Government Interventions and Sovereign Bond Market Volatility during COVID 19: A Quantile Analysis

Claudiu Tiberiu Albulescu, Eugenia Grecu

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Claudiu Tiberiu ALBULESCU[§], Eugenia GRECU[‡*]

Abstract

We test the interaction between COVID-19 governments' interventions, COVID-19- induced uncertainty, and the volatility of sovereign bonds. With a focus on the first waves of pandemic and using a panel-quantile approach and a comprehensive dataset of 31 countries worldwide, we document that containment and closure policies tend to amplify volatility. Furthermore, the price variability is augmented by the spread of the pandemic itself. On the contrary, economic support policies have a substantial stabilizing effect on bond price fluctuations. Both phenomena are not subsumed by additional control variables and are robust to multiple considerations. Our findings may serve financial market participants in their risk management decisions, as well as policy makers to better shape their preparedness for future pandemics.

Keywords: COVID-19, government bond price volatility, government policy responses, international financial markets, containment and closure, economic support, panel quantile regression.

JEL classifications: G01, G12, G15, G18, G41, H12, I18.

[*] Corresponding author.
[§] Claudiu Tiberiu Albulescu, Management Department, Politehnica University of Timisoara, P-ta Victoriei, No. 2, 300006, Timisoara, Romania, claudiu.albulescu@upt.ro.
[‡] Eugenia Grecu, Management Department, Politehnica University of Timisoara, P-ta Victoriei, No. 2, 300006, Timisoara, Romania, eugenia.grecu@upt.ro.
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1. Introduction

A careful mapping of the COVID-19 research shows that much of its efforts and attention has, so far, been focused on the possible impact of government interventions on the equity market.[1] However, the research on sovereign bonds, which account for a large part of global trading volume, has remained relatively sparse. To be specific, only a handful of studies focus on the impact of the pandemic on bond yields, prices, liquidity, or term spreads (see, for example Arellano et al., 2020; Gubareva 2020; He et al., 2020; O'Hara and Zhou, 2021; Sène et al., 2021; Zaremba et al., 2021a, and Zaremba et al., 2022, respectively). Hence, the primary goal of this study is to improve the understanding of the COVID-19-bond market nexus. Specifically, we scrutinize the effect of the government policy responses to the pandemic and of the COVID-19-induced uncertainty on sovereign bond volatility, showing that this effect is asymmetric, being influenced by the volatility level. Our is the first paper assessing the asymmetric, nonlinear effect of government interventions on sovereign bond market Volatility during COVID 19

During the COVID-19 outbreak, financial markets have experienced extraordinary levels of uncertainty leading to significant price drawdowns, volatility spikes, and liquidity shortages (Baker et al., 2020; Belaid et al., 2021; Fakhfekh et al., 2021; Fetzer et al., 2020; Lee et al., 2021; Lyócsa et al., 2020; Szczygielski et al., 2021). Importantly, besides the pandemic itself, which generated a specific form of uncertainty associated with the increased number of new infection cases and deaths (Albulescu et al., 2021) or with news related to COVID-19 (Ftiti et al., 2021), global economies have faced unprecedented government policy responses. These interventions may significantly affect financial market volatility; however, the direction of these forces is far from trivial. On the one hand, any government action may induce additional uncertainty (Pastor and Varonesi, 2012), which in turn, leads to an increase in volatility of government bond markets. On the other hand, several other papers consider government interventions as responsible actions that may curb down the adverse effects of crises and uncertainty (Amengual and Xiu, 2018; Kizys et al., 2020)—which can also be the case for sovereign debt.

Furthermore, the interventions may take different forms. Some of them include containment and closure policies that are targeted at curbing the spread of the pandemic; others

[1] See, e.g., Albulescu (2021), Alexakis et al. (2021), Baig et al. (2021), Duan et al. (2021), Gao et al. (2021), Goodell (2020), James and Menzies (2021), Ozkan (2021), Seven and Yılmaz (2021), Szczygielski et al. (2021), Zaremba et al. (2020), Zaremba et al. (2021b), Zhang et al. (2020).

provide economic support to both enterprises and consumers. The impact of these very different actions does not need to be identical (Kizys et al., 2020). If we consider for instance the containment and closure policies, we expect an immediate negative impact of these measures on the real economy. However, these policies limit COVID-19 propagation and might restore the investors confidence. In this case, the containment policies might reduce the bond price volatility. This is also the case of economic support measures which in the short run generates a positive market sentiment but in the long run they might be associated with fiscal imbalances, increasing thus the market uncertainty. Consequently, we attempt to shed light on this issue, and explore the impact of different government policy responses on government bond volatility.

Towards this end, we examine the behaviour of sovereign bonds in 31 countries during the recent pandemic. Contrary to earlier studies (e.g. Kizys et al., 2020; Zaremba et al., 2021a), we employ the Canay's (2011) panel-quantiles regression approach with fixed effects to determine whether the relationship is consistent across several parts of the bond's volatility distribution. Otherwise said, we investigate if the impact of interventions on sovereign bond market volatility is different, depending on the volatility level.

We therefore build upon Zaremba et al. (2021a) and we extend their analysis in three ways. First, we posit that the effect of government interventions on bond market volatility is not linear and is influenced by the level of volatility recorded in each market. More precisely, it is well known that countries with more developed financial markets tend to record a reduced volatility level (Wang et al., 2018). These mature markets are not reacting to news and uncertainty in the same way the emerging financial markets does. Therefore, we expect that the governmental interventions will have a stronger impact on bond price volatility at upper quantiles, that is, for more volatile bond markets. Highlighting the asymmetric effect of governmental interventions on bond market volatility represents main advantage of a panel quantile approach over the classic panel data models. In addition, a quantile approach has other advantages, including its robustness to non-normality, as well as to heteroscedasticity, skewness, and leptokurtosis—all of which are typical financial data features (Canay, 2011). The estimated conditional quantile functions provide a much more complete image of the covariates' effect on the location, scale, and shape of the distribution of a response variable (Rosen, 2012). Application of this method to study the relationship between COVID-19 and sovereign bond volatility is uncovered by the extant literature. We demonstrate that both the spread of the infections and the policy measures augment the bond market volatility. As novelty, we show that the impact of government interventions increases for upper quantiles, that is, for more volatile markets. The effect is driven principally by containment and closure policies, such as lockdowns or school closing. On the other hand, economic support policies tend to stabilize bond price fluctuations.

Second, we cover the first two waves of the pandemics, while Zaremba et al.'s (2021a) data span only covers the first wave. We investigate the two waves of pandemics (for a description, please refer to Duttilo et al., 2021), given the high level of uncertainty and volatility recorded in 2020. Starting with 2021, financial markets volatility decreased, pointing in the favour of shock accommodation and uncertainty downturn. Moreover, the bond purchases measures (see for example the Federal Reserve quantitative easing program), diminished the market volatility. Third, we check for the "Monday effect" of new infection cases. The new infections are reported at the date "t", for the tests done at date "t-1" (Albulescu, 2021). Given that less tests are performed during the week-end, the number of new infections cases is smaller Monday compared with the other days of the week.

Our findings contribute to the literature on the effect of the COVID-19 outbreak on the bond markets volatility (e.g., He et al., 2020; Arellano et al., 2020; Sène et al., 2021; Gubareva 2020) in several ways.[2] In particular, our study is most closely related to Zaremba et al. (2021a), who applied simple panel regressions to delve into the pandemic-bond volatility nexus. Significantly, our conclusions expand the findings of that study, showing that the interventions impact is influenced by the bond's volatility distribution. Whereas Zaremba et al. (2021a) only found the link between bond volatility and the economic support policies, we also document the essential role of containment and closure interventions—which amplify the price variability. Consequently, while Zaremba et al. (2021a) find the overall stabilizing effect of the government, we demonstrate their detrimental impact.

The structure of the paper is as follows: Section 2 describes data. Section 3 outlines the methods. Section 4 discusses the empirical findings and Section 5 the robustness checks. Finally, Section 6 concludes.

2. Data

As in Zaremba et al. (2021a), the data consists of information on different policy responses from 31 countries that are covered by Datastream: Australia, Austria, Belgium, Canada, China, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, India,

[2] Our focus is on sovereign bond market volatility. A concurrent strand of the literature (e.g. Andrieș et al., 2020; Augustin et al., 2021; Cevik and Öztürkkal, 2020; Daehler et al., 2021; Pan et al., 2021) investigates the pandemic's effect on sovereign bond risk.

Indonesia, Ireland, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, the United Kingdom, and the United States. All of the bond-related data and variables are derived from the Datastream 10-Year Government Bond Total Returns indices. The 10-year maturities are the primary choice in asset pricing literature due to high liquidity and broad international coverage (e.g., Andres et al., 2016; Baltussen et al., 2021). The sample period encompasses the spread of the pandemic, running from January 1, 2020, through November 3, 2020, covering thus the first two waves of COVID-19.[3] Following the typical approach in international bond pricing studies (e.g., Asness et al., 2013), we express the market data in U.S. dollars and the risk-free rate is proxied by the U.S. one-month Treasury-bill rate from Kenneth R. French's website.[4]

To quantify day-to-day changes in volatility, we build on Antonakakis and Kizys (2015); Khalifa et al. (2011); and Zaremba et al. (2020, 2021a—all of whom employ absolute measures of daily returns. Furthermore, to extract the country-specific volatility component, free of the impact of systematic risks, we replace the raw returns with residuals from a factor model. To be precise, in order to capture the multidimensionality of bond returns, we utilize the comprehensive seven-factor model originating from Zaremba et al. (2021a):

$$R_{i,t} = \alpha_i + \beta_i^{MKT} MKT_t^F + \beta_i^{DUR} DUR_t^F + \beta_i^{CRED} CRED_t^F + \beta_i^{SIZE} SIZE_t^F + \beta_i^{MOM} MOM_t^F + \beta_i^{REV} REV_t^F + \beta_i^{CAR} CAR_t^F + \varepsilon_{i,t}. \quad (1)$$

$R_{i,t}$ indicates the daily payoff on a country government i on day t, α_i measures the abnormal return, and $\varepsilon_{i,t}$ is the error term. The regression coefficients β_i^{MKT}, β_i^{DUR}, β_i^{CRED}, β_i^{SIZE}, β_i^{MOM}, β_i^{REV}, and β_i^{CAR} reflect the exposures to the market risk (MKT^F), duration (DUR^F), credit risk ($CRED^F$), size ($SIZE^F$), momentum (MOM^F), long-term reversal (REV^F), and carry (CAR^F) risk factors, respectively. The detailed description of factor construction is provided in Table A1 in the Appendix.

We derive look-ahead bias-free absolute daily residuals by performing the following steps. To begin, for each day t we run the regression (1) using five years of trailing data ending on day *t*-1. Subsequently, we utilize the coefficient estimates and factor realizations from day t to calculate the expected daily returns. Finally, we compute the residual returns as the difference between the actual return realizations on day t and their expected values implied by the model (1).

[3] Most of the existing works on this topic focus on the first wave of pandemics (March-May 2020). In our opinion, the second wave of the sanitary crisis (September-November 2020) is equally important to study the impact of COVID-19 on sovereign bond market volatility, given the additional measures imposed by governments to fight against the pandemics. However, the study of the third wave of pandemics (February-March 2021) should be placed in a totally different context given the start of the vaccination campaign.

[4] Http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html (accessed 03 November 2020).

Our main explanatory variables are based on the policy response indices from the Oxford COVID-19 Government Response Tracker.[5] The indices aggregate data on different government interventions following the COVID-19 outbreak, such as canceling public gatherings and closing workplaces, social distancing requirements, debt relief, or income support. In our baseline approach, we use three different indices: the Government Response Index (***gvt***), which incorporates information on all types of policies; as well as the Containment and Health Index (***cntm***) and the Economic Support Index (***eco***). The latter two constitute sub-indices of ***gvt*** and reflect different types of policies. Whereas ***cntm*** concentrates on containment and closure policies aimed at curbing the pandemic, eco is about economic support to consumers and enterprises during the pandemic.

Besides the primary independent variable, we include a range of additional control variables. These include bond duration (***dur***), default risk (***cred***), money market rate (***mmr***) and convexity (***cx***), carry (***car***), momentum (***mom***), reversal (***rev***), and "Monday effect" dummies (***dummy***). The detailed descriptions for all variables are presented in Table A2 in the Appendix.

Table 1 reports the descriptive statistics for the key variables. Though not reported here, all variables are stationary according to Maddala and Wu's (1999), and Pesaran's (2007) unit root tests.

Table 1. *Summary Statistics*

	Mean	Std. Dev.	Min	Max
R_1	3.392	4.283	0.001	104.7
R_2	5.607	6.966	0.000	125.0
gvt	49.32	24.61	0.000	95.54
cntm	49.28	24.70	0.000	98.96
stg	47.99	26.62	0.000	100.0
eco	49.57	35.21	0.000	100.0
inf	4.578	3.097	0.000	11.49
dur	8.559	1.124	5.390	10.45
cred	4.623	3.663	1.000	13.00
mmr	0.788	1.805	-1.957	7.300
car	0.693	1.107	-1.269	7.623
cx	81.47	20.98	34.86	119.9
size	16.09	0.902	14.13	18.38
mom	-0.496	0.589	-3.138	3.220
rev	-0.656	1.547	-16.54	3.680

Notes: (i) R_1 – daily absolute residuals from a seven-factor model, R_2 – daily absolute returns in U.S. dollars, *gvt* – government response index, *cntm* – containment and health index, *eco* – economic support index, *stg* – original stringency index, *inf* – new infection cases, *dur* – duration, *cred* – credit rating, *mmr* – money market rate, *car* – yield-based carry, *cx* – convexity, *size* – bond market value, *mom* - momentum, and *rev* – reversal; (ii) 6,789 observations. The sovereign bonds price volatility variables (R_1 and R_2) are adjusted ($|\ln(1+R)|$) and multiplied by 1,000 before running the regression.

[5] Https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker (accessed 03 November 2020).

3. Methods

Quantile regression models are useful to account for unobserved heterogeneity and asymmetry. In addition, when relying on fixed-effects models, researchers can control for unobserved covariates. A combination of these approaches represents the basis of panel quantile fixed effects models that is proposed in the literature (e.g., Koenker, 2004; Lamarche, 2010; Galvao, 2011; Rosen, 2012).

Let us consider the following model:

$$Y_{it} = X_{it}'\theta(U_{it}) + \alpha_i, \tag{2}$$

where: $t = 1, \ldots, T$; $i = 1, \ldots, n$; Y_{it} and X_{it} represent the observable variables; U_{it} is an unobservable component; X_{it}' includes a constant term; and $\theta(\tau)$ is the parameter of interest.

It is assumed that the function $\tau \rightarrow X'\theta(\tau)$ is increasing in $\tau \in (0,1)$. In the case α_i is observable, it follows that:

$$P[Y_{it} \leq X_{it}'\theta(U_{it}) + \alpha_i | X_i, \alpha_i] = \tau, \tag{3}$$

where: $U_{it} \sim U[0,1]$, conditional on $X_i = (X_{i1}', \ldots, X_{iT}')'$ and α_i.

The challenge is the $\theta(\tau)$ identification, which cannot be done by imposing only covariates quantile restrictions (Rosen, 2012). If $Q_Y(\tau|X)$ is the τ-quantile of a random variable Y conditional on X and $e_{it}(\tau) \equiv X_{it}'[\theta(U_{it}) - \theta(\tau)]$, equation (2) can be written as:

$$Y_{it} = X_{it}'\theta(U_{it}) + \alpha_i + e_{it}(\tau), \tag{4}$$

Canay (2011) proves that $\theta(\tau)$ is identified for $T \geq 2$ under independence restrictions and the existence of moments. When we move from identification to estimation, we get rid of the fixed effects under the assumption that α_i is a location shift. Practically, Canay (2011) assumes that only $\theta(\tau)$ and $e_{it}(\tau)$ depend on τ and transforms equation (4) as follows:

$$Y_{it} = X_{it}'\theta\mu + \alpha_i + u_{it}, \qquad E(u_{it}|X_i, \alpha_i) = 0. \tag{5}$$

This way α_i is present in the conditional mean of Y_{it}, allowing Canay (2011) to compute the two-step estimator $\hat{\theta}\mu$. First, we obtain a consistent estimator of α_i ($\sqrt{T}$) and $\theta\mu$ ($\sqrt{nT}$), with $\hat{\alpha}_i \equiv E_T[Y_{it} - X_{it}'\hat{\theta}\mu]$. Second, we define $\hat{Y}_i \equiv Y_{it} - \hat{\alpha}_i$ and $\hat{\theta}\mu$ becomes:

$$\hat{\theta}\mu \equiv \underset{\theta \in \Theta}{\operatorname{argmin}}\, \mathbb{E}_{nT}\, [\rho_\tau(\hat{Y}_{it} - X_{it}'\hat{\theta}\mu], \tag{6}$$

where: $\mathbb{E}_{nT}(\cdot) \equiv (nT)^{-1} \sum_{t=1}^{T} \sum_{i=1}^{n} (\cdot)$.

Starting from this framework, we use the first lag of explanatory variables to avoid any endogeneity bias, and we test the following general regression:

$$R_{it} = \alpha_0 + \alpha_1 X_{it-1} + \alpha_2 Z_{it-1} + \mu_i + \gamma_t + \varepsilon_{it}\ , \tag{7}$$

where: R_{it} is the daily measure of sovereign bond volatility in the country i on day t, i.e., the absolute residuals from the model (1); α_0 represents a constant term; X_{it-1} is the vector of COVID-19 variables, represented by new cases of infection and governmental response to the SARS-Cov-2 pandemic; Z_{it-1} is the vector of control variables defined Section 2; and μ_i are the time-invariant country-specific effects, γ_t are the time-specific effects and ε_{it} are the error terms.

4. Empirical findings

Table 2 reports the results of the quantile regressions that account for the overall role of the policy responses. The positive and highly significant coefficients on ***gvt*** suggest that government interventions amplify bond market volatility. The effect is robust across the majority of quantiles tested. The impact of policy measures increases when we shift from lower to higher quantiles. In other words, a volatile financial market environment implies a stronger reaction to the COVID-19 induced policy measures. The only exception is the most volatile quantile—where the ***gvt*** does not differ significantly from zero.

Table 2. *Panel Conditional Quantile Regression – Government Response Index*

	Lower Quantiles			Middle Quantiles				Upper Quantiles		
	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
gvt	0.007***	0.006***	0.005***	0.007***	0.010***	0.012***	0.014***	0.013***	0.011**	-0.007
	(0.002)	*(0.002)*	*(0.002)*	*(0.001)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.005)*	*(0.012)*
inf	0.201***	0.188***	0.192***	0.181***	0.163***	0.159***	0.136***	0.135***	0.117***	0.097
	(0.021)	*(0.017)*	*(0.016)*	*(0.014)*	*(0.016)*	*(0.018)*	*(0.022)*	*(0.025)*	*(0.041)*	*(0.100)*
dur	-2.444***	-2.857***	-2.373***	-2.218***	-2.088***	-2.034***	-1.890***	-1.529***	-1.482*	-3.128
	(0.475)	*(0.374)*	*(0.357)*	*(0.318)*	*(0.361)*	*(0.394)*	*(0.495)*	*(0.559)*	*(0.899)*	*(2.190)*
cred	-0.379***	-0.382***	-0.329***	-0.327***	-0.326***	-0.326***	-0.321***	-0.328***	-0.343***	-0.443***
	(0.020)	*(0.015)*	*(0.015)*	*(0.013)*	*(0.015)*	*(0.016)*	*(0.020)*	*(0.023)*	*(0.038)*	*(0.092)*
mmr	2.361***	2.518***	2.535***	2.558***	2.617***	2.689***	2.753***	2.869***	2.946***	3.495***
	(0.045)	*(0.036)*	*(0.034)*	*(0.030)*	*(0.034)*	*(0.038)*	*(0.047)*	*(0.053)*	*(0.086)*	*(0.211)*
car	2.250***	2.422***	2.338***	2.435***	2.484***	2.598***	2.696***	2.879***	3.220***	4.721***
	(0.071)	*(0.056)*	*(0.053)*	*(0.048)*	*(0.054)*	*(0.059)*	*(0.074)*	*(0.084)*	*(0.135)*	*(0.329)*
cx	0.121***	0.151***	0.127***	0.120***	0.114***	0.114***	0.105***	0.085***	0.083	0.192
	(0.027)	*(0.021)*	*(0.020)*	*(0.018)*	*(0.021)*	*(0.023)*	*(0.028)*	*(0.032)*	*(0.052)*	*(0.127)*
size	-0.445***	-0.506***	-0.540***	-0.621***	-0.717***	-0.844***	-0.936***	-1.073***	-1.274***	-1.568***
	(0.054)	*(0.042)*	*(0.040)*	*(0.036)*	*(0.041)*	*(0.044)*	*(0.056)*	*(0.063)*	*(0.102)*	*(0.248)*
mom	-0.534***	-0.689***	-0.616***	-0.673***	-0.773***	-0.859***	-0.930***	-1.102***	-1.562***	-2.664***
	(0.082)	*(0.065)*	*(0.062)*	*(0.055)*	*(0.062)*	*(0.068)*	*(0.086)*	*(0.097)*	*(0.156)*	*(0.381)*
rev	0.565***	0.482***	0.470***	0.491***	0.494***	0.528***	0.543***	0.519***	0.591***	0.658***
	(0.036)	*(0.029)*	*(0.027)*	*(0.024)*	*(0.028)*	*(0.030)*	*(0.038)*	*(0.043)*	*(0.069)*	*(0.169)*
dummy	0.004	-0.062	-0.087	-0.118	-0.1537	-0.148*	-0.156	-0.062	0.0663	-0.110
	(0.108)	*(0.085)*	*(0.081)*	*(0.072)*	*(0.082)*	*(0.089)*	*(0.112)*	*(0.127)*	*(0.205)*	*(0.498)*

Notes: The table reports slope coefficients from panel regressions along with the corresponding standard errors. (i) standard error in parentheses; (ii) *** p<0.01, ** p<0.05, * p<0.1; (iii) 6,788 observations; (iv) *gvt* – government response index, *inf* – new infection cases, *dur* – duration, *cred* – credit rating, *mmr* – money market rate, *car* – yield-based carry, *cx* – convexity, *size* – bond market value, *mom* - momentum, *rev* – reversal, and *dummy* – binary variable that takes value 1 if Monday and 0 for the rest of the weekdays.

Besides the impact of policy responses to the pandemic, our baseline regression analysis uncovers the role of the pandemic itself: growth in the number of new infections translates into an increase in the bond market volatility. This observation matches similar earlier findings from equity markets (e.g., Zaremba et al., 2020; Baig et al., 2021; Albulescu, 2021), arguing that COVID-19 induced uncertainty contributes to the instability of stock prices. Interestingly, the COVID-19 figures more strongly influence the sovereign bond prices located at the lower and medium volatility quantiles when compared with high volatility bonds. Consequently, less volatile financial markets – typically found in developed countries – are more sensitive to the changes in COVID-19 figures.

The overall government response index, as examined in Table 2, encompasses various interventions that may exhibit differing economic impact. Therefore, in the subsequent analysis, we distinguish between containment and closure measures vs. economic support policies. These two categories are measures with ***cntm*** and ***eco***, respectively.

Table 3 presents the influence of the containment and closure measures on bond market volatility.

Table 3. *Panel Conditional Quantile Regression – Containment and Health Index*

	Lower Quantiles			Middle Quantiles				Upper Quantiles		
	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
cntm	0.010***	0.009***	0.007***	0.009***	0.013***	0.015***	0.017***	0.019***	0.019***	0.007
	(0.002)	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.005)*	*(0.012)*
inf	0.182***	0.170***	0.174***	0.166***	0.143***	0.135***	0.116***	0.101***	0.075*	0.001
	(0.021)	*(0.017)*	*(0.016)*	*(0.014)*	*(0.016)*	*(0.017)*	*(0.022)*	*(0.025)*	*(0.041)*	*(0.101)*
dur	-2.209***	-2.498***	-2.067***	-1.858***	-1.744***	-1.697***	-1.596***	-1.243**	-1.115	-2.561
	(0.466)	*(0.375)*	*(0.364)*	*(0.325)*	*(0.364)*	*(0.386)*	*(0.480)*	*(0.562)*	*(0.910)*	*(2.221)*
cred	-0.374***	-0.374***	-0.317***	-0.324***	-0.314***	-0.322***	-0.315***	-0.315***	-0.329***	-0.424***
	(0.019)	*(0.015)*	*(0.015)*	*(0.013)*	*(0.015)*	*(0.016)*	*(0.020)*	*(0.023)*	*(0.038)*	*(0.093)*
mmr	2.293***	2.470***	2.475***	2.492***	2.538***	2.611***	2.676***	2.791***	2.886***	3.419***
	(0.044)	*(0.036)*	*(0.035)*	*(0.031)*	*(0.035)*	*(0.037)*	*(0.046)*	*(0.054)*	*(0.087)*	*(0.213)*
car	2.170***	2.314***	2.249***	2.345***	2.389***	2.535***	2.608***	2.782***	3.070***	4.610***
	(0.070)	*(0.056)*	*(0.054)*	*(0.049)*	*(0.054)*	*(0.058)*	*(0.072)*	*(0.084)*	*(0.137)*	*(0.334)*
cx	0.110***	0.131***	0.111***	0.099***	0.095***	0.095***	0.089***	0.070**	0.062	0.164
	(0.027)	*(0.021)*	*(0.021)*	*(0.019)*	*(0.021)*	*(0.022)*	*(0.028)*	*(0.032)*	*(0.053)*	*(0.129)*
size	-0.453***	-0.516***	-0.553***	-0.625***	-0.716***	-0.836***	-0.936***	-1.084***	-1.302***	-1.535***
	(0.052)	*(0.042)*	*(0.041)*	*(0.036)*	*(0.041)*	*(0.043)*	*(0.054)*	*(0.063)*	*(0.103)*	*(0.251)*
mom	-0.521***	-0.668***	-0.583***	-0.642***	-0.748***	-0.821***	-0.878***	-1.082***	-1.518***	-2.690***
	(0.080)	*(0.065)*	*(0.063)*	*(0.056)*	*(0.063)*	*(0.067)*	*(0.083)*	*(0.097)*	*(0.158)*	*(0.385)*
rev	0.588***	0.493***	0.481***	0.496***	0.508***	0.539***	0.554***	0.531***	0.607***	0.698***
	(0.035)	*(0.028)*	*(0.028)*	*(0.025)*	*(0.028)*	*(0.029)*	*(0.036)*	*(0.043)*	*(0.070)*	*(0.170)*
dummy	-0.012	-0.051	-0.080	-0.131*	-0.148*	-0.162*	-0.161	-0.057	0.044	0.004
	(0.106)	*(0.085)*	*(0.082)*	*(0.074)*	*(0.082)*	*(0.087)*	*(0.109)*	*(0.128)*	*(0.207)*	*(0.505)*

Notes: The table reports slope coefficients from panel regressions along with the corresponding standard errors. (i) standard error in parentheses; (ii) *** p<0.01, ** p<0.05, * p<0.1; (iii) 6,788 observations; (iv) *cntm* – Containment and Health Index, *inf* – new infection cases, *dur* – duration, *cred* – credit rating, *mmr* – money market rate, *car* – yield-based carry, *cx* – convexity, *size* – bond market value, *mom* - momentum, *rev* – reversal, and *dummy* – binary variable that takes value 1 if Monday and 0 for the rest of the weekdays.

This additional analysis unequivocally reveals the underlying source of the government policy responses on the market volatility. Highly significant ***cntm*** coefficients indicate that these containment and closure interventions constitute a major contributor to bond price variability. In accordance with previous results, the policy measures generate a more substantial impact when we test the higher quantiles of the distribution, whereas the spread of the pandemic as measured by the ***inf*** variable is more powerful in low quantiles. Finally, similar to the previous case, the effect of policy measures (nor the spread of the disease) on bond price volatility is not significant for very volatile markets (i.e., the 0.95 quantile).

Let us now turn to the role of the other category of government interventions: economic support policies (***eco***). Table 4 demonstrates the results of another set of quantile regressions to capture the role of this category of government actions. Our analysis uncovers a negative impact on bond price volatility for lower and upper quantiles, but not for middle quantiles (**Table 4**). For sovereign bonds with smaller and higher volatility, economic support interventions stabilize the markets. The effect is more substantial for the upper quantiles, which is in line with the impact generated by other policy interventions (see, for example, the results reported in **Table 3**).

Table 4. *Panel Conditional Quantile Regression – Economic Support Index*

	Lower Quantiles			Middle Quantiles				Upper Quantiles		
	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
eco	-0.002	-0.004***	-0.002*	-0.001	-0.001	-0.001	-0.001	-0.004**	-0.010***	-0.025***
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.003)*	*(0.007)*
inf	0.273***	0.255***	0.240***	0.236***	0.239***	0.238***	0.224***	0.243***	0.209***	0.170**
	(0.016)	*(0.014)*	*(0.012)*	*(0.011)*	*(0.013)*	*(0.014)*	*(0.019)*	*(0.023)*	*(0.033)*	*(0.085)*
dur	-3.718***	-4.251***	-3.546***	-3.272***	-3.264***	-3.125***	-3.131***	-2.733***	-2.920***	-3.751
	(0.444)	*(0.378)*	*(0.337)*	*(0.316)*	*(0.362)*	*(0.391)*	*(0.507)*	*(0.614)*	*(0.884)*	*(2.282)*
cred	-0.366***	-0.370***	-0.314***	-0.314***	-0.325***	-0.331***	-0.332***	-0.348***	-0.345***	-0.424***
	(0.018)	*(0.015)*	*(0.014)*	*(0.013)*	*(0.015)*	*(0.016)*	*(0.021)*	*(0.025)*	*(0.037)*	*(0.095)*
mmr	2.343***	2.546***	2.572***	2.594***	2.664***	2.721***	2.814***	2.902***	3.006***	3.394***
	(0.043)	*(0.036)*	*(0.032)*	*(0.030)*	*(0.035)*	*(0.038)*	*(0.049)*	*(0.059)*	*(0.086)*	*(0.221)*
car	2.348***	2.463***	2.351***	2.437***	2.555***	2.654***	2.777***	3.006***	3.217***	4.479***
	(0.066)	*(0.056)*	*(0.050)*	*(0.047)*	*(0.054)*	*(0.058)*	*(0.075)*	*(0.091)*	*(0.132)*	*(0.340)*
cx	0.187***	0.226***	0.191***	0.176***	0.178***	0.172***	0.172***	0.148***	0.161***	0.215
	(0.025)	*(0.022)*	*(0.019)*	*(0.018)*	*(0.021)*	*(0.022)*	*(0.029)*	*(0.035)*	*(0.051)*	*(0.132)*
size	-0.331***	-0.419***	-0.468***	-0.544***	-0.640***	-0.757***	-0.840***	-0.982***	-1.175***	-1.347***
	(0.050)	*(0.042)*	*(0.038)*	*(0.035)*	*(0.041)*	*(0.044)*	*(0.057)*	*(0.069)*	*(0.100)*	*(0.258)*
mom	-0.542***	-0.697***	-0.630***	-0.660***	-0.770***	-0.850***	-0.928***	-1.016***	-1.392***	-2.258***
	(0.077)	*(0.066)*	*(0.059)*	*(0.055)*	*(0.063)*	*(0.068)*	*(0.089)*	*(0.107)*	*(0.155)*	*(0.399)*
rev	0.475***	0.388***	0.383***	0.413***	0.416***	0.430***	0.416***	0.377***	0.427***	0.442**
	(0.034)	*(0.029)*	*(0.026)*	*(0.024)*	*(0.028)*	*(0.030)*	*(0.039)*	*(0.047)*	*(0.069)*	*(0.177)*
dummy	0.001	-0.068	-0.085	-0.107	-0.196**	-0.175**	-0.185	-0.019	-0.012	-0.100
	(0.101)	*(0.086)*	*(0.076)*	*(0.072)*	*(0.082)*	*(0.089)*	*(0.115)*	*(0.139)*	*(0.201)*	*(0.519)*

Notes: The table reports slope coefficients from panel regressions along with the corresponding standard errors. (i) standard error in parentheses; (ii) *** p<0.01, ** p<0.05, * p<0.1; (iii) 6,788 observations; (iv) *eco* – Economic Support Index, *inf* – new infection cases, *dur* – duration, *cred* – credit rating, *mmr* – money market rate, *car* – yield-based carry, *cx* – convexity, *size* – bond market value, *mom* - momentum, *rev* – reversal, and *dummy* – binary variable that takes value 1 if Monday and 0 for the rest of the weekdays.

To sum up our considerations, we find that both containment and closure restrictions - as well as economic support policies - affect the market volatility; however, the direction of the impact is opposite. Whereas the first category tends to boost the market fluctuations, the latter helps to stabilize the market.

5. Robustness checks

To assure the validity of our findings, we run a number of additional robustness checks. First, use a different metric to compute the sovereign bond price volatility, relying on absolute raw returns rather than on risk-adjusted returns (residuals).[6] These results are reported in Table 5 and are very similar with those reported in Section 4.

Table 5. *Panel Conditional Quantile Regression – Robustness Analysis Using Daily USD Returns as a Proxy for Bond Price Volatility*

	Lower Quantiles			Middle Quantiles				Upper Quantiles		
	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
gvt	0.002	0.019***	0.020***	0.023***	0.030***	0.033***	0.032***	0.034***	0.029***	-0.036*
	(0.004)	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.004)*	*(0.006)*	*(0.009)*	*(0.020)*
inf	0.310***	0.264***	0.246***	0.238***	0.203***	0.195***	0.217***	0.217***	0.249***	0.349**
	(0.033)	*(0.026)*	*(0.025)*	*(0.024)*	*(0.027)*	*(0.031)*	*(0.037)*	*(0.049)*	*(0.076)*	*(0.165)*
dur	-5.950***	-4.269***	-4.197***	-4.576***	-5.363***	-6.754***	-8.351***	-9.593***	-12.41***	-16.18***
	(0.734)	*(0.576)*	*(0.545)*	*(0.529)*	*(0.589)*	*(0.674)*	*(0.805)*	*(1.066)*	*(1.655)*	*(3.604)*
cred	-0.330***	-0.340***	-0.363***	-0.360***	-0.357***	-0.342***	-0.320***	-0.313***	-0.235***	-0.257*
	(0.031)	*(0.024)*	*(0.023)*	*(0.022)*	*(0.024)*	*(0.028)*	*(0.034)*	*(0.045)*	*(0.069)*	*(0.152)*
mmr	3.716***	3.965***	4.187***	4.258***	4.309***	4.432***	4.540***	4.782***	5.056***	6.006***
	(0.070)	*(0.055)*	*(0.052)*	*(0.051)*	*(0.056)*	*(0.065)*	*(0.077)*	*(0.102)*	*(0.159)*	*(0.347)*
car	3.341***	3.305***	3.543***	3.693***	3.887***	4.119***	4.290***	4.455***	4.791***	6.643***
	(0.110)	*(0.086)*	*(0.082)*	*(0.079)*	*(0.088)*	*(0.101)*	*(0.121)*	*(0.160)*	*(0.249)*	*(0.542)*
cx	0.323***	0.233***	0.231***	0.254***	0.300***	0.388***	0.479***	0.556***	0.726***	0.972***
	(0.042)	*(0.033)*	*(0.031)*	*(0.030)*	*(0.034)*	*(0.039)*	*(0.046)*	*(0.062)*	*(0.096)*	*(0.210)*
size	-0.560***	-0.689***	-0.734***	-0.867***	-0.946***	-1.107***	-1.278***	-1.531***	-1.995***	-2.608***
	(0.083)	*(0.065)*	*(0.061)*	*(0.060)*	*(0.066)*	*(0.076)*	*(0.091)*	*(0.121)*	*(0.187)*	*(0.408)*
mom	-0.371***	-0.609***	-0.791***	-0.904***	-0.947***	-1.046***	-1.117***	-1.175***	-1.770***	-3.300***
	(0.127)	*(0.100)*	*(0.095)*	*(0.092)*	*(0.102)*	*(0.117)*	*(0.140)*	*(0.185)*	*(0.288)*	*(0.627)*
rev	0.846***	0.812***	0.721***	0.799***	0.878***	0.939***	1.006***	1.121***	1.322***	1.588***
	(0.057)	*(0.044)*	*(0.042)*	*(0.041)*	*(0.045)*	*(0.052)*	*(0.062)*	*(0.082)*	*(0.128)*	*(0.279)*
dummy	-0.101	-0.188	-0.312**	-0.319***	-0.375***	-0.330**	-0.423**	-0.413*	-0.134	-0.458
	(0.167)	*(0.131)*	*(0.124)*	*(0.120)*	*(0.134)*	*(0.153)*	*(0.183)*	*(0.243)*	*(0.377)*	*(0.821)*

Notes: The table reports slope coefficients from panel regressions along with the corresponding standard errors. (i) standard error in parentheses; (ii) *** p<0.01, ** p<0.05, * p<0.1; (iii) 6,788 observations; (iv) *gvt* – government response index, *inf* – new infection cases, *dur* – duration, *cred* – credit rating, *mmr* – money market rate, *car* – yield-based carry, *cx* – convexity, *size* – bond market value, *mom* – moo=mentum, *rev* – reversal, and *dummy* – binary variable that takes value 1 if Monday and 0 for the rest of the weekdays.

[6] In an unreported analysis we also consider different nested models. The major results remain unaffected.

Second, we work with alternative sets of control variables, and we show a similar effect of governmental interventions and COVID-19 related uncertainty (Table 6).

Table 6. *Panel Conditional Quantile Regression – Robustness Analysis Using a Different Set of Control Variables*

	Lower Quantiles			Middle Quantiles				Upper Quantiles		
	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
gvt	0.009***	0.015***	0.014***	0.012***	0.012***	0.016***	0.018***	0.018***	0.011**	-0.002
	(0.003)	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.004)*	*(0.005)*	*(0.012)*
inf	0.095***	0.060***	0.042***	0.046***	0.043***	0.031*	0.018	0.017	0.026	-0.133
	(0.025)	*(0.017)*	*(0.016)*	*(0.014)*	*(0.016)*	*(0.017)*	*(0.022)*	*(0.028)*	*(0.044)*	*(0.102)*
dur	-0.126**	-0.223***	-0.200***	-0.168***	-0.182***	-0.158***	-0.166***	-0.188***	-0.188*	-0.084
	(0.055)	*(0.039)*	*(0.035)*	*(0.031)*	*(0.036)*	*(0.038)*	*(0.050)*	*(0.063)*	*(0.097)*	*(0.227)*
cred	0.153***	0.205***	0.225***	0.252***	0.258***	0.262***	0.273***	0.261***	0.284***	0.218**
	(0.022)	*(0.015)*	*(0.014)*	*(0.012)*	*(0.014)*	*(0.015)*	*(0.020)*	*(0.025)*	*(0.039)*	*(0.090)*
car	0.036	-0.067	-0.052	0.006	0.138***	0.232***	0.396***	0.702***	1.044***	2.473***
	(0.071)	*(0.050)*	*(0.045)*	*(0.040)*	*(0.046)*	*(0.048)*	*(0.064)*	*(0.081)*	*(0.125)*	*(0.290)*
size	-0.801***	-0.876***	-0.881***	-0.929***	-1.008***	-1.139***	-1.232***	-1.352***	-1.615***	-1.762***
	(0.061)	*(0.043)*	*(0.039)*	*(0.034)*	*(0.040)*	*(0.042)*	*(0.056)*	*(0.070)*	*(0.108)*	*(0.252)*
mom	0.967***	0.924***	0.935***	0.851***	0.734***	0.599***	0.470***	0.260**	-0.348**	-1.264***
	(0.091)	*(0.064)*	*(0.058)*	*(0.051)*	*(0.059)*	*(0.062)*	*(0.083)*	*(0.104)*	*(0.160)*	*(0.371)*
rev	1.242***	1.138***	1.140***	1.102***	1.125***	1.190***	1.211***	1.249***	1.364***	1.473***
	(0.037)	*(0.026)*	*(0.023)*	*(0.020)*	*(0.024)*	*(0.025)*	*(0.033)*	*(0.042)*	*(0.065)*	*(0.151)*
dummy	0.007	-0.036	-0.092	-0.091	-0.126	-0.141*	-0.116	-0.061	0.112	0.080
	(0.124)	*(0.087)*	*(0.080)*	*(0.070)*	*(0.080)*	*(0.085)*	*(0.113)*	*(0.142)*	*(0.218)*	*(0.507)*

Notes: The table reports slope coefficients from panel regressions along with the corresponding standard errors. (i) standard error in parentheses; (ii) *** p<0.01, ** p<0.05, * p<0.1; (iii) 6,788 observations; (iv) *gvt* – government response index, *inf* – new infection cases, *dur* – duration, *cred* – credit rating, *car* – yield-based carry, *size* – bond market value, *mom* - momentum, *rev* – reversal, and *dummy* – binary variable that takes value 1 if Monday and 0 for the rest of the weekdays.

Third, in an unreported analysis, we employ a modified measure of the strictness of government policies - namely the Stringency Index – which is also sourced from the Oxford COVID-19 Government Response Tracker. None of these extra robustness checks materially affect our findings. Our overall conclusions remain unaffected.

6. Conclusions

We examine the impact of governments' interventions and COVID-19 numbers on the volatility of sovereign bonds. We apply quantile regressions to a sample of 31 countries to scrutinize the importance of different types of policy responses. We posit that the impact of COVID-19 on sovereign bonds is influenced by the level of market volatility.

Our findings demonstrate that the direction of the effect on government bond returns' volatility depends strongly on the type of interventions. Confinement and closure restrictions increase market uncertainty and, in consequence, drive the return volatility up. In contrast, economic support measures tend to calm the volatility level in trading and enhance market stability. Further, we show that the impact of COVID-19 induced policy measures and related uncertainty is higher in the case of more volatile markets (i.e., at higher quantiles).

The conclusions from this study yield clear, practical implications. Since confinement and closure restrictions amplify volatility, our results imply that governments should be transparent and clear with their plans about this type of interventions in the short and longer terms. The COVID-19 period is overwhelmed with increased uncertainty of which governments interventions may even worsen it. Hence, providing information publicly as soon as possible may calm the adverse effect of closures. In addition, since economic interventions seem to be associated with positive response, it does not mean that transparency about economic steps is not needed, especially if such supportive actions are expected to increase the fiscal deficit.

The findings also imply that investors can exploit this information to better shape their investment decisions. They should be aware that non-economic interventions, which are not directly related to financial markets, may spillover to capital markets and are not limited to the equity markets. Therefore, investors, and particularly those operating in the fixed-income markets should monitor the changes in government policy and make the required adjustments to their portfolios. More precisely, to anticipate the volatility dynamics, they need to analyze the type of interventions and the sovereign bond markets' characteristics.

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Appendix

Table A1. *Construction of the Cross-Sectional Asset Pricing Factors*

Symbol	Factor	Description
MKT^F	Market risk factor	MKT^F is the excess return on the market, i.e., the value-weighted return of all the bond indices in the sample at the end of month *t* minus the risk-free rate, i.e., the one-month T-Bill return.
DUR^F	Duration factor	The factor is represented by a long-short zero-investment portfolio that buys (sells) the value-weighted portfolio comprising 30% of bond indices with the highest (lowest) adjusted duration.
$CRED^F$	Credit risk factor	The factor is represented by a long-short zero-investment portfolio that buys (sells) the value-weighted portfolio comprising 30% of bond indices with the highest (lowest) adjusted credit risk score. The credit risk score for each market is calculated as the average numerical rating from three major rating agencies: Moody's, S&P, and Fitch. To obtain the numerical ratings, we convert all the ratings linearly so that the top rating (AAA/Aaa) is associated with 1, and the bottom rating (C) is associated with 21.
$SIZE^F$	Size factor	The factor is represented by a long-short zero-investment portfolio that buys (sells) the value-weighted portfolio comprising 30% of bond indices with the highest (lowest) market value of the relevant bond basket.
MOM^F	Momentum factor	The factor is represented by a long-short zero-investment portfolio that buys (sells) the value-weighted portfolio comprising 30% of bond indices with the lowest (highest) change in yield-to-maturity from *t*-12 to *t*-1. This corresponds with going long (short) bonds with the highest (lowest) return induced by the change in YTMs.
REV^F	Reversal factor	The factor is represented by a long-short zero-investment portfolio that buys (sells) the value-weighted portfolio comprising 30% of bond indices with the highest (lowest) change in the yield-to-maturity (YTM) from *t*-60 to *t*-13. This corresponds with going long (short) bonds with the lowest (highest) return induced by the change in YTMs.
CAR^F	Carry factor	The factor is represented by a long-short zero-investment portfolio that buys (sells) the value-weighted portfolio comprising 30% of bond indices with the highest (lowest) lowest carry. The carry variable is measured as the difference between the yield-to-maturity on 10-year government bonds and the 3-month interbank interest rate.

Notes: The table displays the procedures used to calculate the returns on asset pricing factors used in this study.

Table A2. *Major Variables Used in the Study*

Symbol	Variable	Description
		Panel A: Dependent variables
R_1	Daily absolute residuals from a seven-factor model	R_1 represents the residuals from the seven-factor model (1), computed as $\lvert\ln(1+R)\rvert$.
R_2	Daily absolute returns in U.S. dollars	R_2 represents the daily returns computed as $\lvert\ln(1+R)\rvert$.
		Panel B: Explanatory variables of interest
gvt	Government Response index	COVID-19 government policy response index aggregating all types of policies and rescaling them to create a score between 0 and 100 on day *t*
cntm	Containment and Health index	COVID-19 containment and health index aggregating only containment, closure, and health policies and is rescaled to create a score between 0 and 100 on day t.
stg	Stringency Index	COVID-19 containment and health index aggregating only containment and closure, policies, and is rescaled to create a score between 0 and 100 on day t.
eco	Economic Support Index	COVID-19 economic support index aggregating government only the policy responses targeted and providing economic support and is rescaled to create a score between 0 and 100 on day t.
inf	New infections	The new cases of infection are computed as $\ln(1+\Delta INF')$, where INF' is the number of infected cases.
		Panel C: Control variables
dur	Duration	Average adjusted duration of the bond market index on day t-1.
cred	Quantified credit rating	Numerical sovereign rating of the government bonds in the index on day t-1. The credit risk score for each market is calculated as the average numerical rating from three major rating agencies: Moody's, S&P, and Fitch. To obtain the numerical ratings, we convert all the ratings linearly, so that the top rating (AAA/Aaa) is associated with 1, and the bottom rating (C) is associated with 21.
mmr	Money market rate	Three-month interbank rate that is available in a given country at *t*-1.
car	Carry	The difference between the yield-to-maturity on 10-year government bonds and the 3-month interbank interest rate
cx	Convexity	Average adjusted convexity of the bond market index on day t-1.
size	Market value	Natural logarithm of the market value of the bond index portfolio expressed in U.S. dollars on day t-1.
mom	Momentum	Change in the yield to maturity level on the government bond index in months *t*-12 to *t*-1.
rev	Reversal	Change in the yield to maturity level on the government bond index in months *t*-60 to *t*-13.
dummy	"Monday effect" dummy	The variable takes value 1 if the day of the week is Monday and 0 otherwise.

Notes: The table presents the variables that are used in the study.