				
Adjusted-Patell test	5.68***	13.60***	14.38***	24.11***
BMP test	2.64**	4.49***	4.89***	6.58***
Generalized sign test	3.03***	2.62**	2.62**	3.48***
GRANK test	1.76*	2.99***	3.08***	3.62***
Significance tests: Adjusted spread change				
Adjusted-Patell test	2.92**	6.22***	3.52***	6.16***
BMP test	1.53	2.90***	1.59	2.10**
Generalized sign test	-2.01**	0.75	0.35	1.40
GRANK test	-0.42	0.77	0.33	0.66
Significance tests: Two-factor model				
Adjusted-Patell test	5.36***	13.47***	15.89***	22.28***
BMP test	2.56**	4.64***	5.56***	6.07***
Generalized sign test	-0.88	1.44	1.90*	2.33**
GRANK test	0.78	2.58**	2.98***	3.20***

Note: This table shows the cumulative average abnormal changes (CAACs) of countries CDS spreads for European countries considering the day when the World Health Organisation declared COVID-19 as pandemic (March 11th, 2020), an equally-weighted portfolio as the market index, 150 days estimation window in the market model described in Eq. (2), the constant mean model, the adjusted spread change model where the reference index is constructed as an equally-weighted portfolio of all reference entities from our sample, and a two-factor model similarly to He et al. (2016) to compute the abnormal change. We consider the following event windows: [0; 0], [-1; 1], [-5; 5], and [0; 30]. The estimation window for all other models is 250 days. The table also reports the statistics of the tests used to assess the significance of CAACs described in Section 3.2. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. The number of countries are shown between parentheses.

short run.¹⁷

4.5. Robustness checks

To assess the robustness of our findings, we reran our analysis using different event days, methodologies, and estimation windows.

¹⁷ The same conclusion applies for shorter timeframes, i.e., [0; 10] and [0; 20]. We do not extend the analysis for longer periods to exclude the possibility of additional noise in the market that could influence the results.

Fig. 4. The evolution of the average 5-year CDS spreads for European Union, Euro Area, PIIGS countries (Portugal, Italy, Ireland, Greece, Spain) and the Datastream Europe Sovereign 5-year CDS index between October 1st, 2009 to December 31st, 2010.

Table 7

Market reaction to the sovereign debt crisis.

Event window	CDS CAACs 27 April 2010 (b. p.)			
	[0; 0]	[-1; 1]	[-5; 5]	[0; 30]
Europe (26)	2542.41	2579.73	2132.03	4653.39
European Union (22)	2721.81	2754.19	2365.49	4804.91
Euro Area (11)	3401.63	3443.83	2964.23	3953.67
PIIGS countries (5)	4431.42	4055.07	3955.09	3372.55
Significance tests: Europe				
Adjusted-Patell test	14.78***	9.62***	4.48***	19.01***
BMP test	8.55***	8.03***	5.20***	14.68***
Generalized sign test	4.77***	4.77***	4.38***	4.77***
GRANK test	4.10***	4.05***	3.06***	4.25***
Significance tests: European Union				
Adjusted-Patell test	14.28***	9.38***	4.60***	18.04***
BMP test	7.79***	7.47***	5.58***	13.62***
Generalized sign test	4.42***	4.42***	4.42***	4.42***
GRANK test	3.86***	3.82***	3.13**	4.06***
Significance tests: Euro Area				
Adjusted-Patell test	16.57***	11.11***	5.44***	17.40***
BMP test	6.14***	5.91***	4.23***	9.51***
Generalized sign test	3.38***	3.38***	3.38***	3.38***
GRANK test	3.78***	3.71***	3.08***	3.92***
Significance tests: PIIGS countries				
Adjusted-Patell test	15.80***	10.37***	5.23***	14.92***
BMP test	16.45***	5.38***	3.17***	17.40***
Generalized sign test	2.43**	2.43**	2.43**	2.43**
GRANK test	3.06***	2.91***	2.14**	3.06***

Note: This table shows the cumulative average abnormal changes (CAACs) of countries CDS spreads for European countries, the European Union, Euro Area and PIIGS (i.e., Portugal, Ireland, Italy, Greece and Spain) subsamples, considering the following event windows: [0; 0], [-1; 1], [-5; 5], and [0; 30]. The event refers to 27 April 2010. The estimation window is 250 days and the model employed to compute the expected change is the market model described in Eq. (2). The table also reports the statistics of the tests used to assess the significance of CAACs described in Section 3.2. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. The number of countries are shown between parentheses.

Fig. 5. The evolution of the CDS cumulative average abnormal change (CAAC) 30 days before the event days and 30 day after the event days. The sovereign debt crisis event day is April 27th, 2010 and the COVID-19 event day is March 9th, 2020.

First, we use a different event date, i.e., the date when the World Health Organization (WHO) declared COVID-19 a pandemic, which can be considered a global event. Second, we use an equally weighted portfolio constructed with all reference entities from our sample as the market index. Third, we rerun Eq. (1) considering an estimation window of 150 days to compute β in the market model. Fourth, we employ four different models to compute the expected change. The first model is the Capital Asset Pricing Model (CAPM), where the risk-free rate is the yield on the 10-yr German sovereign bonds, similar to Altavilla et al. (2019). The second model is the constant mean model, which assumes that an asset's return (or change in our case) over time is *i.i.d.* with a constant mean and variance. Brown and Warner (1985) find that the results from the constant mean model are often similar to those of more advanced models. Moreover, Andres et al. (2016) show that the constant mean model leads to very reasonable results in CDS event studies.¹⁸ The third model computes the adjusted spread change as the difference between the sovereign's CDS spread and the spread of an equally weighted portfolio created with all countries in our sample using a similar approach to Ismailescu and Kazemi (2010) and Lee et al. (2018), which resembles the market-adjusted model. Fourth, we follow He et al. (2017) and control for the intermediary capital ratio of primary dealers¹⁹ in a two-factor model. The capital ratio is computed as the market equity divided by the sum of the market equity and book equity. Because the book equity has quarterly frequency, we linearly interpolate the data to obtain daily values (Ericsson et al., 2009). Finally, we compute the average capital ratio with a daily frequency and use it as an additional factor in the CAPM model. The findings are exhibited in Table 6. Overall, the findings are robust and similar to those of the benchmark model described in Eq. (2). However, on the day when the WHO declared COVID-19 a pandemic, the results are not statistically significant, meaning that the event was anticipated by investors and already incorporated in the prices of European sovereign CDS.

4.6. Further analysis

In this section, we compare the actual health crisis with the European sovereign debt crisis from 2009 to 2010. The seeds of the

¹⁸ Andres et al. (2016) employ a four-factor model to detect abnormal CDS spreads. We follow a similar approach and control for the following factors: (i) the implied volatility of the European stock market as measured by the change in the VSTOXX index, (ii) the stock market performance (log-return of the STOXX 600 index), and (iii) the slope of the yield curve estimated as the difference between 10-yr and 1-yr sovereign German bond yield. The findings are consistent with those of our benchmark model and are available upon request.

¹⁹ We select the 20 largest primary dealers from Europe according to their total assets at the end of 2019 (e.g., JP Morgan, HSBC Holdings, BNP Paribas, Bank of America, etc.). The list with all primary dealers from Europe can be found on this website: <https://www.afme.eu/Portals/0/DispatchFeaturedImages/PD%20Handbook%20Updated%202019%202020.pdf>.

Fig. 6. Dynamic Causality Index. This graph exhibits the Dynamic Causality Index (DCI) which denotes the ratio of statistically significant Granger-causality relationships among all $N(N-1)$ pairs of N countries 30 days before the event days and 30 days after the event days. The sovereign debt crisis event day is April 27th, 2010 and the COVID-19 event day is March 9th, 2020. The estimation is performed over a rolling-window of 22 trading days.

sovereign debt crisis were planted after the socialists won the elections in Greece on October 4, 2009. On November 5, 2009, it was revealed by the new socialist government that Greece's 2009 budget deficit would be 12.7 percent of GDP, more than twice the previously published figure. On December 8, 2009, Fitch Ratings downgraded Greek debt to BBB+, below investment grade for the first time in 10 yr. This all culminated on April 27, 2010 when Standard and Poor's cut Greek government debt to junk status, followed by a dramatic hike in sovereign CDS spreads, especially those of the PIIGS countries, i.e., Portugal, Italy, Ireland, Greece, and Spain (Fig. 4). Starting May 2010, the European Systemic Risk Board documented that Greece entered a systemic crisis phase (see Lo Duca et al., 2017 for details).

We consider April 27, 2010 as the epicenter of the sovereign debt crisis and perform an event study following the methodology described in Section 3.1. The results are displayed in Table 7. Not surprisingly, the magnitude on the event day is much higher during the debt crisis, especially for the PIIGS countries, and highly significant according to all tests, both parametric and nonparametric. Moreover, the statistical relevance of the CAACs is maintained for longer periods, i.e., $[-5; 5]$ and $[0; 30]$, but they are of smaller magnitude compared with those of the COVID-19-induced crisis. This can also be detected by examining Fig. 5, which shows the evolution of the CAACs 30 days before the events and 30 days after the events.

Finally, we analyze the interconnectedness in the sovereign CDS spread markets as a channel of risk spillover during the COVID-19 and sovereign debt crises. We follow the approach of Billio et al. (2012) and compute the Dynamic Causality Index (DCI). The DCI is defined as the proportion of Granger causality relationships (at the 5 percent level of statistical significance) among all $N(N-1)$ pairs of N sovereign CDS spread changes based on a 22-d rolling window. We set the threshold of noncausal relationships at 6 percent. An increase in the DCI indicates a higher level of interconnectedness between countries. The DCI can provide new information because it can reveal how connected the CDS markets are during certain periods of time: when interconnectedness between markets increases, one can associate this with a higher level of uncertainty among investors and thus with more channels through which shocks can propagate to the real economy.

Fig. 6 illustrates the evolution of the DCI 30 days before the events and 30 days after the events. We note that the interconnectedness between countries during the sovereign debt crisis was much higher before the event than during the pandemic-induced crisis and followed a sharp increase several days before the event and a few days after the event. The same pattern can be observed in the DCI of the COVID-19 crisis, but at a smaller magnitude. Thus, one can associate this pattern with a rise in the dynamic interconnectedness between countries that have become highly interrelated, increasing the channels through which shocks can propagate to the real economy.

5. Conclusion

The pandemic has spread economic uncertainty and has put the global economy to a synchronized standstill. Governments around the world are tackling the pandemic with a mix of strategies and policy measures, including but not limited to health, fiscal, macroprudential, monetary, or market-based measures. In this paper, we assess the impact of the arrival of the pandemic in Europe on European sovereign CDS spreads and the investors' responses to general containment measures imposed to curb the spread of the virus using an event study methodology. We find that the increased number of cases and deaths and nonpharmaceutical interventions significantly increase the uncertainty among investors in European government bonds, resulting in an increase in CDS spreads. Moreover, we investigate whether policies with a monetary stance adopted by European governments mitigate or augment the negative effect and find that in the short run, the mix of policies tends to amplify the effect as countries incur significant losses due to disruptions in the supply chain. Additionally, an increased debt/GDP ratio significantly boosts the cumulative abnormal change in CDS spreads, which indicates that investors are concerned about countries that are too indebted and thus have a limited capacity to intervene and provide fiscal stimuli and emergency fiscal packages to businesses and households.

In the early stage of the pandemic, lockdown measures tend to be excessive and slow economic activity that relies on social interactions through both supply and demand channels. Thus, as government measures become more stringent, investors penalize those countries by requiring higher premia to invest in the bonds issued by these European sovereigns.

Declaration of Competing Interest

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

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Appendix

Table A1

Dates when specific policies were adopted in the countries from our sample.

Country	Fiscal	Macroprudential	Microprudential	Market-based	Monetary	Other type
Austria	16-Mar-20	25-Mar-20	19-Mar-20	15-Apr-20	12-Mar-20	19-Mar-20
Belgium	06-Mar-20	27-Mar-20	01-Apr-20		12-Mar-20	
Bulgaria	23-Mar-20	19-Mar-20	19-Mar-20			16-Mar-20
Croatia	17-Mar-20		19-Mar-20	12-Mar-20	09-Mar-20	12-Mar-20
Cyprus	16-Mar-20		06-Mar-20	13/03/2020	12-Mar-20	12-Mar-20
Czechia	06-Mar-20	16-Mar-20	16-Mar-20		16-Mar-20	
Denmark	09-Mar-20	12-Mar-20	12-Mar-20		12-Mar-20	
Estonia	20-Mar-20	06-Apr-20	26-Mar-20		12-Mar-20	15-Mar-20
France	16-Mar-20	01-Mar-20	26-Mar-20	15-Apr-20	12-Mar-20	01-Mar-20
Germany	13-Mar-20	18-Mar-20	12-Mar-20		12-Mar-20	27-Mar-20
Hungary	18-Mar-20	18-Mar-20	18-Mar-20		17-Mar-20	18-Mar-20
Ireland	13-Mar-20	18-Mar-20	24-Mar-20	27-Mar-20	12-Mar-20	18-Mar-20
Italy	06-Mar-20	20-Mar-20	11-Mar-20	12-Mar-20	12-Mar-20	02-Mar-20
Latvia	19-Mar-20	26-Mar-20	26-Mar-20		12-Mar-20	
Lithuania	16-Mar-20	31-Apr-20	16-Mar-20		31-Mar-20	
Poland	17-Mar-20	18-Mar-20	18-Mar-20	19-Jun-20	16-Mar-20	13-Mar-20
Portugal	06-Feb-20	24-Mar-20	16-Mar-20	13-Mar-20	12-Mar-20	17-Mar-20
Romania	18-Mar-20		24-Mar-20		20-Mar-20	18-Mar-20
Slovakia	23-Mar-20	13-Mar-20	13-Mar-20		12-Mar-20	
Slovenia	20-Mar-20	24-Mar-20	09-Mar-20		12-Mar-20	
Spain	12-Mar-20		02-Mar-20	17-Mar-20	12-Mar-20	14-Mar-20
Sweden	01-Mar-20	16-Mar-20	20-Mar-20		12-Mar-20	30-Mar-20

Note: This table presents the first date when specific policies were adopted by countries from our sample used in the regression analysis according to the European Systemic Risk Board. We use these dates to construct the Fiscal, Macroprudential, Microprudential, Market-based, Monetary, Other and Intervention indices. Because some measures were adopted during the weekend days, we set these dates to the next working day. For example, Austria adopted the first fiscal measure on March 15th, 2020 (Sunday) and we set this day on March 16th, 2020 (Monday).

Table A2

Type of measures for every type of policy adopted by the European countries as a response to COVID-19 crisis.

Fiscal	Macroprudential	Microprudential
Direct grants	Borrower-based measure	Buffer usability
Equity participation	Capital Conservation Buffer	Dividend distribution policy
Moratoria on other claims	Countercyclical Capital Buffer	Internal models
Other measure	Other Systemically Important Institution Buffer	Lending standards
Private moratoria	Systemic Risk Buffer	Liquidity measure
Public guarantees		Other measure
Public loans		Reporting requirements
Public moratoria		Special provisioning policy
Public support for trade credit insurance		Supervisory expectations
Tax deferrals		
Tax reliefs		
Market-based	Monetary	Other
Market stop	Asset purchase programme	Announcement or public statement
Other measure	Credit facilities	Construction sector measure
Redemption gate	Emergency liquidity	Dividend distribution policy
Short selling ban	Interest rate change	Exemption from penalties/fines
Trading curbs	Market liquidity	Health sector measure
	Other measure	Other labour market measure
	Swap lines	Other measure
		Other state of emergency measure
		Private moratoria
		Tourism sector measure
		Travel bans

Note: This table presents each type of measures for every type of policy adopted by the European countries as a response to COVID-19 crisis according to the European Systemic Risk Board.

Table A3

Summary statistics of the variables used in the regression analysis.

	Mean	St. dev.	p25	Median	p75	Min	Max	Obs.
CAC	3649.89	3272.36	823.40	2951.09	6174.89	-1610.43	13155.73	682
Fiscal index	0.85	0.36	1.00	1.00	1.00	0.00	1.00	682
Macroprudential index	0.59	0.49	0.00	1.00	1.00	0.00	1.00	682
Microprudential index	0.78	0.42	1.00	1.00	1.00	0.00	1.00	682
Market-based index	0.23	0.42	0.00	0.00	0.00	0.00	1.00	682
Monetary index	0.83	0.38	1.00	1.00	1.00	0.00	1.00	682
Other interventions index	0.52	0.50	0.00	1.00	1.00	0.00	1.00	682
Intervention index	3.79	1.65	3.00	4.00	5.00	0.00	6.00	682
Stringency index	69.35	21.62	58.33	76.85	83.33	0.00	96.30	682
Economic support index	55.17	32.89	37.50	62.50	87.50	0.00	100.00	682
Government response index	56.18	17.50	46.11	60.28	70.00	5.00	83.33	682
Debt to GDP	62.05	32.45	35.24	59.26	95.47	8.42	134.80	682
Equity index return	0.00	0.04	-0.01	0.00	0.02	-0.19	0.12	682
Exchange rate return	0.00	0.01	-0.01	0.00	0.01	-0.03	0.04	682
ΔVIX	0.06	8.10	-4.45	-1.56	3.08	-17.64	24.86	682
ΔEuribor 3M-Eonia	0.01	0.02	0.00	0.00	0.02	-0.03	0.06	682

Note: This table presents the summary statistics of the variables used in the regression analysis. A complete description of the variables can be found in [Table A4 from Annexes](#). To minimize the influence of the outliers, we winsorize all variables (except macroprudential, microprudential, market-based, monetary, other and intervention indices) between 1st and 99th percentiles.

Table A4

Description of variables.

Variable name	Description	Source
CDS change	Log-change of countries' CDS spreads	Own computation, Datastream
AC	Abnormal change of countries' CDS spreads	Own computation
AAC	Average abnormal change of countries' CDS spreads	Own computation

(continued on next page)

Table A4 (continued)

Variable name	Description	Source
CAC	Cumulative abnormal change of countries' CDS spreads over the event window	Own computation
CAAC	Cumulative average abnormal change of countries' CDS spreads over the event window	Own computation
Fiscal	Fiscal measures with financial stability relevance. They include: public moratoria; tax relief; state guarantees of credit; deferral of tax payments; subsidised loans etc.	European Systemic Risk Board
Macroprudential	Macroprudential measures. They include: systemic risk buffer; O-SII buffer; countercyclical capital buffer; borrower-based measures etc.	European Systemic Risk Board
Microprudential	Microprudential measures. They include: buffer usability; reporting requirements; dividend distribution policy; special provisioning policy etc.	European Systemic Risk Board
Market-based	Market-based measures. They include: short selling ban; reporting requirements; announcement or public statements etc.	European Systemic Risk Board
Monetary	Monetary policy measures. They include: interest rate change; market liquidity; credit facilities; swap lines; asset purchase programme etc.	European Systemic Risk Board
Other	Other measures. They include: health sector measures; tourism sector measures; private moratoria etc.	European Systemic Risk Board
Intervention index	The sum of fiscal, macroprudential, microprudential, market-based, monetary, and other measures. The index takes values from 0 to 6, higher values being associated with an enhanced intervention	Own computation
Economic support index	Index constructed based on the following measures: (i) income support for households; and (ii) debt/contract relief for households. The index takes values from 0 to 100, higher values being associated with an enhanced economic support	Hale et al. (2020)
Government response index	Index constructed based on the following measures: (i) school closing; (ii) workplace closing; (iii) cancel public events; (iv) restrictions on gatherings; (v) close public transport; (vi) stay at home requirements; (vii) restrictions on internal movement; (viii) international travel controls; (ix) income support for households; (x) debt/contract relief for households; (xi) public information campaigns; (xii) testing policy; (xiii) contact tracing; (xiv) facial coverings; and (xv) vaccination policy. The index takes values from 0 to 100, higher values being associated with an enhanced government response	Hale et al. (2020)
Stringency index	(i) school closing; (ii) workplace closing; (iii) cancel public events; (iv) restrictions on gatherings; (v) close public transport; (vi) stay at home requirements; (vii) restrictions on internal movement; (viii) international travel controls; and (ix) public information campaigns. The index takes values from 0 to 100, higher values being associated with more stringent measures	Hale et al. (2020)
Datastream Europe Sovereign 5y CDS Index	Log-change of Datastream Europe Sovereign 5-year CDS Index	Own computation, Datastream
Debt/GDP	Government gross debt over GDP ratio	AMECO
Equity index return	Log-return of national equity indices	Datastream
Exchange rate	Log-change of country's exchange rate represented as units of the national currency per one unit of US dollar	Datastream
Volatility index (VIX)	First difference of the implied volatility of the S&P 500 index measured by the Chicago Board Options Exchange	Datastream
Euribor-Eonia	First difference of the spread between 3-month Euribor rate and Eonia rate	Datastream

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