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COVID-induced sovereign risk in the euro area: When did the ECB stop the spread?✩

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This paper studies how the announcement of the ECB’s monetary policies stopped the spread of the COVID-19 pandemic to the European sovereign debt market. We show that up to March 9, the occurrence of new cases in euro area countries had a sizeable and persistent effect on 10-year sovereign bond spreads relative to Germany: 10 new confirmed cases per million people were accompanied by an immediate spread increase of 0.03 percentage points (ppt) that lasted 5 days, for a total increase of 0.35 ppt. For periods afterwards, the effect falls to near zero and is not significant. We interpret this change as an indicator of the success of the ECB’s March 12 press conference, despite the “we are not here to close spreads” controversy. Our results hold for the stock market, providing further evidence of the effectiveness of the ECB’s March 12 announcements in stopping the financial turmoil. A counterfactual analysis shows that without the shift in the sensitivity of sovereign bond markets to COVID-19, spreads would have surged to 4.2% in France, 12.5% in Spain, and 19.5% in Italy by March 18, when the ECB’s Pandemic Emergency Purchase Programme was finally announced.

“I can assure you on that page that first of all we will make use of all the flexibilities that are embedded in the framework of the asset purchase programme, (...) but we are not here to close spreads”. Christine Lagarde, president of the ECB, press conference, 12 March 2020.

“The ECB will ensure that all sectors of the economy can benefit from supportive financing conditions that enable them to absorb this shock. This applies equally to families, firms, banks and governments”. ECB Governing Council press release, 18 March 2020.

1. Introduction

The COVID-19 virus pandemic started on December 31, 2019, in China and reached Europe almost one month later, according to the World Health Organization (WHO). As a serious threat to the economy, the rapid spread of the virus led to sizeable financial turmoil in Europe. The downturn was particularly strong in Italy, the most affected country in Europe, where the interest rate spread vis-à-vis Germany rose sharply from 1.4% to 2.5% and the stock market fell by 40% between February 19 and March 12 (Fig. 1). On

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The WHO offers regular rolling updates on the coronavirus disease. See also its daily situation reports.

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March 12, the European Central Bank (ECB) announced a set of monetary policy measures to support the economy in the face of the pandemic. The announcement of these measures gave rise to controversy over ECB president Christine Lagarde’s announcement that the ECB would certainly use “all the flexibilities that are embedded in the framework of the asset purchase programme” but also that the central bank was “not here to close spreads”. This last sentence has been widely cited as a communication failure, contrasting with the famous “whatever it takes” of her predecessor Mario Draghi. After a crash on March 12, the stock index plateaued, while the interest rate spread kept soaring to reach more than 2.8% on March 17. On March 18, the ECB conducted an exceptional longer-term refinancing operation (LTRO) to provide liquidity and announced the launch of a massive intervention program known as the Pandemic Emergency Purchase Programme (PEPP), which led to a turnaround in sovereign rates and a reboot in stock prices (Fig. 1). While the COVID-19 pandemic continued to spread in Europe, its transmission to financial markets stopped in Italy and the rest of the euro area. What was the role of these successive ECB interventions in stopping the spread of the pandemic to financial markets? What would have happened without these interventions?

To answer these questions, we measure the reaction of sovereign spreads to new COVID-19 cases and examine how it evolved around the time of the ECB interventions. Using local projection methods developed by Jordà (2005), we measure the reaction at the time of impact, that is, on the day of the occurrence of COVID-19 cases, and in dynamics, that is, up to 5 days after the release of data on new confirmed COVID cases. We provide state-dependent estimates of the sovereign spread reaction to COVID-19 by splitting our full sample (from January 2, 2020, to May 29, 2020) into two subsamples divided at a reference date falling between March 5 and March 25. We include national stock markets and both country and time fixed effects to capture an unbiased measure of the time-varying impact of COVID-19 severity on euro area sovereign risk.

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2 The Bloomberg article “Christine Lagarde Does Whatever It Doesn’t Take” illustrates the reaction in the press and social media to Christine Lagarde’s press conference.
We show that despite the controversy generated by the “we are not here to close spreads” declaration of Christine Lagarde (March 12),\(^3\) the ECB actually stopped the spread of the pandemic-sparked crisis to the euro area sovereign debt markets on March 12, before the announcement of the PEPP and the conduct of market operations that occurred on March 18, leading to the reversal of sovereign spreads (Fig. 1). Unfortunately, it should be stressed that the methodology and the data used in this paper do not allow us to dissociate the effects of ECB monetary policy announcements from those of Christine Lagarde’s statements at the press conference. Indeed, these two events took place simultaneously on March 12, and it is quite possible that Christine Lagarde’s statement substantially canceled out the effects of the ECB announcements.\(^4\) Nevertheless, our study allows us to identify the effectiveness of ECB communication since the announcements on March 12 were not accompanied by any major market operations.\(^5\) In fact, the ECB’s balance sheet expansion in reaction to the COVID-19 pandemic outbreak started the week after, on March 18, through substantial LTROs of €109.1305 billion, while the PEPP actually began on March 24.

At the start of the pandemic outbreak, the sovereign spread reaction to COVID-19 was increasing in the time horizon: the occurrence of 10 new cases per million people was accompanied by an immediate spread increase of 0.03 percentage points (ppt), which lasted 5 days for a total increase of almost 0.35 ppt. This explosive pattern is a hallmark of financial market turmoil in times of sovereign debt crises. Thus, we support the view that the ECB’s unprecedented monetary policy responses to the COVID-19 pandemic were very effective in disrupting the explosive path of sovereign default risk within eurozone countries.\(^6\) Indeed, our estimates indicate that without these interventions, sovereign debt rates would have risen to 4.2% in France, 12.5% in Spain, and 19.5% in Italy by March 18, which would have undoubtedly raised the question of debt sustainability in these countries and potentially led to a sovereign debt crisis.

Our study provides empirical evidence for the theoretical framework developed in Arellano et al. (2020) that clarifies the link between the ongoing COVID-19 pandemic and the increasing probability of sovereign default in emerging economies. Introducing a standard epidemiological methodology into a sovereign default model, the authors argue that lockdowns imposed by governments in reaction to the pandemic-induced health crisis save lives but are costly in terms of output and unemployment. They show how fiscal transfers engaged by governments to smooth consumption are constrained by borrowing capacity and default risk, which, in turn, increases the cost of lockdown. Hence, according to their model, the more severe the pandemic, the higher the risk of default on sovereign debt. This argument holds for the euro area as well. Indeed, ECB (2020a) indicates that the outbreak of the crisis led to an immediate increase in direct costs, mainly to address the public health consequences, but that from a macroeconomic perspective, much of the impact relates to the containment measures, which place a severe economic burden on firms, workers, and households, and the packages of fiscal measures implemented in all euro area countries. As a result, the general government budget deficit in the euro area was projected to increase significantly in 2020 to 8% of GDP, compared with 0.6% in 2019. The risk of transmission to the banking sector through a worsening of bank balance sheets was emphasized early by Schularick and Steffen (2020) and analyzed in Coupey-Soubeyran et al. (2020), among others. In a recent publication, ECB (2020b) warns that banks in some countries have indeed increased their domestic sovereign debt holdings, triggering concerns that the sovereign-bank nexus could re-emerge in the euro area.

Our paper also supplements recent empirical works on the drivers of euro area sovereign risk during the COVID-19 crisis. Among them, Delatte and Guillaume (2020) highlight the heterogeneous effects of European policies on sovereign spreads: while the announcement of the PEPP reduced spreads in the euro area, the contrary was true for the financial assistance announced by the European Council. In regard to the direct impact of the COVID-19 crisis, they report a nonlinear relationship between spreads and the logarithm of the number of deaths per 100,000 people but do not consider the variation in the number of cases and deaths, as we do. Augustin et al. (2020) and Klose and Tillmann (2021) are closer to our setup since they consider the daily percentage change in COVID-19 cases. Augustin et al. (2020) use a large international panel of developed countries (including European countries) and also report results for a set of U.S. states. They show that countries’ sovereign risk reacts positively and significantly to the pandemic outbreak and that the strength of this reaction is conditional on initial fiscal conditions. Klose and Tillmann (2021) consider both sovereign and equity markets in Europe and conclude that monetary policy has been more effective in closing spreads. Finally, Andries et al. (2020) measure the intensity of the pandemic as the day when the number of cases and deaths reaches a threshold and do not consider the daily change, as we do. They study how the intensity of the pandemic and policy measures explain the cumulative abnormal returns of sovereign Credit Default Swap (CDS) spreads.

Our contribution with respect to these references is as follows. First, we go further by dealing with the dynamic response of sovereign bond spreads to the COVID-19 pandemic outbreak in the euro area. Our results demonstrate that these dynamics are a key feature of COVID-induced sovereign risk, which is cumulative over days. Focusing on the sensitivity of spreads to COVID-19 news at the time of impact leads to a sharp underestimation of the severity of the issue. Second, by running a split sample analysis,

\(^3\) Christine Lagarde walked back this spreads comment by stating in a CNBC interview after the press conference, “I am fully committed to avoid any fragmentation in a difficult moment for the euro area. High spreads due to the coronavirus impair the transmission of monetary policy. We will use the flexibility embedded in the asset purchase programme, including within the public sector purchase programme. The package approved today can be used flexibly to avoid dislocations in bond markets, and we are ready to use the necessary determination and strength”.

\(^4\) Our daily data do not allow us to identify the specific effects of each event, and our conclusions should be interpreted as the global effect of all March 12 announcements. Further work should be carried out in the future using intraday data to dissociate the effects of the different announcements on the markets, taking into account the television interview of Ms. Lagarde on CNBC.

\(^5\) We are conscious of the above-described dramatic consequences of the March 12 statement on that day, in particular for Italian financial markets. We consider that despite this crash, this ECB intervention could have stopped the transmission of the pandemic outbreak to sovereign spreads and stock indices.

\(^6\) The ECB was not the only European institution involved in the management of the crisis. However, as explained in Section 2, its interventions were earlier than those of other bodies such as the European Commission and the European Council.
we can identify when this sensitivity was broken and interpret the results as being in line with the calendar of policy announcements. Third, we apply our empirical procedure to the stock market to provide additional evidence on the evolution of the nexus between the ongoing pandemic and financial markets. Fourth, we assess possible spillovers from the spread of the pandemic in Italy that may have been at work during the COVID crisis. Fifth, we provide a counterfactual analysis by simulating the path of sovereign bond spreads that would have occurred without this change in the sensitivity of bond spreads to the COVID-19 crisis.

Related literature. This paper is part of the burgeoning literature on the macroeconomic effects of the COVID-19 crisis and policy responses to the pandemic outbreak, as studied in Guerrieri et al. (2020), for instance. Atkeson (2020) and Eichenbaum et al. (2020) investigate the economic impact of the spread of the pandemic using a simple SIR model. In the latter, the severity of the pandemic is measured by the number of new deaths. This proxy has been found to strongly affect macroeconomic aggregates such as GDP or consumption and rates of return on stocks and government bonds (Barro et al., 2020; Jordà et al., 2020).

This paper also contributes to the extensive strand of literature on the determinants of long-term government yields and sovereign bond spreads in European Monetary Union (EMU) countries, including Manganelli and Wolsiwijk (2009), Favero and Missale (2012), Aizenman et al. (2013), Georgoutsos and Migiakis (2013), Costantini et al. (2014), and Afonso et al. (2015b). Furthermore, Delatte et al. (2017) use a panel smooth threshold regression model and show that EMU sovereign risk pricing is state dependent. Other papers assess a time-varying relationship between EMU sovereign spreads and their fundamental determinants such as liquidity or risk factors, as in Afonso et al. (2015a, 2018) or Afonso and Jelles (2019). The latter papers also highlight the role of ECB monetary policies as an important driver of sovereign bond spreads.

The methodology used in this paper is based on the growing literature employing local projection methods developed by Jordà (2005). Local projection methods have been employed to conduct inference on dynamic impulse responses to address several issues in applied macroeconomics. For instance, Ramey and Z zabairy (2018), Auerbach and Gorodnichenko (2013), Born et al. (2019) and Clóyne et al. (2020) use state-dependent local projections to examine fiscal issues. Meanwhile, state-dependent aspects of monetary policy transmission are also studied in Tenreyro and Thwaites (2016).

Structure of the paper. The rest of the paper is organized as follows. Section 2 presents the data and the chronology of events related to COVID-induced sovereign risk in the euro area. Section 3 explains the methodology used in this paper. Section 4 is devoted to the results. Section 5 is dedicated to several robustness checks. Section 6 proposes an extension of our baseline model, including an application to the stock market in the euro area, a cross-country analysis, and a counterfactual exercise. Section 7 concludes.

2. Data sources and chronology

This section presents the sources of data and summarizes the main events of the COVID-19 outbreak in Europe. The data are given at a business daily frequency (5 days per week) and run from January 2, 2020, to May 29, 2020. They come from different sources.

European sovereign debt and stock markets. Long-term interest rates and stock indices are from Datastream via Thomson Reuters Eikon. Sovereign bond spreads are constructed as the yield differentials between bonds issued by each euro area government and German bonds at a given maturity. The 10-year spread is our benchmark, and we consider the 2-year spread for robustness analysis. We restrict the sample to 15 euro area countries for which 10-year spreads and stock market indices are available on a daily basis for this period: Austria, Belgium, Cyprus, Finland, France, Greece, Ireland, Italy, Lithuania, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain.

Spreads are plotted for each country in Online Appendix B. The pattern highlighted above for Italy in Fig. 1 is representative of most European countries, which experienced a sharp increase in their government spreads when the pandemic spread to Europe.

Stock market indices are also plotted in Online Appendix B. The figures show that all the countries in our sample experienced an enormous drop in their main national stock market index. This crash occurred at the same time that euro area government spreads started to skyrocket, stressing how severe financial markets in the euro area interpreted the economic impact of the pandemic to be.

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7 SIR models are widely used in epidemiology and consist of studying the transmission of infectious diseases through a population (SIR stands for three population categories: S = number of susceptible, I = number of infectious and R = number of recovered–or deceased–individuals).

8 Asset purchase and especially bond-buying programs have directly contributed to lowering bond spreads within the euro area, as discussed by Falagia rda and Reitz (2015), Kilponen et al. (2015), Szczewiowicz (2015), Eser and Schwaab (2016), Fratzscher et al. (2016), Gibson et al. (2016), Ghysels et al. (2017), Jäger and Grigoriadis (2017), De Pooter et al. (2018), Krishnamurthy et al. (2018), and Pacca et al. (2019). Casiraghi et al. (2016) focus on the impact of the ECB's unconventional monetary policy on Italian government bond yields, Trebesch and Zettelmeyer (2018) emphasize the Greek case, and Lhuissier and Nguyen (2021) uses an external instrument to estimate the impact of ECB's APP on intra-euro area sovereign spreads.

9 See the series of papers using local projections to assess the impact of credit expansion on business cycle fluctuations (Jordà et al., 2013), equity and housing price bubbles on financial crisis risks (Jordà et al., 2015; Jordà et al., 2016), austerity on macroeconomic performance (Jordà and Taylor, 2016), and monetary interventions on exchange rates and capital flows (Jordà et al., 2020). Recently, local projections have been introduced for micro data as an alternative to vector autoregressive (VAR) models to avoid any distortion in impulse responses in nonlinear frameworks (see Favara and Imbs, 2015; Crouzet and Mehrotra, 2020 and Cezar et al., 2020).

10 Similarly, local projection methods have been applied in other monetary analyses to investigate the yield impact of unconventional monetary policy (Swanson, 2021) or uncertainty (Castelnuovo, 2019; Tillmann, 2020).

11 The Reuters identification codes (RICs) used to construct the dataset are listed in Online Appendix A.
**Health statistics on the COVID-19 pandemic in Europe.** COVID-19 data are extracted from the European Centre for Disease Prevention and Control (ECDC), an agency of the European Union aimed at strengthening defenses against infectious diseases. Since the beginning of the pandemic, the ECDC has been collecting the number of COVID-19 cases and deaths on a daily basis based on reports from health authorities worldwide. To be consistent with our financial series database, we discard observations for weekends to obtain a business week database of COVID-19 cases and deaths. The main implication of this transformation is that (business) daily variations in the number of cases and deaths on Monday are computed with respect to the previous Friday and not to Saturday or Sunday, when financial markets are closed. Total cases and deaths are plotted for each country of our sample in Online Appendix B.

Our database starts just after the report by the Wuhan Municipal Health Commission in Wuhan City of a cluster of 27 pneumonia cases (December 31). The pandemic then spread to Europe. The first European case was reported in France on January 24, but Italy was the most heavily affected country in Europe. The Italian authorities reported clusters in Lombardy on February 22 and implemented lockdown measures on March 8 at the regional level, which were rapidly extended to the national level on March 11. The Director General of the WHO declared COVID-19 a global pandemic on March 11 and said that Europe had become the epicenter of the pandemic on March 13. All countries of the European Union were affected by March 25, according to the ECDC.

**ECB interventions.** Central banks’ response to the COVID-19 crisis was quick and massive, as documented by Cavallino et al. (2020) and Delatte and Guillaume (2020). Major central banks across advanced economies launched new asset purchases and lending operations to face the pandemic outbreak. Among them, the ECB reacted strongly to the COVID-induced economic downturn by making substantial decisions during March 2020. On March 12, the Governing Council decided on a package of policy measures providing (i) additional longer-term refinancing operations (LTROs) to provide liquidity for the euro area financial system until June 2020, (ii) more favorable terms for the third series of targeted longer-term refinancing operations (TLTRO III) from June 2020 to June 2021 to support bank lending to small and medium-sized enterprises affected by the spread of the virus, and (iii) a temporary envelope of additional net asset purchases of €120 billion until the end of 2020 to support financing conditions under the existing Asset Purchase Programme (APP). On March 18, the ECB announced the launch of a new temporary asset purchase program called the Pandemic Emergency Purchase Programme (PEPP) consisting of assets purchases of €750 billion, including assets eligible for the APP, until the end of 2020.

Fig. 2 shows the growth rate of ECB total assets (in percentage, at weekly frequency) and the respective contribution of the two main open market operations: “LTROs” and “Securities held for monetary policy purposes”. The category “Others” includes all other assets on the ECB balance sheet. Unfortunately, these series are not available on a daily basis and cannot be decomposed into national shares. However, they provide several helpful insights for interpreting our results.

ECB interventions can be classified as only communication on March 12 and as a mix of communication and market operations on March 18. Indeed, the ECB balance sheet expansion started the week that ended on March 20 and not on March 13. Thus, the ECB intervention on March 12 can be considered a communication policy only, without significant market operations. This is not the case for the ECB press conference on March 18. On this date, the ECB provided exceptional LTROs of €109.1305 billion for 98 days, which implies an enormous increase of 17.73% for LTROs in comparison with their level in the previous week. Considering the full balance sheet, this increase explains half of the 4.74% increase in total assets on March 20—with increases of 2.31% from LTROs, 0.36% from securities held for monetary policy purposes, and 2.05% from other assets. Actually, the new PEPP was announced on March 18 by Christine Lagarde but was only effective from March 24. As shown in Fig. 2, the rise in debt securities held for monetary policy purposes (which include the PEPP) was gradual and became predominant in the expansion of the ECB balance sheet only from April 2020. Thus, the ECB intervention on March 18 was a mix of communication (mainly on the PEPP) and market operations (through LTROs).

Additionally, it is important to mention that all European institutions were involved in managing the crisis. On March 10, the members of the European Council and heads of European institutions, including the ECB’s Christine Lagarde, held a video conference on COVID-19. They discussed how to coordinate European Union efforts to respond to the pandemic outbreak. We focus on the ECB

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12. The complete COVID-19 dataset is updated daily by “Our World in Data” and is available in a CSV file on the OWID webpage. We downloaded the dataset on May 30, 2020, and do not consider updated versions since we are interested in the market reaction to the numbers of cases and deaths publicly available in real time during the pandemic outbreak and not in the revised data reported afterwards. We have checked with the ECDC Epidemic Intelligence team and the Head of Data of OWID that no major data retro-correction has been recorded from January to May 2020 to make sure that our results are not affected by any COVID data revision.

13. For additional information, see the ECDC timeline and WHO timeline.

14. https://www.ecb.europa.eu/press/pr/html/index.en.html.

15. Simultaneously, the ECB stated on March 18, “The Governing Council was unanimous in its analysis that in addition to the measures it decided on 12 March 2020, the ECB will continue to monitor closely the consequences for the economy of the spreading coronavirus and that the ECB stands ready to adjust all of its measures, as appropriate, should this be needed to safeguard liquidity conditions in the banking system and to ensure the smooth transmission of its monetary policy in all jurisdictions.”

16. The ECB publishes a bimonthly breakdown of public sector securities under the PEPP.

17. There was also an MRO of €1.4699 billion for 7 days this day; see the calendar of open market operations.

18. This was mainly due to the change in the net position of the Eurosystem in foreign currency, as explained by the ECB (link).

19. See the Q&A on PEPP. March 24 is the date of the publication of the ECB decision. In June 2020, monthly net purchases under the PEPP reached a maximum with an amount of €120,321 million, in comparison with €15,444 million in March 2020.

20. See the “Timeline of EU action”.

21. Four priorities were identified at the end of the meeting: limiting the spread of the virus, providing medical equipment, promoting research (including vaccine research), and dealing with the socioeconomic consequences. For more details, see the dedicated meeting webpage.
interventions, which came earlier and were more commented on in terms of their effects on sovereign debt markets. For example, the activation of the general escape clause of the Stability and Growth Pact was proposed by the European Commission on March 20 and agreed upon by the ministers of finance of the member states of the EU on March 23, after the main ECB interventions.

**The March 5–25 window.** Based on the data and on the abovementioned events, we focus on the March 5–25 period to identify when and how the sovereign interest rate response to the spread of the COVID-19 pandemic changed. This choice is motivated by two considerations. First, March 5 fell one business week before the first ECB intervention (March 12), and March 25 fell one week after the ECB decision of March 18. Thus, the window is large enough to ensure that we do not miss any monetary policy effects in our analysis. Second, by March 5, only a few European countries had reported deaths (France, Italy, and Spain), while by March 25, only Latvia, Malta and Slovakia had not reported deaths from COVID-19. Thus, the window corresponds to the period of the generalization of the pandemic in Europe. In the remainder of this paper, we take as our benchmark the series of COVID-19 cases and not that of deaths. Since the number of confirmed cases leads the number of reported deaths, the series of COVID-19 cases provides more data for the estimation at the beginning of the sample—by March 5, only six countries had not reported cases, against fourteen that had not reported deaths.

### 3. Methodology

Our primary interest is in the dynamic response of government spreads to the outbreak of the COVID-19 pandemic. To obtain an estimate of the response, we rely on the local projection method following Jordà (2005). Considering the whole sample period, we estimate:

\[
\Delta s_{i,t+h} = a_{i,h} + \eta_{i,h} + \beta_h \Delta x_{i,t} + \Gamma_h(L) s_{i,t-1} + \Theta_h(L) z_{i,t} + \epsilon_{i,t+h}
\]

for country \( i \) and horizon \( h = 0, 1, \ldots, H \) as of time \( t \), where \( \epsilon_{i,t+h} \) is the error term. \( \Delta s_{i,t+h} = s_{i,t+h} - s_{i,t-1} \) is the variation in the 10-year government bond spread at horizon \( h \). \( \Delta x_{i,t} = x_{i,t} - x_{i,t-1} \) is the daily change in the number of total COVID-19 cases in country \( i \) as of time \( t \). We consider the change in the number of cases per 100,000 people. The main motivation for this choice is that the attention...
of observers has been focused on the number of daily new cases by population since the beginning of the pandemic, sometimes in absolute terms but never as a percentage of the number of total cases already reported, as illustrated by the very popular figures published and massively distributed by the Financial Times. However, we check the robustness of our results by considering the daily change in the number of deaths per million people due to COVID-19, the 3-day rolling average of new cases, new cases in absolute terms, the lagged values of new cases, and the growth rate of total cases as the independent variable. Additionally, other robustness checks involve separately adding the growth rate of total cases, the logarithm of the total number of cases, the first difference of new cases, or the lagged values of new cases as control variables in the baseline specification. Tables and figures containing the results are given in Online Appendices D and E. The coefficient of interest $\beta_h$ measures the variation in government spreads $h$ days after the release of data on new COVID-19 cases. A series of regressions are estimated for each horizon $h$. Since the model is estimated on a business daily basis, we assume that a one-week horizon is sufficiently long to capture the path of the response coefficients $\beta_h$.

Then, we set $H = 5$.

To obtain an accurate estimate of these coefficients, we use a two-way fixed effects framework and add a set of control variables as recommended by Herbst and Johannsen (2020). First, country fixed effects $a_{i,h}$ take into account the structural differences between countries. Second, time fixed effects $n_{i,h}$ absorb features that are common across all countries but change over time, including the global evolution of the COVID-19 pandemic. Third, the current value and the first four lags of the log of the stock index $z_{i,t}$ control for the state of the economy and the effects of other news that could have an impact on government spreads. $\Theta(L)$ is a polynomial in the lag operator associated with the domestic stock markets, with $\Theta(L) = \sum_{n=0}^{N} \theta_n L^n$, where $N$ stands for the number of lags. Finally, it also includes the first four lags of the dependent variable to control for any serial correlation in the error term through the polynomial in the lag operator $\Gamma_h(L)$, defined by $\Gamma_h(L) = \sum_{n=1}^{N-1} \gamma_n L^n$. We set $N = 4$ as the number of lags.

The linear local projection method described above can be transformed into a state-dependent model. State-dependent local projection methods have been mainly applied to fiscal policy issues by Auerbach and Gorodnichenko (2013) and Ramey and Zubairy (2018). For the linear model, we estimate a series of regressions at each horizon $h$:

$$
\Delta s_{i,t+h} = a_{i,h} + n_{i,h} + D_{i,t}[\beta_{a,h} \Delta x_{i,t} + \Gamma_{a,h}(L) s_{i,\ell-1} + \Theta_{a,h}(L) z_{i,t}] 
+ (1 - D_{i,t})[\beta_{b,h} \Delta x_{i,t} + \Gamma_{b,h}(L) s_{i,\ell-1} + \Theta_{b,h}(L) z_{i,t}] + \epsilon_{i,t+h}
$$

(2)

where $D_{i,t}$ is a dummy variable that takes 0 before a given date $\ell$, that is, when $t < \ell$, and 1 thereafter, when $t \geq \ell$. Equation (2) captures the dynamic response of government bond spreads to new COVID-19 cases conditional on the ECB intervention through the coefficients $\beta_{a,h}$ and $\beta_{b,h}$. It is worth emphasizing that this response is different from the direct effect of a policy intervention on sovereign rates, which is gauged by the time fixed effect $n_{i,h}$. Since we are mostly interested in the $\beta_{a,h}$ and $\beta_{b,h}$ coefficients, responses in period $t + h$ to new information on the severity of the COVID-19 situation at time $t$, conditional on the state of the economy, are computed as in Born et al. (2019) by the following expression:

$$
\left. \frac{\partial \Delta s_{i,t+h}}{\partial \Delta x_{i,t}} \right|_{D_{i,t}} = D_{i,t} \times \beta_{a,h} + (1 - D_{i,t}) \times \beta_{b,h}
$$

(3)

which is a linear combination of impulse response coefficients. As our aim is to investigate possible nonlinearities in the response coefficient $\beta_h$ according to the state of the economy during the March 5–25 window (see Section 2), event dummies are constructed according to $\ell \in \{3/5, \ldots, 3/25\}$.

4. Results

This section presents our main results to identify when the COVID-induced rise in sovereign spreads was halted.

**Results for the full sample.** Let us start with equation (1) for the full sample of observations. Fig. 3 shows the path of the estimated coefficient $\beta_h$ and the 95% confidence interval, and Table C.1 (Online Appendix) contains the estimation results. The response coefficient is slightly negative at all horizons. However, the magnitude of the effect is very small: the change in the interest rate spread is very close to zero at all horizons and reaches $-0.002$ ppt at horizon $h = 3$ for 10 new cases per million people. As shown by the confidence interval, the impact of new cases is not significantly different from zero when we consider the full sample. As explained above, this does not mean that policy interventions have no direct effects on sovereign interest rates but that these rates do not react significantly to the occurrence of new COVID-19 cases. What happens, however, when the sample is split? In particular, we draw attention to the period before ECB interventions.

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22 Moreover, Herbst and Johannsen (2020) also suggest using large sample sizes to avoid bias in impulse responses estimated by local projections. Our setup is in line with this recommendation since the size of our subsample exceeds 500 observations.

23 Indeed, as indicated in Figure C.1 (Online Appendix), the time fixed effects $n_{i,h}$ are significantly negative around key ECB intervention dates, namely, on March 12 and March 18.
Fig. 3. Impulse responses of 10-year government bond spreads to new COVID-19 cases in the euro area. Note: Impulse responses represent the $\beta_h$ coefficient from equation (1), and the gray shaded area represents the 95% confidence interval.

Fig. 4. Impulse responses of 10-year government bond spreads to new COVID-19 cases in the euro area. Note: Impulse responses are computed following equation (2). The left panel shows the coefficient $\beta_{b,h}$ (before the split date), whereas the right panel shows the coefficient $\beta_{a,h}$ (after the split date). The gray shaded area represents the 95% confidence interval.

The difference between the beginning and the end of the March 5–25 window. Fig. 4 compares the response coefficients $\beta_{b,h}$ and $\beta_{a,h}$ of 10-year government spreads to new COVID-19 cases before and after March 5 ($\tilde{t} = 3/5$, the first date of our window). For the period before March 5, without the ECB intervention, the response coefficient $\beta_{b,h}$ follows an explosive path. Spreads on 10-year government bonds increase by more than 0.021 ppt for 10 new cases per million people on impact. This rise significantly accelerates to reach 0.240 ppt up to 5 business days. This explosive path severely threatened debt sustainability in the euro area as the pandemic spread. On March 12, Italy reported 38.256 new cases per million residents and Spain 24.66 and France 7.614 new cases. This $\beta_{b,5}$ estimate considering only this date would imply a cumulative increase in the spread over 5 days of 0.92 ppt in Italy, 0.59 ppt in Spain and 0.18 ppt in France for 10 new cases per million people. After March 5, the estimates for this sample including the ECB interventions show a response coefficient $\beta_{a,h}$ that is very close to zero and not significant.

Fig. 5 also compares the response coefficients $\beta_{b,h}$ and $\beta_{a,h}$ of bond spreads to new COVID confirmed cases before and after March 25 ($\tilde{t} = 3/25$, the last date of our window). The response coefficient $\beta_{b,h}$ on impact ($h = 0$) is smaller (0.001 ppt against 0.021 for $\tilde{t} = 3/5$) and still not significantly different from zero. However, in this case, the coefficient no longer follows an explosive path: the response of the interest rate spreads to new cases is even below zero at a 3-day horizon and becomes slightly positive up to a 5-day horizon (reaching 0.002 instead of 0.240 for $\tilde{t} = 3/5$). Note that the $\beta_{b,h}$ coefficient is not significant at any horizon. Similarly, the response coefficient $\beta_{a,h}$ is muted when we consider the subsample after March 25. In the latter case, government bond spreads do not react to new cases at all. These results indicate that a major change took place in the euro area sovereign debt market between March 5 and March 25. To identify when it occurred, we now consider various split dates $\tilde{t}$ falling within this time interval.

Time-varying split dates for the March 5–25 window. Fig. 6 depicts estimated values of the coefficient $\beta_{b,h}$ at each horizon $h$ based on various split dates $\tilde{t} \in \{3/5, \ldots, 3/25\}$. At horizon $h = 0$, the coefficient is positive and significantly different from zero up to March
Fig. 5. Impulse responses of 10-year government bond spreads to new COVID-19 cases in the euro area. Note: Impulse responses are computed following equation (2). The left panel shows the coefficient $\beta_{b,0}$ (before the split date), whereas the right panel shows the coefficient $\beta_{a,h}$ (after the split date). The gray shaded area represents the 95% confidence interval.

| Horizon (h) | before March 25 | after March 25 |
|-------------|-----------------|----------------|
| h = 0       | 0.17            | 0.99           |
| h = 1       | 0.50            | 0.75           |
| h = 2       | 0.74            | 0.49           |
| h = 3       | 0.00            | 0.28           |
| h = 4       | 0.00            | 0.27           |
| h = 5       | 0.00            | 0.27           |

Note: The table displays p-values of Chow statistics from the test.
should be emphasized that an impact response at a 3-day horizon on March 9 measures the effect of new cases reported on March 9 on spreads 3 days later (i.e., March 12). Moreover, the March 10 video conference between the members of the European Council and heads of European institutions, including the ECB (see Section 2), may have been perceived by financial markets as a positive signal of future ECB decisions scheduled on March 12. Hence, it could explain our key finding of a break date on March 9 through market expectations.\textsuperscript{24} Overall, our results indicate that the decision made by the ECB on March 12 was decisive in closing the spread of the COVID-19-induced financial crisis to euro area sovereign bonds.

Although we believe that ECB interventions—particularly those on March 12—were effective in controlling the COVID-induced sovereign risk in the euro area, we are fully aware that the break around March 12 may be the consequence of the generalization of the pandemic and not of ECB announcements. From this point of view, the strong relationship identified between COVID-19 cases and sovereign spreads may have been relevant only at the beginning of the pandemic, allowing financial markets to integrate the risk associated with the occurrence of a pandemic before losing their sensitivity to the severity of the health crisis. Thus, it is crucial to check the robustness of our results to the modeling of the pandemic outbreak.

5. Robustness

This section is dedicated to alternative specifications of our model to test the robustness of our results. First, alternative measures of pandemic dynamics are introduced as controls in the specification to differently capture the evolution of the pandemic. Then, the sample countries are divided into two subgroups according to their debt-to-GDP level to assess the role of initial fiscal conditions in COVID-induced sovereign risk in the euro area. Additional robustness tests are provided in Online Appendix D, where our baseline model is specified with alternative dependent and independent variables.

\textsuperscript{24} This point is discussed in detail in Section 6.1. Note also that the meeting held on March 12 was scheduled, which was not the case for the meeting of March 18 (see ECB’s March 2020 calendar).
5.1. Controlling for the shape of the pandemic

Our baseline regression (2) is extended to include additional controls. Using the reference date, we investigate whether these controls may alter our estimate of $\beta_{a,h}$ and $\beta_{b,h}$ for the reference date $\bar{t}$. The specification now takes the following form:

$$
\Delta s_{i,t+h} = a_{i,h} + \eta_{i,h} + D_{i,j}[\beta_{a,h} \Delta x_{i,t} + \Psi_{a,h}(L)x_{i,t} + \Gamma_{a,h}(L)s_{i,t-1} + \Theta_{a,h}(L)z_{i,t}] + (1 - D_{i,j})[\beta_{b,h} \Delta x_{i,t} + \Psi_{b,h}(L)x_{i,t} + \Gamma_{b,h}(L)s_{i,t-1} + \Theta_{b,h}(L)z_{i,t}] + \epsilon_{i,t+h}
$$

Fig. 7. Impulse responses of 10-year government bond spreads to new COVID-19 cases in the euro area. Note: Impulse responses are computed following equation (2). The impulse response coefficients $\beta_{a,b}$ are estimated before the following split dates: $i \in [3/5,...,3/9]$ in red, $i \in [3/10,...,3/16]$ in blue, and $i \in [3/17,...,3/25]$ in green. The shaded area represents the 95% confidence interval for each coefficient. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Fig. 8. Impulse responses of 10-year government bond spreads to new COVID-19 cases in the euro area. Note: Impulse responses are computed following equation (2). The left panel shows the coefficient $\beta_{a}$ (before the split date), whereas the right panel shows the coefficient $\beta_{a,b}$ (after the split date). The gray shaded area represents the 95% confidence interval.
where $\Psi_{x,h}(L)$ is a polynomial in the lag operator associated with the control variable $X_{1,t}$ defined hereafter. The results are reported in regression tables in Online Appendix E.25 The symbol $\cdot$ indicates both before ($b$) and after ($a$) for estimated coefficients.

**Growth rate of total cases.** First, we control for the growth rate of the number of total cases. The growth rate of total cases is measured as the first difference (daily change) of the logarithm of the number of total cases. Hence, $X_{1,t} = \log x_{1,t}$. Moreover, since no lagged value of controls is included in the estimate, we set $\Psi_{x,h}(L) = \sum_{n=0}^{N} \Psi_{x,h,n} L^n$, with $N = 0$. Table E.1 (Online Appendix) shows that including the growth rate of the number of total cases in the model does not alter our baseline results. The $\psi_{b,0}$ coefficient is close to zero and not significant at all over the horizon.

**Logarithm of total cases.** We also control for the logarithm of the number of total cases to take into account the state of the ongoing pandemic in its effect on sovereign bond spreads. Hence, $X_{1,t} = \log x_{1,t}$. As in the previous case, we set $\Psi_{x,h}(L) = \sum_{n=0}^{N} \Psi_{x,h,n} L^n$, with $N = 0$. Table E.2 (Online Appendix) shows that including the log of total cases by population in the model does not alter our baseline results, even if the $\psi_{b,0}$ coefficient is significantly positive up to horizon $h = 4$.

**Lagged values of new cases.** Next, we control for lagged values of new COVID cases, and we estimate equation (4) setting $\Psi_{x,h}(L) = \sum_{n=0}^{N} \Psi_{x,h,n} L^n$, with $N = 2$. The control variable is expressed as $X_{1,t} = \Delta x_{1,t-1}$, where $\Delta x_{1,t-1} = x_{1,t-1} - x_{1,t-2}$. The lagged values of new cases are measured as the first and second lags of new cases per 100,000 people. Table E.3 (Online Appendix) reports the results. The $\beta_{0,2}$ coefficient is not as strong and statistically significant as in our baseline estimates. Note that both coefficients on the first and second lagged values of new cases, $\psi_{b,1}$ and $\psi_{b,2}$, respectively, are often significant over the horizon. This is especially true for the $\psi_{b,2}$ coefficient. Thus, we capture the persistent effect of new confirmed COVID cases on government bond spreads.

**First difference of new cases.** Finally, we use the “variation of the variation” of new COVID-19 cases to account for the stretched S-shaped dynamics of the pandemic. In this case, $X_{1,t} = \Delta x_{1,t} - \Delta x_{1,t-1}$, which is positive in the first phase of the pandemic outbreak and negative at the end. The new cases variable (in its first difference) is now measured as the daily change in the number of new cases. Table E.4 (Online Appendix) shows that including the first difference of new cases as a control variable does not change our baseline results much. Note, however, that the $\psi_{b,0}$ coefficient is significantly positive on impact and turns out to be negative over the horizon but is always lower than the estimated $\beta_{0,2}$.

### 5.2. Public debt-to-GDP

Delatte and Guillaume (2020) and Augustin et al. (2020), among others, highlight the key role of initial fiscal conditions in the sovereign debt market reaction to the pandemic outbreak. To investigate the role of country fiscal conditions, we run the regressions defined by equation (2) for two subsamples of countries. The first subsample refers to high debt-to-GDP countries and consists of states for which the debt-to-GDP ratio is above the median calculated for the full sample at the end of 2019: Belgium, Cyprus, Spain, France, Greece, Italy, and Portugal. The second subsample refers to low debt-to-GDP states and includes countries with a ratio below the median: Austria, Finland, Ireland, Lithuania, Malta, the Netherlands, Slovenia, and Slovakia.

Estimation results are shown in Online Appendix F. Figure F.1 reports the results for our benchmark split date, that is, March 9. Like Delatte and Guillaume (2020) and Augustin et al. (2020), we observe substantial heterogeneity in the response of bond spreads to new COVID-19 cases, which are positive and significant in the high debt-to-GDP subsample but not significantly different from zero in the low debt-to-GDP subsample of countries. We then investigate whether this heterogeneity alters our narrative of the crisis. To do so, we conduct a Chow test to identify structural breaks between the coefficients $\beta_{b,h}$ and $\beta_{0,h}$ in high debt-to-GDP countries only. The results are reported in Table F.1. The test results indicate that the null hypothesis is now rejected at the 10% level of significance for the period after March 9. For the full sample, March 9 turns out to be the key reference date after which the sovereign debt markets no longer reacted to the development of the pandemic.

### 6. Extensions

This section extends the analysis to three issues. First, we assess whether the ECB stopped the euro area stock market crash. Second, we assess the existence of spillovers from the Italian pandemic outbreak to other European sovereign markets. Third, and finally, we investigate what would have happened without the structural break identified in the sovereign market reaction to the occurrence of new COVID cases.

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25 March 9 is chosen as the break date in all the regression tables to allow for comparison with our baseline results. Figures depicting the impulse response functions and Chow test tables are available upon request.
In this section, we extend our empirical strategy to assess the dynamic effect of the COVID-19 outbreak on stock markets in the euro area. Thus far, we have included equity market data as a control variable in our regressions for sovereign spreads to measure their reaction to the occurrence of new COVID-19 cases given all the information already anticipated by the markets. Cox et al. (2020) find evidence that Federal Reserve announcements were decisive in the reversal of the U.S. equity markets in March and April after the market crash in February. At that time, only a tiny fraction of the credit announced had been distributed, leading the authors to conclude that market movements were the outcome of a shift in investors’ risk aversion.

To investigate the response of the stock market to new cases in the euro area, the model defined by equation (1) now takes the form:

\[
\Delta z_{i \cdot h} = a_{i,h} + \eta_{i,h} + \beta_h \Delta x_{i \cdot t} + \Gamma_h(L)z_{i \cdot t-1} + \Theta_h(L)s_{i \cdot t} + \epsilon_{i \cdot t+h}
\]  

(5)

with the notation described in Section 3. The dependent variable is \(\Delta z_{i \cdot h} = z_{i \cdot h} - z_{i \cdot t-1}\) and is the variation of the log of the stock index (i.e., the cumulative logarithmic return) at horizon \(h\). The coefficient of interest \(\beta_h\) is the response of the national stock index to the pandemic outbreak. The model is still specified with country and time fixed effects and a set of control variables including the first four lags of the dependent variable and the current and four past values of 10-year sovereign bond spreads. The horizon is still 5 days, \(H = 5\).

In the spirit of equation (2), the state-dependent local projection framework is now expressed as follows:

\[
\Delta z_{i \cdot h} = a_{i,h} + \eta_{i,h} + D_{i,j}[\beta_{a,h} \Delta x_{i \cdot j} + \Gamma_{a,h}(L)z_{i \cdot j-1} + \Theta_{a,h}(L)s_{i \cdot j}] + (1 - D_{i,j})[\beta_{b,h} \Delta x_{i \cdot j} + \Gamma_{b,h}(L)z_{i \cdot j-1} + \Theta_{b,h}(L)s_{i \cdot j}] + \epsilon_{i \cdot t+h}
\]  

(6)

where \(D_{i,j}\) is a dummy variable that takes 0 before a given date \(i\), that is, when \(t \leq i\), and 1 thereafter, that is, when \(t > i\). Here, again, these event dummies are constructed according to \(i \in \{3/5, \ldots, 3/25\}\). We employ exactly the same procedure as that developed in Section 4: comparing the impulse response coefficients \(\beta_{a,h}\) and \(\beta_{b,h}\) with the split dates set on March 5 (\(i = 3/5\)) and March 25 (\(i = 3/25\), focusing on the path of \(\beta_{b,h}\) when the model runs over various split dates \(i \in \{3/5, \ldots, 3/25\}\), and testing for structural changes in the response coefficients over time.

The results are presented in Online Appendix G and summarized in Fig. 9, which replicates Fig. 7 for the cumulated stock market return instead of the sovereign spread. For the period up to March 9, the stock market response to new COVID-19 cases is explosive, with a cumulative fall of 11% in the stock market index 5 days after the occurrence of new cases. The response is no

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26 Davis et al. (2021) show that the stock market foreshadows workplace mobility.

27 Lucca and Moench (2015) and Cieslak et al. (2019) show that asset prices could be affected by central banks outside of the public communication events. Interestingly, and as a possible explanation of our main results, the former paper documents high stock excess returns in anticipation of monetary policy decisions made at scheduled meetings of the Federal Open Market Committee (FOMC) in the U.S.
longer explosive thereafter (blue lines) and is completely muted when the last dates of the window are considered (green lines). Hence, ECB interventions not only closed spreads in the euro area but also prevented an even more dramatic stock market crash. Given the timing of balance sheet expansion, these results also support the existence of the communication channel linking the ECB intervention to stock markets—as reported in Cox et al. (2020) for the U.S. economy—since there was no significant balance sheet expansion before March 18.

6.2. Are there spillovers from the Italian pandemic outbreak?

As recalled in Section 2, Italy was the first country in Europe to be severely affected by the COVID-19 pandemic. It is interesting to assess the extent to which both sovereign debt and stock markets in other European countries reacted to the health crisis in Italy, which may indicate how the markets anticipated the spread of the pandemic and the economic crisis in the rest of Europe. In this regard, we investigate potential spillovers from the Italian pandemic outbreak on financial markets across the euro area. For the sake of clarity, it is noteworthy that the notion of spillovers that is used hereafter refers to the effect of new COVID cases reported in Italy on sovereign spreads and stock indices in the other countries of our sample. This definition differs from the one employed in the literature on financial markets’ interdependence following Diebold and Yilmaz (2009), which measures spillovers from one financial market to others.

To examine this issue, we adapt our empirical framework as follows. Instead of using panel data regressions defined by equation (2), we estimate country by country the following series of regressions at each horizon $h$:

$$
\Delta s_{i,t+h} = \alpha_{i,h} + D_{i,t} \left[ \beta_{a,h,i} \Delta x_{i,t} + \beta_{IT,h,i} \Delta x_{IT,t} + \Gamma_{a,h,i}(L) s_{i,t-1} + \Theta_{a,h,i}(L) z_{i,t} \right] + (1 - D_{i,t}) \left[ \beta_{b,h,i} \Delta x_{i,t} + \beta_{IT,b,h,i} \Delta x_{IT,t} + \Gamma_{b,h,i}(L) s_{i,t-1} + \Theta_{b,h,i}(L) z_{i,t} \right] + \epsilon_{i,t+h}
$$

with the notation described in Section 3. There are a couple of differences with respect to equation (2). First, we consider the occurrence of new COVID cases per 100,000 people as explanatory variables both in country $i$ ($\Delta x_{i,t}$) and in Italy ($\Delta x_{IT,t}$) simultaneously, $\beta_{IT,h,i}$ being the response of sovereign spreads in country $i$ to new COVID cases in Italy. Second, all other estimated coefficients $\beta_{a,h,i}$, $\Gamma_{a,h,i}$, and $\Theta_{a,h,i}$ are also now specific to country $i$. Third, there are no longer time fixed effects, and $\alpha_{i,h}$ denotes an intercept. Fourth, we drop Italy from the sample of countries.

The aim of this estimation is to compare the distribution of $\beta_{b,h,i}$, that is, the sensitivity of sovereign spreads to domestic COVID cases, with $\beta_{IT,b,h,i}$, that is, the sensitivity of sovereign spreads to COVID cases in Italy, before the reference date $\tilde{t}$. A high value of $\beta_{IT,b,h,i}$ would suggest strong spillovers from the pandemic outbreak in Italy to other European countries. Fig. 10 shows the distribution of the estimated coefficients (the median and the interquartile range) before $\tilde{t}$ using March 9 as the reference date.

Our main results are as follows. First, it can be seen that the median of the coefficients $\beta_{b,h,i}$ estimated using the country-by-country regressions defined by equation (7) is not too far from the average estimate $\beta_{h,i}$ using panel regressions. Interestingly, even if the interquartile range of $\beta_{b,h,i}$ is much lower than $\beta_{h,i}$ at all horizons $h$, and the interquartile range of $\beta_{IT,b,h,i}$ includes the zero value at horizon $h \leq 2$. We thus conclude that national sovereign spreads are much more sensitive...
to the COVID cases that occur domestically than to those in Italy. Considering that the health crisis in Italy preceded those in other European countries, we conclude that the spillover effects of the Italian crisis were fairly weak and did not lead to significant anticipation in other European sovereign debt markets.

We replicate this country-by-country analysis for the stock markets by estimating the following regressions:

$$\Delta z_{i,t+h} = a_{i,h} + D_{t,\bar{t}}[\beta_{a,h,i} \Delta x_{i,t} + \beta_{IT}^{a,h,i} \Delta x_{IT,t} + \Gamma_{a,h,i}(L)s_{i,t-1} + \Theta_{a,h,i}(L)z_{i,t}]$$

(8) + (1 - D_{t,\bar{t}})[\beta_{b,h,i} \Delta x_{i,t} + \beta_{IT}^{b,h,i} \Delta x_{IT,t} + \Gamma_{b,h,i}(L)s_{i,t-1} + \Theta_{b,h,i}(L)z_{i,t}] + \epsilon_{i,t+h}

where the dependent variable $\Delta z_{i,t+h}$ is the variation of the log of the stock index (i.e., the cumulative logarithmic return) at horizon $h$ and the notation used is that described in Sections 3 and 6.1. Fig. 11 reports the results. They confirm the robustness of our conclusions based on panel data regressions and show weak spillover effects from new COVID cases reported in Italy to other European stock markets.

6.3. What would have happened without the structural breaks?

This section proposes a counterfactual analysis. We simulate the path of the spread between March 9 and March 18 given the number of cases reported during this period using the estimated coefficient $\beta_{b,h}$ for $\bar{t} = (3/9)$ depicted in Fig. 8.\(^{30}\) We interpret this path as the spread induced by the COVID crisis that would have occurred without the break in the relationship between the pandemic outbreak and sovereign risk that we attribute to policy interventions during this period. New cases $\Delta x_{i,t}$ in country $i$ at time $t$ induce a spread variation for the $h$ period ahead denoted $\Delta s_{i,t+h}$ that is defined as follows:

$$\Delta s_{i,t+h} = \beta_{b,h} \Delta x_{i,t}$$

(9) for $h = 0, 1, \ldots, H$. The COVID-induced spread deviation as of time $t$ is then the sum of the values of new cases reported $H$ periods before weighted by the coefficient $\beta_{b,h}$:

$$\Delta s_{i,t} = \sum_{h=0}^{H} \beta_{b,h} \Delta x_{i,t-h}$$

(10) By definition, the spread at $K$ periods ahead is equal to the initial value of the spread plus the cumulative sum of spread variations. Then, the spread induced by the COVID crisis is given by:

$$s_{i,t+K} = s_{i,t-1} + \sum_{h=0}^{K} \beta_{b,h} \Delta x_{i,t+h-k}$$

(11) where $K = 0$ on March 9. Also, we assume that new cases reported up to March 9 have no impact on the predicted spreads series.

Fig. 12 shows the evolution of $s_{i,t+K}$ between March 9 and March 18 for Italy, Spain, and France. On March 6, the Italian government bond spread, denoted by $s_{i,t-1}$ in equation (11), was at 1.807%, and the number of total confirmed cases per million people rose from 121.978 to 521.089 between March 9 and March 18 in Italy. Given the value of $\beta_{b,h}$ estimated before March 9,
the spread induced by the COVID crisis in Italy would have surged during this week to reach 19.5% on March 18. We can then conclude that without any change in the effect of new COVID cases on sovereign yields in Italy, a sovereign debt crisis may have occurred in the middle of March. The pattern for Spain and France would have been less dramatic but still dangerous with spreads of approximately 13% and 4%, respectively. Hence, this counterfactual analysis shows that the earlier policy intervention of the ECB on March 12 seriously restrained the spread of pandemic-induced crisis to sovereign debt markets.
7. Conclusion

The COVID-19 health crisis has revived fears of a sovereign debt crisis in Europe. The results presented in this paper indicate that the first confirmed COVID-19 cases were at the origin of an explosive increase in interest rate spreads on sovereign debt. The results also show that this explosive dynamic broke around the time of the ECB’s intervention on March 12 and that otherwise, there could have been a sudden surge in rates in the countries most affected by COVID-19 (Italy, Spain, and France), reaching spread values close to those observed during the 2010–2012 sovereign debt crisis in Europe within just a few days.

This conclusion rests on the study of sovereign debt markets during the first few months of the sanitary crisis and is corroborated by the extension of our analysis to stock markets. The duration of this health crisis is still uncertain given the state of medical knowledge. However, its economic consequences for public finances will certainly be longer lasting and raise additional challenges for public decision-makers in Europe and around the world in managing the public debt induced by the COVID crisis.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.eurocorev.2021.103809.

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