Covid 19: a new challenge for the EMU *

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Abstract: While the pandemic was an exogenous shock leading to increasing sovereign debt across the board, the dynamics of sovereign risk premiums has been heterogeneous in the Euro Area (EA). We estimate the determinants of sovereign bond spreads in the EA during the pandemic from January 2 2020 to May 26 2020. We find that resiliency to COVID shock depended on initial fiscal situation, robustness of the banking sector and healthcare capacity. Policy announcements by the ECB and the European executive bodies have been associated with narrowing down the spreads, with differentiated contribution to largely indebted countries. However, while securities purchases by the ECB have unambiguously been associated with lower spreads, the financial assistance package put together by the European Council have contributed to larger spreads, specifically those based on loans.

Keywords: Sovereign risk; European Monetary Union; Covid; event studies.
JEL Code:: F30, F45, H63

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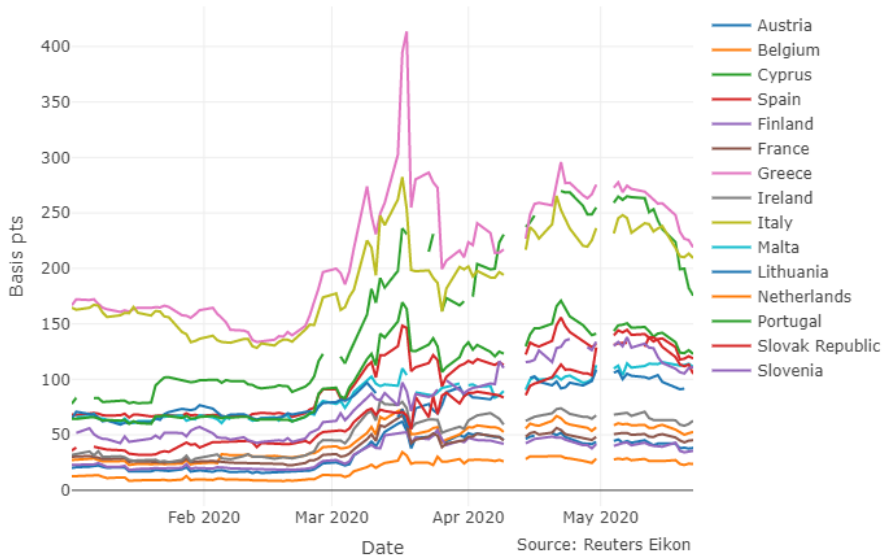
1 Introduction

The Italian bond spread relative to Germany's has increased by 43% between January, 2 and May, 26 2020 from 164 bps to 236 bps; other members of the Euro Area (EA) have also experienced dramatic increase in their spreads (see Fig. 1).[1] While the sanitary crisis was an exogenous and homogeneous shock leading to real damages and a surge of private and sovereign debt across the board (Richard and Weder di Mauro, 2020), it is striking that sovereign risk premium has been heterogeneous in the EA. In a sense, the geography of sovereign risk might recall pre-2012 sovereign debt crisis when the sovereign spread of peripheral countries also surged and put a disruption risk on the euro area (Aizenman, Binici, and Hutchison, 2013). However, the dramatic hikes of bond spreads in 2010 dwarf the ones experienced during the pandemic so far (see Fig. 2). First, there has been significant reforms over the last decade (Baldwin and Giavazzi (2015)). Second, this time, there has been swift policy reactions at the European level compared to the previous 2010-2012 episode, by the European Central Bank and by euro-area leaders who all announced major monetary and financial assistance packages as soon as in March and April 2020 respectively (see more below). What drove the EA sovereign risk premium during the pandemic crisis? What explains heterogeneity across members? Did spreads reflect investor confidence in the capacity of the EA institutions to sustain the euro? Addressing these questions is important because it sheds light on the functioning of the European Monetary Union (EMU) and will hopefully help improving its resiliency to shocks.

In this paper, we find that cross countries resiliency to the COVID shock depended on healthcare capacity factors on the one hand and robustness of the banking sector and fiscal prospects on the other hand. Policy announcements by the ECB and the European executive bodies have been associated with spreads reactions, most of them being narrowing down. However, while the monetary measures put

1. The bond spreads of Spain, Portugal and Greece have increased by 93%, 119% and 65% resp.

Figure 1: Sovereign Bond Spreads in the Eurozone



This Figure shows the 10 year bond yield spread against German bond since January 2 2020. Jumps are due to missing data in the original database. Author's calculations with Eikon Reuters data.

together by the ECB have unambiguously been associated with lower spreads, the financial assistance package put together by the European Council have contributed to larger spreads, specifically those based on loans.

On the one hand, heterogeneity drivers could arise from three different channels, i.e. sanitary, macroeconomic and banking channels. First, Covid 19 pandemic has hit EMU members differently as illustrated by Fig.3 which plots the number of Covid death per 100,000 people on May 1. In order to mitigate casualty, countries have implemented heterogeneous lock-down policies (Hale, Petherick, Phillips, and Webster, 2020) as displayed on Fig.4. This could have affected spreads: the more stringent the isolation measures, the more severe the expected negative effect on activity and thus on public debt.

Second, the higher the burden of the debt of a country, the higher investors price the risk of repudiation (Calvo, 1988). Fig.5 which displays the level of public

debt at the onset of the crisis and its projection for 2020, illustrates the heterogeneous fiscal situation across the zone that could result in amplification dynamics for largely indebted countries: four out of the five stressed countries over the last crisis stand out, Italy, Spain, Portugal and Greece. In addition, heterogeneity comes from the fiscal responses that countries have implemented in order to mitigate macroeconomic consequences of isolation measures as illustrated Fig.6. Last, Fig.7 shows the heterogeneous banking situation across the EA in terms of non performing loans in domestic banking sectors. Despite the prudential reforms since the Euro crisis, vulnerabilities in the banking sector of some countries remain and investors could well price them in, expecting that they could ignite a new doom loop (Schularick and Steffen, 2020).[2]

On the other hand, it is remarkable that compared to 2010-2012 sovereign debt crisis, members have benefited from swift common policy responses by supranational institutions and from inter-governmental arrangements.[3] On the monetary side, after an initial announcement that disappointed the market on March 12, on March 18, the European Central Bank announced the Pandemic Emergency Purchase Program consisting in EUR 750 billion program of private and public securities purchase with flexible capital keys as part of the Asset Purchase Program. In addition, the ECB eased further collateral eligibility rules to enable banks to mobilise more collateral.[4] And in fact, sovereign spreads narrowed down after March 18 announcement (see Fig. 1). On the financial assistance side, there was a series of announcement by the European Commission and euro-area leaders at the occasion of European Councils. In total, EUR 580 billion of loans and EUR 40 billion of budget line have been mobilized and discussions of additional EUR 750 billion of budget are ongoing at the time of writing the paper. In the meanwhile, the European Commission lifted the budgetary rules of the Stability and Growth Pact on March 20, 2020. And indeed,

2. These Figures as well as additional maps and graphs are compiled on a companion website of this paper.

3. See the timeline of the crisis in the companion website of this paper

4. See PEPP announcement and collateral easing measures.

data speak for themselves: the standard deviation of bond spreads of all EA members is larger on days of common policy announcement than on non-announcement days, stressing the importance of ECB and European Executive announcements on spreads.[5]

In this paper, we explore the dynamics of EMU members' sovereign spreads between January, 2 and May 26 2020 by testing potential drivers of sovereign risk premium. We create a balanced data panel including sanitary, financial and macroeconomic variables for 13 EA members and we construct original variables to capture the different common policy announcements and the monetary and financial assistance packages.[6] In addition, our specification allows nonlinearity across EA members along the initial level of public debt to fit the literature on sovereign debt crisis.

Related literature. This paper is related to papers examining the determinants of the sovereign bond spread in the euro area (Costantini, Fragetta, and Melina (2014), Favero and Missale (2012), Aizenman, Binici, and Hutchison (2013), Manganelli and Wolswijk (2009), Delatte, Fouquau, and Portes (2017)). To the best of our knowledge, we are the first paper dealing with the drivers of the sovereign risk during the pandemic of Covid 19. A finding very specific to the nature of this crisis is that sanitary factors mattered and that healthcare capacity did affect the sovereign risk during the crisis. Beyond the specifics of the sanitary crisis, the paper is related to the works assessing the role of monetary policy (Afonso and Jalles (2019), Falagiarda and Reitz (2015)) and inter-governmental announcements on spreads (Afonso, Jalles, and Kazemi (2019)). We differ from them by bringing the role of monetary policy and the European executive together during a specific crisis episode. Our findings emphasize the unambiguous positive effect of the ECB on the price of risk compared to counter-effective effect of financial assistance pro-

5. We compute the standard deviation of daily spread (in basis points) for announcement and non-announcement days over January, 2 to May 26 2020: it is 75 and 65 respectively.

6. All data and codes are available on github

grams put together by the European executive bodies. Bahaj (2019) examine how country specific events transmit to the sovereign spread of other EA members. Compared to them, our paper takes the opposite perspective of a common and exogenous shock affecting members asymmetrically. We show that initial conditions regarding budget, healthcare and banking sector made countries differently vulnerable to the shock; and that monetary policy managed to marginally smooth the asymmetric effect of the shock. Several empirical papers found a regime switch in the spread determination model for EA peripheral sovereigns during the last crisis (Aizenman, Binici, and Hutchison (2013), Delatte, Fouquau, and Portes (2017)). Here we take a different perspective by focusing on a short period of time starting with the virus outbreak in order to better understand the factors influencing countries' resiliency during the crisis. We allow geographic heterogeneity and we find that European level policy measures affect groups of countries differently. Heterogeneous dynamics after common policies in a monetary union is an important lesson for the theory of optimal currency area that we discuss in this paper. Next Section presents the empirical strategy and the data and Section 3 our findings. Section 4 discusses the lessons for the EA. We provide a broad exercise of robustness estimates and tests in Section 5. Section 6 concludes.

2 Empirical strategy

We regress the sovereign bond yield spread relative to Germany's on the following vectors of determinants:

$$Spread_{it} = \theta_i + \beta_1 X_{it} + \beta_2 Y_{it} + \beta_3 Z_{it} + \gamma_1 U_i + \gamma_2 V_i + \varepsilon_{it} \tag{1}$$

The dependent variable, $Spread_{it}$, is the difference between the 10-year German Bund and the 10-year Treasury bill of country i. X_{it} and Y_{it} include sanitary and financial time-varying factors and Z_{it} a set of policy intervention variables. More

precisely X_{it} includes $StringencyIndex$, a nine-point aggregation of social isolation measures compiled by Hale, Petherick, Phillips, and Webster (2020).[7]; Y_{it} includes RVol, the realized volatility of Euronext price index, i.e. the daily difference of Euronext index return. Last, Z_{it} is composed of variables capturing policy interventions. First, it includes $FiscalStim$, a data compiled by the IMF measuring the domestic fiscal stimulus program as a percentage of GDP; second, we include our own variables of European policy interventions based on a *timeline of the crisis* that we have put together[8]: $EUBudget$ and $EULoans$ measure the financial assistance package put together by European executive bodies; they consist in the cumulative Euros amounts of existing and additional EU budget funds to be distributed by the European Commission and the new package of loans confirmed by the European Council to support member states; the monetary policy package $PSPP$, $PEEP$ and APP are the daily variation of ECB asset securities purchase under the Public Sector Purchase Program, the Pandemic Emergency Purchase Program and the rest of the Asset Purchase Program respectively; in addition we test the contribution of different announcements on the spreads: $D0312$, $D0318$, $D0407$ are three dummies capturing the days the ECB announced additional purchase programs (March 12 and March 18) and the easing of collateral requirement rules (April 7); $D0320$ is a dummy equal to one the day the European Commission announced the lifting of budgetary rules of the Stability and Growth Pact and zero instead (March 20); $D0409$ a dummy equal to one the day when Eurogroup announced the EUR 540 billion safety net and zero instead (April 9);$D0505$ is a dummy equal to one the day he German Court of Justice ruled on the PSPP program and declared it illegal and zero instead (May 5); $D1805$ is equal to one the day Angela Merkel and Emmanuel Macron announced a proposal of EUR 500 bn EU recovery fund to be discussed at the following European Council and zero instead (May 18). Contrary

7. Computation and sources of all variables are detailed in Appendix A

8. We provide the *timeline of the crisis* in the companion website of this paper where we detail the different interventions including amounts and market reactions.

to the other dummies, $D0318$ is equal to one after the PEPP announcement on March 18, 2020 in order to test the contribution of the policy announcement on the trend of the spreads. The reason is that this announcement has been compared to the "whatever it takes" speech by Governor M. Draghi in July 2012.

Before getting further, we point to a caveat: the inclusion of policy variables raises the question of endogeneity. Indeed, a part of the ECB and the European executive bodies intervention is a reaction to the evolution of the sovereign risk in the EA, a fact that may bias our coefficient estimates. However we think that two elements mitigate the issue: first, there is more inertia in the reaction of the political bodies than in the market dynamics, i.e. policy reacts after a while, whereas spreads move overnight, especially during the crisis episode; second, the sovereign spreads are one component of the reaction function of European bodies only (real variables and international developments are probably other elements) and we do not know the weighting schemes of the different components.

Last, we test whether spreads co-variate with pre-crisis conditions. More precisely, U_i includes $Debt19$, the public debt in 2019 in percentage of GDP and NPL the rate of non performing loans in the domestic banking sector at the onset of the pandemic outbreak; this is to test to which extent fiscal situation and banking sector solidity are priced in by investors; V_i includes health expenditures as a percentage of GDP to test whether investors factor in the fact that healthcare capacity of a country affect their macroeconomic recovery dynamics after a pandemic. The inclusion of pre-crisis conditions variables should inform us on the drivers of countries resiliency.

In introduction, we mention that four out of the five peripheral countries most stressed over the last decade entered the sanitary crisis with unfavorable fiscal situation; and that the literature on sovereign debt crisis suggests that it may have trigger amplification dynamics : Italy, Spain, Greece and Portugal recorded a public

debt-to-GDP ratio of 134%, 95%, 179% and 117% respectively (see Fig. 5). And indeed, we observe that the standard deviation of their bond spreads is larger than the rest of the sample (65.2 versus 45.5). Therefore, in addition to the linear equation specified in Eq.1, we allow heterogeneity by interacting time-varying variables with a dummy equal to one for Italy, Spain, Greece and Portugal and zero instead.[9]

We run a the regression using an OLS pooled estimate including with standard errors clustered at the country level.

3 Results

Table 1 displays the estimate results of Eq. 1. The linear and nonlinear estimates yield similar results on estimated coefficient of common variables; and in the nonlinear specification, most interacted variables are significant, a result that suggests heterogeneity across the EA. In addition, the AIC and BIC information criteria both indicate that the nonlinear specification is a better fit. Therefore, in the following, we comment the nonlinear specification.

Rvol is significant and positive, implying that the larger the realized volatility, the larger the spread. The contribution is even larger for the subsample of peripheral large debtor countries, suggesting that financial development has contributed to the sovereign risk across the board and more severely for them (in the Robustness Section, we find similar results with one alternative); in turn, $StringencyIndex$ is not significant, suggesting that the isolation measures have not contributed to spreads (however in the robustness Section, we find a nonlinear contribution using an alternative measure based on the number of COVID death); in addition, the estimated coefficient of the domestic fiscal package is significant but with a positive sign contrary to expectations. To be sure, we test one alternative domestic policy measure in the Robustness Section and we confirm that the estimated coefficient is

9. We do not interact time-invariant variables because it would yield a point estimate on four observations

not significant.[10]

Then we turn to the variables constructed to capture European policy intervention: we find that the estimated coefficients of March 12 is significant and positive suggesting that it contributed to a wider spread. On the contrary, March 18 ECB and April 9 Eurogroup announcements are significant with a negative sign, as well as the variations of securities purchase by the ECB under the PEPP and PSPP programs suggesting that they all contributed to reduce the spreads. In sum, while the first announcement of the ECB securities purchase package did not meet expectations, the following PEPP announcement and the first agreement of the European Council managed to ease tensions.[11] We confirm p-value and signs in most alternative specifications tested in the Robustness Section.

In addition, we find that other policy interventions have no significant contribution across the board: the estimated coefficients of the collateral easing measure on April 7, the remaining APP package (excluding PEEP and PSPP), the decision of the German Court of Justice and the Franco-German announcement on May 18 are not significant. It is however interesting to examine their specific contribution on the subsample of largely indebted peripheral countries. The PEPP announcement on March 18 as well as the EUR variations of securities purchases are unambiguously associated with a larger reduction of spread in these countries. The same holds for Eurogroup announcement on April 9 which is associated with a larger reduction of spreads in these countries. The estimated coefficient of collateral easing measures is significant and negative for these countries only, as well as of the Franco-German announcement on May 18 suggesting also a differentiated contribution. These results are confirmed in most alternative specifications in the Robustness Section. In sum, the finding of nonlinear contribution suggests that the policy interventions met

10. We find it however tricky to conclude on the absence of contribution of domestic packages; it will be worth testing alternative variables when we have enough solid data in the future.

11. During March 12 press conference, Ch. Lagarde stated that it was not the role of the ECB to "close spreads". While she rectified this quickly after the press conference, her comment casts doubt about her commitment. See A dangerous slip-up from Lagarde, by Claire Jones, March 12, Financial Times

the differentiated market expectations on how these countries would fare.

The opposite holds for financial assistance packages put together by European executive bodies. On the one hand, estimated coefficients of the packages $BudgetUE$ and $LoansUE$ are significant and positive, a result that suggests that they contributed to widen the spreads. Investors might perceive that they are not sufficient to tackle the massive negative shock on the macroeconomic situation of the EA members.[12] On the other hand, we find a differentiated contribution on largely indebted countries where the package based on loans are associated with larger spread, suggesting that investors price them up because they consider that they add to what are already substantial sovereign debt burdens. We will get back to this in the next Section. The differentiated contribution of loans-based assistance package is confirmed in all alternative specifications in the Robustness Section.

Last, our results suggest that the lifting of budgetary rules on March 20 and the PSPP ruling of the German Court of Justice have not contributed to move the spreads.

Last, we turn to pre-crisis conditions. We find that the larger the public debt, the larger the spread, implying that unfavorable fiscal position made countries more vulnerable to the sanitary shock, a result that our nonlinear specification has already emphasized ; similarly, the larger non performing loans, the larger the spread, suggesting that investors have priced in banking fragility despite reforms implemented to neutralize the doom loop (Schularick and Steffen (2020), Couppey-Soubeyran, Perego, and Tripier (2020)); last we find that the larger health expenditures in a country, the lower their spread; it suggests that investors have anticipated that healthcare capacity could potentially influence the economic recovery capacity.

12. This result needs to be taken with caution because it holds only in a part of the alternative specifications tested in Robustness.

4 Three lessons for Monetary Unions

Some lessons can be drawn from our estimates. The Covid pandemic was an exogenous shock with heterogeneous effects on the EA members and we uncover which initial conditions made countries resilient. With the caveat that the shock was only heterogeneous and not asymmetric, the theory of Optimal Currency Area can help us shedding light on how adjustment proceeded after the virus outbreak.

1. The constraint of a one-size-fits-all monetary policy has been alleviated and that may be due to mechanisms associated with quantitative Monetary Policy. Indeed, our results suggest heterogeneous contribution of the monetary policy on members' spreads. A likely mechanism is that securities purchase programs with flexible capital keys and collateral easing have relaxed the constraints on the market of countries that most needed it. More precisely, on the one hand, PEPP with flexible capital keys has compensated the drop of demand for bond market of stressed countries. The flexibility of capital keys has most likely magnified the effect by allowing the ECB to buy bonds on most stressed countries instead of following a GDP weighted allocation.[13] On the other hand, the easing of collateral rules endogenously relaxed supply constraints on stressed credit market. Indeed, providing banks access to cheaper credit through a loosening of collateral requirement by the ECB aimed at offsetting credit shortage in the banking sector where the quality of banks balance sheet has deteriorated the most.

2. Loan-based financial assistance does not operate as an adjustment mechanism like fiscal transfers do. Indeed, our results suggest that financial assistance programs based on loans have contributed to widen the spreads. How was it possible? Kenen (1969) showed that fiscal transfers play an important role in

13. As an illustration, the ECB deviated from its capital keys in April buying EUR 11 bn of Italy bonds (EUR 6.4 bn above capital keys) and EUR 0.6bn of German bonds (EUR 6.4bn below capital keys). Computation by F. Ducrozet based on ECB statitsics.

most monetary unions in offsetting region-specific demand shocks. However, transfers based on loans may well carry the opposite effect by adding debt on already indebted countries. The mechanism may be that loans contribute to increase future government budget constraint and therefore decrease present household consumption by virtue of Ricardo's equivalence. As a result, financial assistance based on loans increase the risk premium of countries that most need these transfers.

3. The central bank can act as a lender of last resort in different ways. Indeed we find a non-transitory contribution of March 18 speech on spreads: the contribution of the speech lasts over the entire estimate period after March 18. Similarly, Delatte, Fouquau, and Portes (2017) finds that "whatever it takes" speech in July 2012 tamed market tensions and restored the pricing regime prevailing before the crisis. It is interesting to observe that modus operandi were different either way: the commitment announced on March 18 was limited and unconditional while 2012 speech was based on unlimited commitment associated with some conditions.

5 Robustness

We re-estimate the determinants of sovereign spreads along alternative vectors of variables, alternative estimation method and an alternative sample of countries.

1. Alternative variables:

   - Instead of Stringency Index, we include the number of COVID deaths per 100,000 people (in log) and and its squared value (Table 3, column 9): contrary to Stringency Index, the estimated coefficients are significant with a negative and positive sign respectively, a result that suggests a threshold effect, i.e. passing up a certain death ratio may have stressed

up markets. Therefore it suggests that the severity of sanitary factors could have mattered.

- Instead of the realized volatility of the Euronext Index, we include Euronext daily return (Table 2 columns 7 and 8): the estimated coefficient is significant and negative as expected: the lower the aggregated European stock return, the higher the domestic spreads; in addition, the estimated coefficient on the interaction with the Dummy South confirms the differentiated contribution of stock market stress to most indebted countries
- We test one alternative measure of domestic policy measure, Policy-Tracker, the COVID-19 Response Tracker (CFRT) computed by Yale Universitywhich tracks 13 economic policy responses by country and by date (Table 3, column 10): the estimated coefficient is negative as expected but not significant, as in our main estimate.
- Instead of Health Expenditure, we include the number of hospital beds and median age of the population (Table 2, columns 3-6): none of these two alternative is significant. We suspect that this is due to the inclusion of the Stringency index with which they covariate. And indeed, Median Age becomes significant and positive when we drop "Stringency Index" from the Estimate (not displayed for the sake of Table 3's readability).
- Instead of Debt-to-GDP in 2019, we include the projected debt-to-GDP in 2020, $Debt20$ (Table 2, columns 2, 4 and 6): the estimated coefficient has the same sign and p-value as $Debt19$.

In general, our main results presented in Section 3 hold constant within most alternative specifications. Consistent with previous results, NPL, Debt and Health Expenditures seem to be good predictors of spreads. Our findings on the contribution of policy announcements holds: March 18 and April 9

have contributed to reducing the spreads, with an amplified contribution in largely indebted countries. We also confirm a differentiated contribution on these countries of the weekly purchase of securities under the PEPP on the one hand (reducing the spreads) and of financial assistance programs based on loans on the other hand (increasing spreads).

2. Alternative specification: instead of using a pooled OLS, we estimate Eq. 1 with country fixed effects and we cluster standard errors at the country level. The inclusion of country FE accounts for all observable and unobservable invariant factors; therefore, we include only time-varying factors at the aggregate and country-levels (Table 3 column 11): adding country fixed effects rather than a country's vector of invariant variables does not affect our main findings about differentiated contribution of policy measures and announcements on spreads of largely indebted countries.

3. Shorter sample:

   (a) We restrict the sample of countries to 9 main EA economies as in Afonso, Jalles, and Kazemi (2019) and we obtain same signs and p-value (Table 3 column 12)

   (b) We exclude Italy from the sample and our main results hold with a few exceptions and lower values of coefficient: we confirm the differentiated contribution on highly indebted countries of market volatility, of the PEEP, of the financial package assistance based on loans, of the Executive European announcements; it suggests that our findings are not driven by one country only ((Table 3 column 13).

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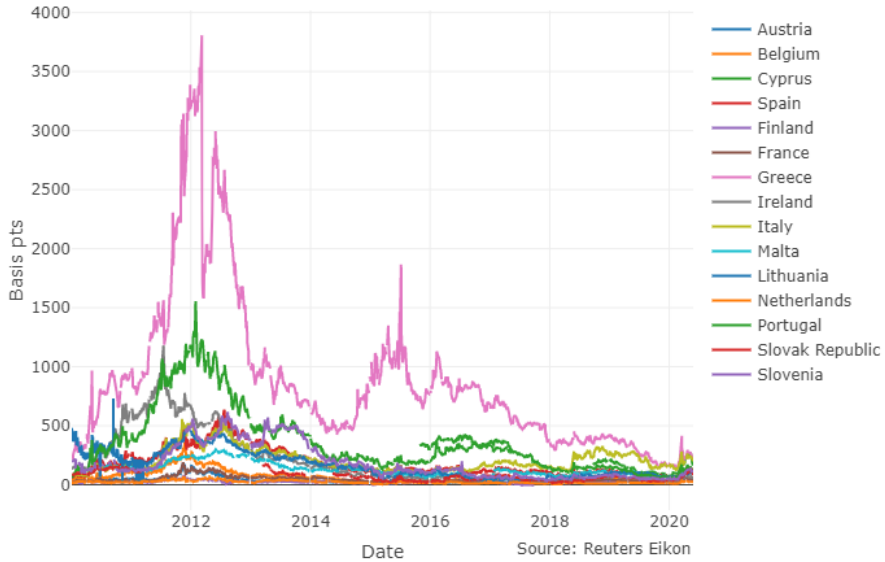
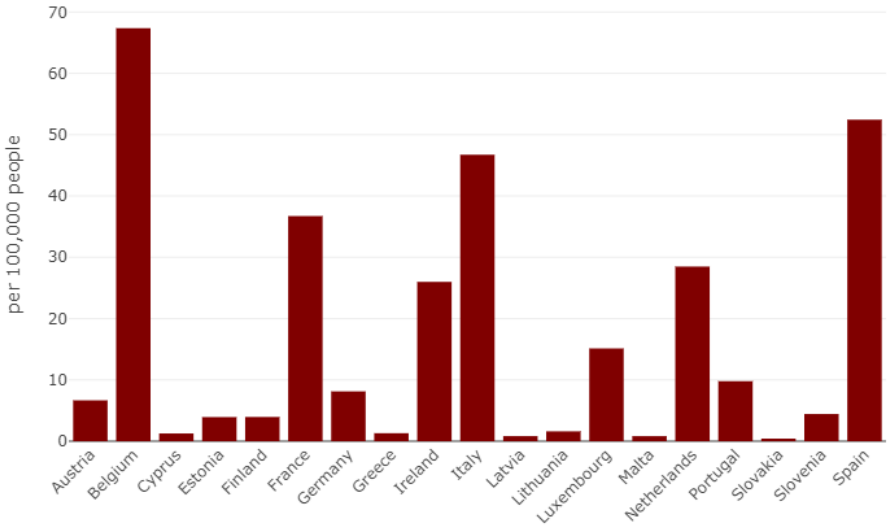
Figure 2: Sovereign Bond Spreads in the Eurozone



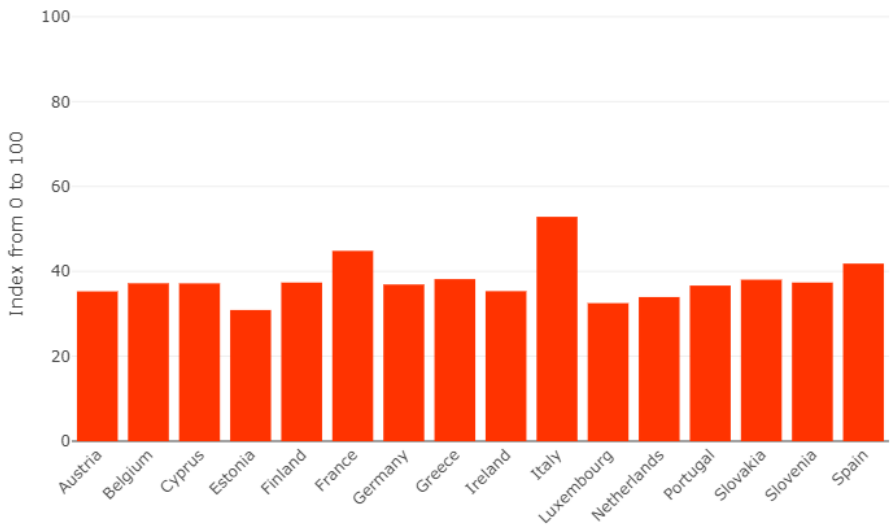
This Figure shows the 10 year bond yield spread against German bond since January 2 2010 of euro area members mostly affected in 2010. We exclude Greece which spread level dwarfs the others. We observe that the increase in bond spreads during the pandemic are limited compared to 2010. Source: Author's calculations with Eikon Reuters data.

Figure 3: Number of death due to Covid 19 per 100,000 people



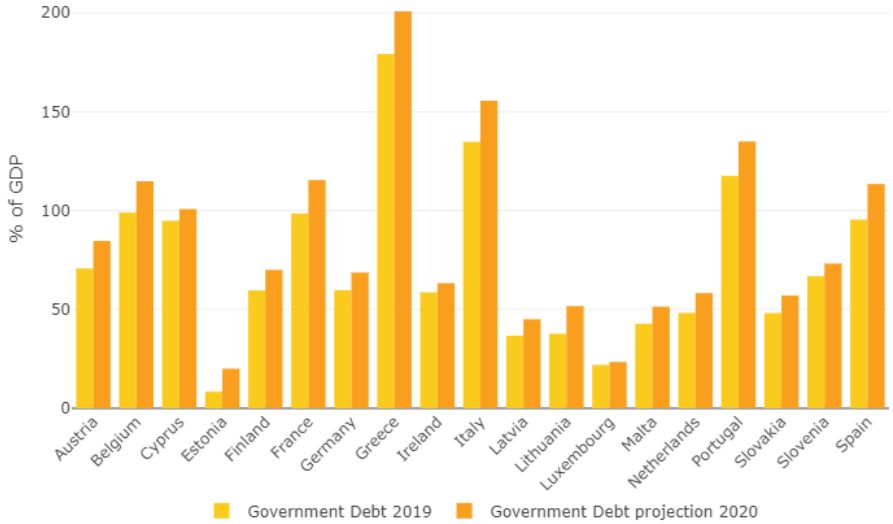
This Figure shows the number of death due to Covid 19 per 100,000 people as of May 1. Source: John Hopkins University Corona Virus Resource Center.

Figure 4: Stringency Index



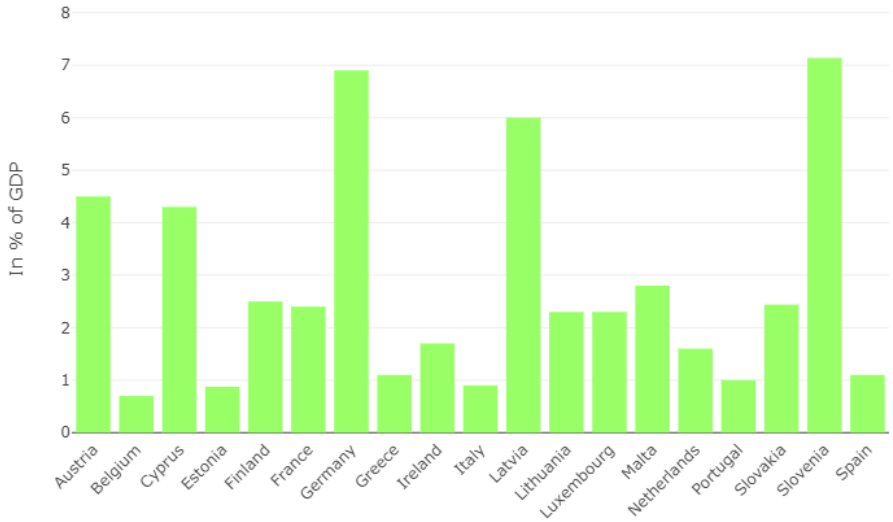
This Figure shows the Stringency Index, a number between 0 to 100 that reflects the overall stringency of the governments response. It aggregates eight containment and closure indicators as well as public information campaigns. Source: Oxford CGRT

Figure 5: Public Debt-to-GDP



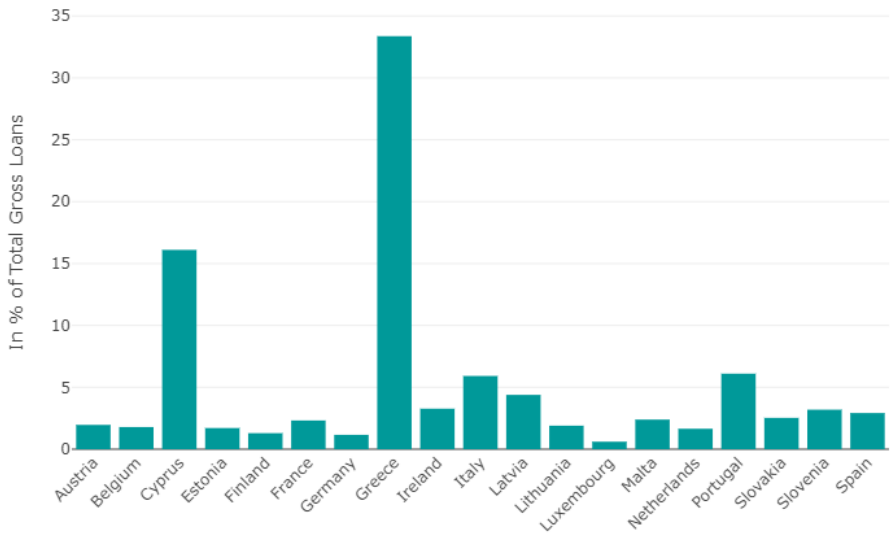
This Figure shows the level of public debt-to-gdp in 2019 and the projected debt-to-gdp in 2020. Source:IMF Fiscal Monitor 2020

Figure 6: Fiscal Stimulus Plans



This Figure shows the different domestic fiscal packages adopted by the EA governments as a percentage of GDP (as of May 1st, 2020). The plans correspond to government spending and cancellation of tax. Source:IMF Fiscal Monitor 2020

Figure 7: Non Performing Loans



This Figure shows the level of non performing loans in the banking sectors as a percentage of total gross loans and advances. Source:ECB

A Appendix: Data and sources

1. **Stringency Index:** It reports a number between 0 to 100 that reflects the overall stringency of the governments response. It aggregates eight containment and closure indicators as well as public information campaigns. This is a measure of how many of the these nine indicators a government has acted upon. It does not take into account any economic indicators or health system policies beyond public information campaigns. Source: Oxford CGRT

2. **Number of confirmed COVID-19 cases and deaths**. Source: Center for Systems Science and Engineering (CSSE) at Johns Hopkins University

3. **Euronext 100 price index**: Top 100 companies admitted to listing on Euronext, ranking and weighting based on market capitalization. Source: Eikon Reuters

4. **Itraxx sub-financials price index**: a basket of 25 single CDS covering 25 junior subordination European banks. *Subordinated* refers to one of four levels of debt in the capital structure of the reference entities. Each tier represents a different level of seniority or preference in liquidation or bankruptcy. Source: Eikon Reuters

5. **RVol**: the realized volatility of Euronext price index computed as the absolute daily rate changes.

6. **FiscalStim:** we use two alternative measures of the domestic fiscal stimulus package; the first one is based on data of the IMF Policy Responses to COVID-19 collected May 1st 2020. More precisely, we collect the data reported in the fiscal section for each country, and we keep only the data corresponding to government spending and cancellation of tax (and not deferrals or credit guaranty); As the distinction is not clear for some countries, we collect the data from Bruegel Dataset, an alternative source which focuses on 7 members of the EMU only

7. **PolicyTracker:** is the COVID-19 Response Tracker (CFRT) computed by Yale University which tracks 13 economic policy responses by country and by date (Credit Facilities, Credit Guarantees, Emergency Liquidity, Fiscal Policy, Fiscal Stimulus, Interest Rate Change, Loan Guarantees, Macroprudential Policy, Market Liquidity, Monetary Policy, Swap Lines). We construct a dummy equal to the cumulative score of a country based on their responses. More precisely, we imput one the day one country implements one of the 13

policies; we then compute the cumulative score over the period. Since it is not weighted by the size of the intervention, the variable captures policy reactivity and the broadness of the policy range. *Buruegel*

8. **EUBudget and EULoans**: the cumulative amounts of existing and additional allocated EU budget funds and package of loans to support member states. The governance process implies that EU level policy measures are announced several times at several different dates by the European Commission, the European Parliament and the European Council. We use the date of announcement by the European Commission for budget amounts, the date of announcement by the European Investment Bank and the official conclusions of European Council meetings for loans amounts. Sources: We collect the information on the press release of the European Commission and the meeting calendar of the European Council. We cross-check all volumes and date information on Financial Times articles tagged with "Eurozone Economy" to make sure that all information are consistent with market news.

9. D_0409**:** a dummy equal to one on April 9 2020, the day the Eurogroup agreed on a Euros 540 billion loans package and disagreed on the issue of Corona bonds.

10. D_0423**:** a dummy equal to one the day of the following European Council meeting and zero instead.

11. $PSPP$, $PEEP$ and $RemAPP$ are the daily variation of ECB asset securities purchase under the Public Sector Purchase Program, the Pandemic Emergency Purchase Program and the remaining programs included in the Asset Purchase Program respectively. We use a linear interpolation to transform weekly purchase data into daily data. Source: ECB Minimum Reserves and Liquidity

12. D_0312**:**a dummy equal to one the day of the first ECB announcement of a total of Euros 120 billions securities purchase in addition to the APP and zero instead.

13. D_0318**:** a dummy equal to one from the day of the second ECB announcement of a total of Euros 750 billions securities purchase in addition to the APP and zero before.

14. D_0407: a dummy equal to one the day the ECB announced the easing of collateral requirement rules.

15. **Public debt in 2019, Projected public debt in 2020**. Measured in percentage of GDP. Source:IMF Fiscal Monitor 2020

16. **Non Performing Loans:** in percentage of total gross loans and advances. Source:ECB

17. **Median age:**.

18. **Number of hospital beds:** per 100,000 people in 2018. We also include its variation between 2000 and 2018.Source:OECD

19. **Health expenditures:** as a percent of GDP in 2018. We also include its variation between 2000 and 2018. Source:World Health Organization

B Estimation Tables

Table 1: Determinants of sovereign bond spreads

	Time-varying variables		Interacted Variables	
	Linear specification	Nonlinear specification	Nonlinear specification (cont')	
StringencyIndex	4.961	1.504	South*D_1203	14.955
	(2.960)	(2.442)		(8.457)
Rvol	104.635**	72.457**	South*D_1803	-46.657***
	(39.903)	(25.197)		(10.538)
FiscalStim	1.660	3.901***	South*D_2003	6.311
	(2.130)	(1.233)		(11.248)
D_1203	14.180**	7.406*	South*D_0704	-16.271***
	(4.818)	(3.535)		(4.867)
D_1803	-29.786***	-14.329***	South*D_0904	-20.657***
	(7.963)	(3.081)		(5.990)
D_2003	-0.931	-0.766	South*D_0505	1.908
	(4.390)	(2.163)		(5.043)
D_0704	-6.764**	-0.977	South*D_1805	-9.825*
	(2.669)	(2.989)		(4.815)
D_0904	-13.232***	-5.666*	South*RemAPP	463.149
	(3.981)	(3.103)		(3,031.991)
D_0505	4.628	2.936	South*PEPP	-2.211**
	(2.975)	(3.792)		(0.841)
D_1805	-3.699	-1.276	South*PSPP	-3,055.437
	(2.408)	(2.169)		(2,067.573)
RemAPP	478.817	418.930	South*BudgetUE	0.028
	(609.454)	(971.026)		(1.900)
PEPP	-1.654***	-0.852**	South*LoansUE	6.165***
	(0.504)	(0.377)		(1.697)
PSPP	-2,529.358***	-944.554*	South*Stringency	8.012
	(745.699)	(462.445)		(4.760)
BudgetUE	1.539*	1.414	South*Rvol	117.110*
	(0.806)	(1.047)		(64.208)
LoansUE	3.340**	0.640	South*FiscStim	-1.028
	(1.161)	(0.598)		(4.079)
	Time-Invariant variables			
HealthExp	-121.865*	-92.287*		
	(62.739)	(43.053)		
NPL	28.517*	26.259**		
	(14.575)	(10.645)		
Debt19	76.705*	46.867*		
	(39.143)	(25.007)		
Constant	-55.675	14.390		
	(95.520)	(66.370)		
Observations	1,204		1,204	
R-squared	0.827		0.885	
AIC	11539.9		11048.56	
BIC	11601.02		11109.68	
Number of id	13		13	

This table reports the estimates of the the spread determinants specified in Eq.1. The period of estimation is January 1- May 26 2020 on daily data (5 days per week). The sample of countries include Austria, Belgium, Cyprus, Estonia Finland, France, Germany, Greece, Ireland, Italy, Latvia Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain. ***, ** indicates a correlation significant at the 0.01 and 0.05 level resp.

Table 2: Determinants of the sovereign bond spreads: Robustness

Variables	Rvol						Euronext Daily Value	
	Health Exp		Hospital Beds		Median Age		Health Exp	
	Debt 19	Debt 20	Debt 19	Debt 20	Debt 19	Debt 20	Debt 19	Debt 20
	1	2	3	4	5	6	7	8
StringencyIndex	3.477	3.497	4.892	4.948	6.078**	6.135**	2.935	2.982
	(3.435)	(3.406)	(3.429)	(3.389)	(2.710)	(2.659)	(3.497)	(3.463)
Rvol	51.055	58.576*	31.327	32.924	19.905	18.933		
	(29.592)	(30.212)	(36.474)	(37.608)	(38.283)	(38.854)		
FiscalStim	3.965***	4.138***	2.419*	2.441*	1.029	1.005	3.878***	4.045***
	(1.051)	(1.103)	(1.231)	(1.263)	(1.444)	(1.460)	(1.022)	(1.077)
D_1203	10.477**	10.170**	10.771**	10.668**	11.261**	11.253**	3.995	4.128
	(3.696)	(3.660)	(4.298)	(4.335)	(4.432)	(4.460)	(3.746)	(3.771)
D_1803	-19.215***	-19.167***	-17.564***	-17.528***	-15.642***	-15.641***	-19.231***	-19.330***
	(4.744)	(4.784)	(4.501)	(4.464)	(4.825)	(4.827)	(4.930)	(4.967)
D_2003	-5.682	-5.490	-7.124	-7.085	-8.941*	-8.982*	-3.738	-3.792
	(5.001)	(5.013)	(4.517)	(4.508)	(4.967)	(4.981)	(5.411)	(5.421)
D_0704	-3.567	-3.415	-3.294	-3.254	-2.889	-2.905	-3.575	-3.596
	(3.660)	(3.696)	(3.222)	(3.244)	(2.876)	(2.875)	(3.293)	(3.354)
D_0904	-6.357**	-6.237*	-6.204*	-6.173*	-5.978*	-5.993*	-5.768*	-5.748*
	(2.918)	(2.892)	(2.978)	(2.989)	(2.794)	(2.783)	(2.725)	(2.726)
D_0505	5.944	5.636	7.014	6.952	7.632	7.668	10.011**	9.984**
	(4.185)	(4.117)	(4.513)	(4.536)	(4.447)	(4.451)	(3.554)	(3.562)
D_1805	-1.725	-2.023	-0.383	-0.441	0.361	0.392	2.372	2.089
	(2.450)	(2.503)	(3.012)	(3.063)	(2.822)	(2.821)	(2.771)	(2.794)
RemAPP	-24.130	138.780	144.456	189.980	605.299	603.931	-1,008.145	-843.084
	(785.941)	(767.124)	(850.961)	(838.632)	(614.331)	(616.457)	(964.923)	(929.296)
PEPP	-1.096**	-1.119**	-1.154**	-1.161**	-1.261**	-1.261**	-0.826	-0.840
	(0.456)	(0.451)	(0.503)	(0.500)	(0.534)	(0.535)	(0.506)	(0.498)
PSPP	-1,295.177*	-1,237.917*	-1,826.605***	-1,818.277***	-2,223.424***	-2,233.194***	-591.110	-463.470
	(640.402)	(650.029)	(533.535)	(535.732)	(675.607)	(679.536)	(887.666)	(902.076)
BudgetUE	1.349	1.276	1.138	1.107	0.942	0.932	2.258*	2.264*
	(0.931)	(0.919)	(1.031)	(1.016)	(0.884)	(0.877)	(1.143)	(1.126)
LoansUE	1.280	1.277	1.595	1.598	1.923**	1.925**	0.777	0.727
	(0.999)	(0.988)	(0.927)	(0.924)	(0.836)	(0.836)	(1.133)	(1.114)
HealthExp	-105.797**	-119.218**					-106.487**	-120.343**
	(43.497)	(45.520)					(44.233)	(46.388)
Debt19	48.145*		10.507		0.018		49.914*	
	(25.788)		(23.817)		(18.287)		(26.499)	
NPL	31.033***	30.231***	49.704***	49.920***	54.460***	54.737***	30.460**	29.629**
	(9.838)	(9.680)	(7.453)	(6.813)	(7.193)	(6.680)	(10.049)	(9.885)
Debt20		53.757*		10.882		-1.097		55.659*
		(27.656)		(23.831)		(17.340)		(28.331)
HospitalBeds			-7.493	-8.360				
			(19.165)	(19.773)				
Medage					84.078	86.518		
					(75.977)	(76.278)		
Euronext							-77.253**	-77.073**
							(27.157)	(27.024)
South*D_1203	9.795	10.845	8.292	8.581	8.442	8.395	7.048	6.100
	(10.708)	(10.822)	(11.955)	(12.238)	(11.822)	(11.858)	(8.498)	(8.237)
South*D_1803Long	-36.337*	-36.209*	-39.475*	-39.522*	-42.436*	-42.439*	-37.284*	-36.819*
	(20.185)	(20.063)	(20.313)	(20.305)	(20.232)	(20.227)	(18.101)	(17.950)
South*D_2003	11.189	10.732	12.793	12.696	14.429	14.483	9.961	10.462
	(10.413)	(10.482)	(9.967)	(10.044)	(9.126)	(9.159)	(9.493)	(9.363)
South*D_0704	-10.332*	-10.685*	-10.796*	-10.897*	-11.715**	-11.686**	-12.768**	-12.617**
	(5.595)	(5.558)	(5.381)	(5.383)	(4.975)	(4.980)	(5.044)	(5.088)
South*D_0904	-22.859***	-23.148***	-23.146***	-23.224***	-23.729***	-23.704***	-23.742***	-23.654***
	(6.443)	(6.412)	(6.802)	(6.805)	(6.521)	(6.504)	(6.958)	(6.991)
South*D_0505	-4.382	-3.650	-5.479	-5.312	-5.434	-5.494	4.329	4.649
	(4.955)	(4.904)	(5.593)	(5.761)	(5.011)	(5.028)	(3.987)	(3.959)
South*D_1805	-8.368*	-7.568	-9.977*	-9.801*	-10.028**	-10.088**	-3.132	-2.003
	(4.149)	(4.250)	(4.901)	(5.113)	(3.972)	(3.993)	(3.778)	(3.961)
South*RemAPP	2,381.189	1,693.050	2,825.072	2,650.186	1,723.414	1,761.446	1,407.272	626.607
	(3,191.753)	(3,052.499)	(3,439.387)	(3,348.217)	(2,859.711)	(2,883.939)	(3,529.182)	(3,375.721)
South*PEPP	-1.538**	-1.412**	-1.607**	-1.575**	-1.391**	-1.397**	-1.098	-0.976
	(0.596)	(0.604)	(0.624)	(0.631)	(0.601)	(0.605)	(0.616)	(0.614)
South*PSPP	-3,064.172	-3,165.139	-2,595.322	-2,611.483	-2,279.798	-2,269.053	-1,394.581	-1,589.593
	(1,940.856)	(1,910.794)	(1,989.673)	(1,997.666)	(1,818.704)	(1,820.177)	(2,100.955)	(2,084.476)
South*BudgetUE	0.375	0.725	0.131	0.230	0.583	0.572	2.415	2.616
	(1.664)	(1.617)	(1.972)	(1.951)	(1.778)	(1.782)	(1.774)	(1.708)
South*LoansUE	5.779**	5.746**	5.429**	5.414**	4.996**	4.996**	4.507**	4.552**
	(2.286)	(2.267)	(2.283)	(2.280)	(2.286)	(2.287)	(2.051)	(2.024)
South*Stringency	5.146	4.428	5.315	5.089	3.642	3.640	5.501	4.672
	(4.781)	(4.728)	(5.365)	(5.349)	(4.867)	(4.853)	(4.891)	(4.852)
South*FiscStim	-4.627	-5.083	-2.482	-2.556	-1.069	-1.031	-5.042	-5.444
	(7.513)	(7.439)	(7.937)	(7.927)	(8.068)	(8.054)	(6.948)	(6.860)
South*Euronext							-95.360*	-104.020*
							(50.992)	(50.011)
South*Rvol	168.750**	151.495**	185.580**	181.466**	180.060**	181.587**		
	(65.733)	(67.962)	(71.267)	(76.196)	(64.492)	(65.978)		
Constant	31.300	29.770	-48.691	-50.811	-335.982	-340.498	27.179	25.806
	(68.355)	(64.791)	(82.522)	(85.086)	(283.579)	(282.489)	(68.611)	(64.682)
Observations	1,204	1,204	1,204	1,204	1,204	1,204	1,216	1,216
R-squared	0.862	0.865	0.846	0.846	0.848	0.848	0.862	0.864
Number of id	13	13	13	13	13	13	13	13

This table reports the estimates of the the spread determinants specified in Eq.1 along alternative variables, alternative estimation methods and an alternative sample of countries. The period of estimation is January 1- May 26 2020 on daily data (5 days per week). ***, ** indicates a correlation significant at the 0.01 and 0.05 level resp.

Table 3: Determinants of the sovereign bond spreads: Robustness (Cont')

Variables	Covid Deaths 9	PolicyTracker 10	FE Estimate 11	9 countries sample 12	Without Italy 13
StringencyIndex		3.497	6.548*	-1.999	4.832
		(3.245)	(3.632)	(2.773)	(3.451)
Rvol	-36.711	8.545	19.674	74.653**	50.322
	(34.811)	(36.379)	(24.456)	(25.219)	(34.884)
FiscalStim	4.239***		1.208	0.790	3.658***
	(1.175)		(0.789)	(1.336)	(1.048)
D_1203	18.892***	16.258**	10.755***	11.812***	11.762***
	(5.693)	(6.263)	(2.965)	(3.371)	(3.161)
D_1803	-17.617***	-10.923**	-15.446***	-13.491***	-18.466***
	(4.347)	(3.974)	(3.920)	(3.334)	(4.914)
D_2003	-17.762**	-11.885	-7.335	-0.243	-6.653
	(8.223)	(7.750)	(4.518)	(0.961)	(5.446)
D_0704	-4.639	-2.698	-3.413	2.375*	-3.671
	(3.957)	(2.652)	(2.796)	(1.054)	(4.124)
D_0904	-8.988**	-6.504**	-6.473**	-2.902*	-6.915*
	(3.735)	(2.877)	(2.702)	(1.372)	(3.281)
D_0505	12.866***	8.644*	7.211	-1.349	7.323
	(3.914)	(4.717)	(4.160)	(1.050)	(4.485)
D_1805	7.692**	2.259	-0.338	-2.792*	-1.791
	(3.336)	(3.120)	(2.072)	(1.230)	(2.783)
RemAPP	-1,675.433*	36.358	602.534	-323.172	198.332
	(891.455)	(775.259)	(538.435)	(1,021.837)	(861.531)
PEPP	-0.781	-1.327*	-1.295**	-0.287	-1.241**
	(0.591)	(0.668)	(0.590)	(0.244)	(0.511)
PSPP	-3,261.100***	-2,906.886**	-2,014.164***	-687.832**	-1,438.578*
	(1,090.366)	(1,258.371)	(657.328)	(233.841)	(712.876)
BudgetUE	2.335***	1.808*	0.783	3.116***	0.868
	(0.589)	(0.852)	(0.897)	(0.851)	(1.008)
LoansUE	2.289*	2.668*	1.872*	0.537	1.618
	(1.179)	(1.234)	(0.929)	(0.522)	(1.109)
HealthExp	-76.166	-92.242*		-53.191	-66.260**
	(52.088)	(44.186)		(42.867)	(28.983)
Debt19	18.213	50.968*		51.759*	20.173
	(30.079)	(25.010)		(27.243)	(11.572)
NPL	37.380***	30.993***		30.345**	43.591***
	(11.039)	(9.433)		(10.086)	(6.513)
Euronext					
Per 100k Deaths	-21.120*				
	(9.872)				
Per 100k Death^2	3.691*				
	(2.063)				
PolicyTracker		-1.142			
		(1.556)			
South*D_1203	4.631	8.831	11.546	9.479	1.028
	(9.178)	(10.088)	(11.545)	(10.198)	(9.660)
South*D_1803Long	-35.616	-44.152***	-24.152	-42.921*	-26.519
	(22.698)	(13.516)	(15.472)	(20.047)	(15.424)
South*D_2003	24.856**	12.014	10.263	5.756	16.397
	(10.587)	(11.051)	(11.287)	(9.461)	(10.934)
South*D_0704	-3.021	-11.206**	-7.669*	-16.660***	-9.548
	(6.208)	(4.594)	(3.772)	(4.131)	(6.615)
South*D_0904	-13.324*	-24.327***	-21.466***	-26.523***	-20.175**
	(6.565)	(5.975)	(6.329)	(5.799)	(8.674)
South*D_0505	-14.523**	-4.952	-4.782	3.238	-7.861
	(5.174)	(4.660)	(4.555)	(2.752)	(5.238)
South*D_1805	-18.152***	-9.821**	-6.507	-6.970	-8.851**
	(5.253)	(4.418)	(4.326)	(4.062)	(3.748)
South*RemAPP	4,231.937	1,990.837	-302.354	2,047.707	-178.138
	(3,737.843)	(3,003.448)	(943.068)	(3,298.300)	(2,772.511)
South*PEPP	-2.084**	-1.379	-0.718	-2.247***	-1.214**
	(0.789)	(0.828)	(0.823)	(0.570)	(0.496)
South*PSPP	-173.327	-2,296.380	-3,235.933**	-3,607.804*	-1,477.612
	(1,493.037)	(1,993.434)	(1,150.235)	(1,905.935)	(1,118.055)
South*BudgetUE	1.084	0.236	2.106	-1.026	1.327
	(0.733)	(1.617)	(1.316)	(1.654)	(2.222)
South*LoansUE	5.231**	4.980**	5.812**	6.436**	4.936*
	(2.405)	(1.812)	(2.004)	(2.189)	(2.295)
South*Stringency		4.772	-1.818	9.560*	1.328
		(4.679)	(5.124)	(4.899)	(4.735)
South*FiscStim	-0.264		-7.835	-1.370	
	(8.810)		(5.779)	(7.496)	
South*Euronext					-5.495
					(6.587)
South*Rvol	453.966***	169.294**	211.687***	136.693*	203.843***
	(132.014)	(70.392)	(67.898)	(72.098)	(58.690)
Constant	102.980	-9.616	53.410***	-96.460*	46.222
	(69.138)	(86.878)	(6.658)	(49.751)	(61.901)
Observations	1,447	1,204	1,204	842	1,016
R-squared	0.822	0.863	0.695	0.901	0.884
Number of id	14	13	13	9	12

This table reports the estimates of the the spread determinants specified in Eq.1 along alternative variables, alternative estimation methods and an alternative sample of countries. The period of estimation is January 1- May 26 2020 on daily data (5 days per week). ***, ** indicates a correlation significant at the 0.01 and 0.05 level resp.