Journal of International Money and Finance 131 (2023) 102792

Contents lists available at ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

How has COVID-19 affected the performance of green investment funds? ☆

Maria-Eleni K. Agoraki [a], Nektarios Aslanidis [b,*], Georgios P. Kouretas [c,d]

[a] *Department of Accounting and Finance, University of the Peloponnese, Antikalamos GR–24100, Greece*
[b] *ECO SOC, Universitat Rovira i Virgili, FEE, Avinguda Universitat 1, 43204 Reus, Spain*
[c] *IPAG Business School, 184 Boulevard Saint-Germain, FR–75006 Paris, France*
[d] *Department of Business Administration, Athens University of Economics and Business, 76 Patission Street, GR–10434 Athens, Greece*

ARTICLE INFO

Article history:
Available online 23 December 2022

Keywords:
Sustainable finance
Climate change
Green assets
COVID-19
Economic support
Quantile methods
Asset management

ABSTRACT

This paper adopts quantile regressions to scrutinize the dynamics of green investment funds in relation to the outbreak of the COVID-19 pandemic. We use data on three of the largest green investment funds (BNP PARIBAS Funds Climate Impact, Nordea Global Climate & Environment, and AMUNDI Funds Global Ecology ESG), whose proceeds finance environmental-focused projects. We consider explicitly how different types of COVID-19 measures impact on these green assets. We show evidence that economic support due to COVID-19 has a positive effect on the green assets. The effect is especially strong when the returns are negative. We further report that strigency owing to the pandemic is also positively associated with green investment funds, but again, for negative returns. On the other hand, the effect of confirmed deaths is not as strong shows up mainly at lower quantiles. A similar results applies to infectious disease equity market volatility. We account for the broader macroeconomic environment and subject our models to a battery of sub-sample robustness checks. Our research offers interesting insights in terms of investment and portfolio diversification, that can be applied to the analysis of asset management and policy making.

1. Introduction

Since the declaration of the "Green Bond Principles" by the International Capital Markets Association (ICMA) in January 2014, new green finance opportunities have arisen for individual and institutional investors. The investors' interest in environmental risk was further engaged by the provisions of the 2015 Paris Agreement and the willingness of many countries to move towards a more climate-resilient economy. Within this framework, green bonds have become an increasingly popular

☆ An earlier version of the paper was presented at the 3rd Financial Economics Meeting, Paris, 30 June–1 July 2022 and thanks are due to conference participants for many helpful comments and discussions. The paper has benefited from valuable comments by seminar participants at the Athens University of Economics and Business and IPAG Business School. We are grateful to Joscha Beckmann, Rafael Casellas Aparicio, Zied Ftiti, Davide Furceri, Dimitris Georgoutsos, Jean-Yves Gnabo, Paul McNeilis, Francisco Nadal de Simone, and George Tavlas for stimulating discussions on earlier drafts of the paper. We also thank Editor-in-Chief Mark Spiegel, an anonymous referee and a discussant for very constructive comments. Nektarios Aslanidis acknowledges financial support by the Spanish Government, Ministry of Science and Innovation through the project PID2019–105982GB-I00. The usual caveat applies.

* Corresponding author.
E-mail addresses: m.agoraki@uop.gr (M.-E.K. Agoraki), nektarios.aslanidis@urv.cat (N. Aslanidis), kouretas@aueb.gr (G.P. Kouretas).

https://doi.org/10.1016/j.jimonfin.2022.102792
0261-5606/

financial instrument, since they are recognized as an efficient instrument to finance the transition to a low-carbon economy (OECD, 2017). Hence, the green bond market has been thriving. For example, in March 2014, Unilever issued a green bond of 250 million pounds sterling with the purpose of reducing by 50 % the amount of waste, the use of water, and the emission of greenhouse gases from existing factories.

Green bonds have characteristics similar to brown fixed-income corporate bonds, although their revenues are channeled to environmentally friendly projects. Certainly, the development of the green bond market depends on the risk-return profile of green bonds. In addition, Reboredo (2018) argues for a connection between green bonds and other financial markets, which provides the mechanism to evaluate the performance of green bonds and their usefulness for hedging and managing portfolio risks. An important issue that arises when we examine investors' preference for green assets is whether investors knowingly accept lower expected financial returns in exchange for nonpecuniary benefits when they invest in assets with dual objectives. Consequently, the introduction of green assets has led to the development of modified asset pricing models with utility functions that take care of the implications of investors' preferences for social benefits that arise from green projects (see, for example, Pastor et al. 2021, among others).

According to the 2021 Global Sustainable Investment Review, sustainable investing assets were over 42 trillion USD globally at the beginning of 2021 – a 49 % increase in two years. By the end of 2021, more than 3215 organizations, representing 102 trillion USD in assets, have become signatories to the United Nations Principles of Responsible (UNRPI). However, it is notable that the signing of the UNPRI accords does not imply that the holder of the capital or the asset manager must invest in green assets, but rather that UNPRI investors can comply by adopting principles of corporate governance within their investing organization. Further evidence is provided by a survey conducted by BlackRock (2020), which shows that 88 % of its clients ranked the environment as "the priority most in focus" among ESG criteria.[1]

KPMG's (2021) Survey of Corporate Responsibility Reporting reports that in 1999, 35 % of the world's 250 largest companies by revenue included CSR and ESG information in their annual financial reports, whereas about 90 % showed the positive effects of such social concerns by 2021. Thus, all major consulting groups have implemented a social impact practice, whereas all major investment banks have established an impact division to meet the corporate, institutional, and private wealth demands for investing in assets that have a social impact.

Green investment funds are another important green asset class that has emerged in recent years. These are climate-aware investment funds that mitigate climate risk by facilitating the flow of investment capital toward green projects, in conjunction with the shift away from brown industries and firms. Green investment funds invest heavily in companies that are leaders in the climate revolution and are having a real impact on global warming while helping to accelerate the transition to a more sustainable world. Specifically, these funds invest at least 75 % of their total assets in equities and equity-related securities issued by companies with business activities focused on enabling the adaptation to, or the mitigation of, climate change. Examples include companies in the fields of renewable energy, pollution prevention and control, sustainable management of living natural resources, terrestrial and aquatic biodiversity conservation, clean transportation, sustainable water management, climate change adaptation, and eco-efficient products and production technologies and processes. Most of these companies are headquartered in countries such as Australia, Canada, Denmark, Germany, France, Japan, Netherlands, Norway, Spain, Taiwan, the United Kingdom, and the United States.

The economic recovery from COVID-19 has been ongoing in countries around the world since the end of 2021. However, although governments during the pandemic mainly implemented short-term stimulus measures, they now face the challenge of designing and implementing deeper structural measures that will have a far-reaching effect. Such a challenge is considered to be a main issue for the banking industry (and for the economy in general) where, given time to adjust to the consequences of the pandemic with monetary, fiscal, and prudential measures, it remains unclear what the industry has done with this additional time. If the industry has improved the quality of its assets, continued to beef up its capital, and replenish liquidity buffers despite prudential forbearance measures, then it will be resilient to the continued supply-side disruptions inherited from the pandemic and compounded by the Russian attack on Ukraine, as well as perpetuated by the COVID-19 zero-tolerance Chinese policy, with its dampening effects on world growth. In addition, the demands on production and consumption imposed by the transition to a greener economy challenge the banking industry beyond the prudential direct effects of their stress-testing obligations. Given these challenges and the ongoing digitization requirement of introducing deeper and wider changes in banks' business models, the removal of support measures might reveal profit weaknesses and structural, deep-rooted inefficiencies in the banking industry.

Furthermore, the need to build green structural measures has recently been recognized and laid down (OECD, 2021). Within this framework, governments have considered several prioritization criteria in designing structural reform packages. It is evident that the green skills measures are very important, as are the integrated planning and structural reform measures. There is also a call for green fiscal reform and natural capital investment. As the economists at OECD (OECD, 2021) argue, the most ambitious and structural green policy agendas have been implemented by high-income countries with less restricted financing conditions, and the situation is different in less-developed countries where fiscal and monetary are not available. Mealy et al. (2021) suggest that credible green structural reform must tackle the real and substantive transactional political economy barriers; thus, discussing the consequences of the removal of monetary policy support is now more of a moot point,

[1] See also BNP Paribas (2019) Survey on investors' motivation for ESG investing.

given the end of the long-delayed increase in policy rates. Several structural green recovery strategies have been recently applied under UN agencies (coordinated multilateral planning) in Senegal (green economy principles in the recovery process), in Argentina, in Mauritius (COVID-safe green tourism), and in Mato Grosso, Brazil (greening family agriculture).

The primary objective of this paper is to provide a rigorous methodology for scrutinizing the dynamics of green investment funds in relation to the outbreak of the COVID-19 pandemic. To this end, we adopt quantile regressions to provide a more comprehensive picture of the effect of COVID-19 on every part of the distribution of returns. By contrast, standard regression models assume a linear relationship across the entire distribution. In the present paper, we use daily prices on three of the largest green investment funds, namely, BNP PARIBAS Funds Climate Impact, Nordea Global Climate & Environment, and AMUNDI Funds Global Ecology ESG. These financial institutions are active players in the green securities market, issuing a significant amount of green funds. Using green investment funds in our analysis, we look at the asset side of financial institutions' balance sheets, which has interesting policy implications. According to Fatica et al. (2021), a decrease in lending to less-polluting sectors may not *ipso facto* reduce the system-wide transitional risks that could arise from the process of adjusting to a lower-carbon economy (changes in technology). However, the authors argue that this would reduce the physical risks that could arise from climate and weather-related events (e.g., floods and storms).

We consider our study alongside a number of recent papers that investigate returns on green versus brown (conventional) assets. First, several papers examine returns on an *ex ante* basis, in which case they use proxies for expected future returns. Pastor et al. (2022), Baker et al. (2022), Flammer (2021), Barber et al. (2021), Fatica et al. (2021), Tang and Zhang (2020), and Zerbib (2019) are among the studies focusing their analysis on the pricing of green bonds. In the stock market, there is also a large group of studies that examine returns on an *ex post* basis, measuring realized green versus brown returns. Studies by Aswani et al. (2021), Bolton and Kacperczyk (2021, 2022), Pastor et al. (2021), Shackleton et al. (2022), and Hsu et al. (2022) follow this line of research. Finally, our paper draws on studies by Hammoudeh et al. (2020) Reboredo and Ugolini (2020), and Reboredo (2018), among others, which examine co-movement and price spillover effects between green assets and other financial markets. However, there is a lack of a broad exploration of the impact of COVID-19 on green assets to conduct a comparative analysis before and after the outbreak of the pandemic.

To fill the gap, this paper sheds light on the economic impact of COVID-19 on green investment funds. The global nature of both the green securities market and the pandemic makes this study particularly relevant. As noted by Goodell (2020), COVID-19 can lead to a long-term shift in the costs of equity, which can greatly affect financial markets. Consequently, a large increase in perceived equity risk is reasonably expected for financial assets, including green assets.

We make a contribution by demonstrating the heterogeneous effect of the pandemic and by considering explicitly how different measures of COVID-19 impacted green assets. First, we show evidence that economic support due to COVID-19 has a positive effect on green assets, but mainly when the returns are negative (at the lower quantiles). Second, we report that stringency owing to the pandemic is also positively associated with green investment funds, but again, for negative returns. Third, the effect of confirmed deaths is not as strong and shows up mainly at the lower quantiles. Finally, the infectious disease equity market volatility index of Baker et al. (2020) shows a negative link, but mainly for AMUNDI and at the upper quantiles. This evidence is confirmed by accounting for the broader macroeconomic environment and by the findings in the battery of sub-sample tests that we run to gain further insights regarding the main determinants of the returns in the green investment funds market. Particularly, our main findings hold and are reinforced post−2016, in a sample period that excludes the global financial and European sovereign debt crises. This robustness result shows that the impact of COVID-19 is not weakened by the use of a long time span (2009–2012), with the health crisis period applying basically towards the end of the sample.

In a nutshell, using a unique daily data set for the period from November 12, 2009, to March 31, 2022, for the three largest green investment funds, namely, *BNP PARIBAS Funds Climate Impact*, *Nordea Global Climate & Environment,* and *AMUNDI Funds Global Ecology ESG*, we first show that the influence of COVID-19 on green assets is greatly more substantial when green asset returns are negative (at the lower quantiles) than when they are positive (at the higher quantiles). This is an important result as it shows that the effect of the pandemic is more pronounced when the green asset market is weak, which can be essential information for investors and policymakers. Second, we account for the broader macroeconomic environment and show that long-term interest rates have the expected positive coefficient, with breakeven inflation having a negative connection but mainly at the upper quantiles. Equity market volatility is found to have a negative effect when the green fund returns are negative, while for positive returns the effect is positive.

The remainder of the paper is structured as follows. Section 2 reviews relevant studies. In Section 3, we describe our empirical methodology. Section 4 identifies the data sources, describes the sample selection, and reports the summary statistics. In Section 5, we present the findings of the empirical analysis, and the final section provides our summary and concluding remarks.

2. Literature review

Numerous recent studies have emerged that highlight the growing interest of investors in eco-friendly firms and corporate and sovereign green bonds. Following OECD (2017) it has been well documented that the transition path to a climate-resilient economy requires allocating financial resources from fossil energies to green projects. This would provide new green finance opportunities for individual and institutional investors. Our research is closely related to the burgeoning literature on green assets with a significant number of recent contributions investigating the consequences of the green designation on the pricing of bonds. Pastor et al. (2021) develop an equilibrium model to study the financial and real effects of sustainable investments that consider environmental, social, and governance (ESG) criteria. The model features many heterogeneous firms and agents since firms differ in the sustainability of their activities. Thus, "green" firms generate positive externalities for society, whereas "brown" firms impose negative externalities. Agents differ in their preferences for sustainability. Moreover, agents derive utility from holding green firms and disutility from holding brown firms, and agents certainly care about financial wealth. Pastor et al. (2021) show that green assets have negative CAPM alphas, whereas brown assets have positive alphas. Therefore, agents' price green firms higher, implying that they are willing to accept lower expected returns but they are not unhappy because they derive utility from their holdings.

In a follow-up paper, Pastor et al. (2022) employ the equilibrium model of Pastor et al. (2021) to further explore the performance of green assets since it is a stylized fact that they have delivered high returns in recent years. Pastor et al. (2022) argue that this performance reflects an unexpectedly strong increase in environmental concerns, rather than high returns, and this argument holds for both the case of German green bonds and US green stocks. However, despite the recorded outperformance, the authors estimate lower expected returns for green stocks than for conventional ones both *ex ante*, using the implied cost of capital, and *ex post*, using realized returns purged of shocks from climate concerns and earnings. This finding is consistent with the theory, whereby the introduction of a green factor explains much of value stocks' underperformance.

Barber et al. (2021) confirm that green assets underperform brown assets since social norms lead investors to demand compensation for holding assets that are issued to finance eco-friendly projects. Barber et al. (2021) explore these arguments by employing data from venture capital funds. They show that investors derive nonpecuniary utility from investing in dual-objective venture capital funds, thus sacrificing returns. Furthermore, the authors find that venture capital funds that have the objectives of earning financial returns while having a social impact earn lower returns than other funds. Shackleton et al. (2022) examine the dynamic relation between the environmental and social performance of a firm and its stock market returns. They find strong evidence that worse stock market performance increases firms' efforts on environmental and social activities. Moreover, their finding that poor stock market performance precedes enhanced ES performance is mainly detected in firms with substantial financial slack, in firms with higher customer awareness, in firms with intense shareholder activism on ES issues, and finally during the post-financial crisis period.

Baker et al. (2022) investigate the pricing and ownership characteristics of US municipal and corporate green bonds during the 2013–2018 period. Accounting for several bond and credit market characteristics, the authors show that municipal green bonds are priced at a premium of five to nine basis points (bps) relative to bonds with similar attributes that lack a green designation, but mainly in the secondary market. This premium can be explained by a subset of investors that have a nonpecuniary component of utility, such as a sense of social responsibility, from holding green bonds. These environmentally conscious investors with green preferences bid up the price and thus affect the valuations of these bonds. Given the transaction costs, the authors further argue that the premium would be too small for arbitrage to take place. Regarding ownership, Baker et al. (2022) note that green bonds have more concentrated ownership, especially smaller ones and those with low risk.

Zerbib (2019) even more carefully examined the possibility of a green bond premium. Specifically, the author identifies the effect of the nonpecuniary component of utility by the use of a very tight matching methodology, in which he pins down the yield of an equivalent synthetic standard bond (brown bond) for each green bond issued in the secondary market during 2013–2017. To this end, the author considers a counterfactual conventional bond from the same issuer, having the same maturity, currency, rating, liquidity, bond structure, seniority, collateral, and coupon type, as well as a limited difference in issue date and size. Zerbib finds that green bonds are priced at a small premium of two bps relative to conventional bonds. Furthermore, this premium is more pronounced for financial and low-rated bonds.

Tang and Zhang (2020) analyze global corporate green bonds and confirm a positive stock market reaction to green bond issuance. Furthermore, institutional ownership, especially by domestic institutions, and stock liquidity increase after a green bond issue. In a similar spirit, Flammer (2021) examines green corporate bonds and shows that these bonds have become increasingly popular in recent years, especially in China, the US, and Europe. Importantly, the author puts forward three hypotheses regarding the rationale for issuing green bonds instead of conventional bonds. First, *the signaling argument* says that green bonds may give a credible signal of firms' commitment to finance climate-friendly projects. Second, the *greenwashing argument* states that firms issue green bonds to show that they are committed to the environment, but in practice they do not genuinely take on green projects. Third, the *cost of capital argument* considers green bonds as a form of accessing capital markets to obtain cheaper financing. Flammer's empirical findings are consistent with the signaling argument and do not corroborate the greenwashing hypothesis. Specifically, there is a positive abnormal stock market reaction to the issuance of bonds (a significant cumulative abnormal return (CAR) of 0.49 %), which is stronger for green bonds that are certified by independent third parties and for first-time issuers. Moreover, ownership of green bonds is mainly composed of long-term investors and green investors post-issuance, which again presents evidence for the signaling argument. As for the cost of capital argument, the results do not support this hypothesis as there is no pricing difference between green and conventional bonds.

Fatica et al. (2021) use a worldwide sample of data over the 2007–2018 period to investigate whether different types of issuers matter for the premium (or discount) of green bonds in the primary market. The authors find several interesting results, with their baseline findings being as follows. First, they find that over the entire sample, green bonds are priced at a moderate premium (albeit not statistically significant) relative to bonds that lack the green designation. More interestingly, Fatica et al. (2021) find that green bonds carry a premium, which is heterogeneous across types of issuers. Specifically, looking across different issuers they document a premium of 80 bps for green bonds issued by supranational institutions and a premium of 21 bps for green bonds issued by non-financial corporations (the premium is statistically significant in both cases). This premium can be sizeable for supranational institutions, being around 15 % of the average yield of conventional bonds issued by supranationals. On the other hand, for corporates this premium is rather small, at around 4.5 % of the average yield of conventional bonds issued by corporates. By contrast, for financial institutions, there is no evidence of premium compared to standard bonds. The authors attribute the differences in the premiums across issuer types to the strong reputation of supranational institutions as opposed to corporates and financial institutions. Due to information asymmetry on the use of funds raised by the financial issuer, there are inherent difficulties in tracing the proceeds of the bond to specific green projects.

In a similar vein, Flammer (2021) analyzes the financing of climate-friendly projects through the issuance of corporate green bonds, which are a relatively new instrument in sustainable finance. As recent literature has shown, the rational for such an increase in green bonds is that eco-friendly behavior has certain benefits for firms in the long run, and possibly even in the short run. Moreover, this rationale is consistent with the positive relation between ESG and performance and the negative relation between ESG and risk. Flammer (2021) underlines that corporate green bonds have become increasingly popular in recent years. Furthermore, it is well documented that corporate green bonds are more prevalent in those industries in which the environment is a central element in the firm's operations. Finally, based on recent experience, green bond markets are flourishing in China, the US, and Europe. Flammer (2021) analyzes the degree of responsiveness of the stock market to the issuance of corporate green bonds and finds strong evidence that the stock market responds positively to the announcement effect, whereby this response is more pronounced for green bonds that are certified by independent third parties and first-time issuers.

Our paper relates particularly to another strand of the literature on the interaction between green assets and traditional financial markets such as treasury bonds, stocks and commodities. Reboredo (2018) examined the existence of co-movement between the green bond and financial markets to determine the dependence structure of the green bond market with alternative financial markets. Employing the copulas approach and data based on four global green indices showed that investors compare returns and volatility of green bonds with alternative investments. The main finding of the analysis was that there are weak spillovers between green bonds and stocks and energy commodities, implying important diversification benefits, whereas the diversification benefits are negligible for the case of green, corporate, and treasury bond markets. Reboredo and Ugolini (2020) further studied the price connectedness between the green bond and financial markets using a structural VAR model. They find that there are significant price spillovers from the fixed-income and currency markets, and while there are negligible reverse effects, there is a weak connection between green bonds and high-yield corporate bonds.

Within this framework, perhaps the contribution that best matches our paper is from Hammoudeh et al. (2020), who examined the time-varying nature of the causal relationship between green bonds and other financial and commodities assets during the 2014–2020 period by applying a novel time-varying Granger causality. Overall, the results reflect the time-varying nature of the causal relationship. Specifically, Hammoudeh et al. (2020) find that there is a significant causality running from the US 10-year Treasury bond index to green bonds from the end of 2016 to February 2020. In addition, they reveal a significant time-varying running for the CO2 emission allowances price to green bonds during the period from 30 July 2014 to the end of December 2015. A final result is related to the causality that runs from the clean energy index to green bonds, which was detected only for the year 2019.

3. Empirical methodology

To pin down the actual effect of COVID-19 on green investment funds, we adopt quantile regressions in the period before and during the COVID-19 pandemic. Quantile regression is a useful tool in risk modeling as it provides significant insight into empirical analysis in finance. The quantile regression approach allows for a heterogenous impact and thus provides a more comprehensive picture of the effect of COVID-19 on the entire distribution of returns as opposed to standard conditional mean regressions. For example, with ordinary least squares (OLS), one concludes that despite the different levels of returns, the various economic forces affect green funds in the same way. Instead, with quantile regression, we can identify the possibly non-linear COVID-19 effect on green assets. Moreover, quantile regressions are less sensitive to outliers and make no assumption about the distribution of the data. All the above are important advantages in the context of financial data and in our study of green funds. Specifically, the quantile regression under study takes the following form:

$$r_t^{green} = \alpha_\tau + \beta_\tau COVID19_{t-1} + \delta_\tau VIX_{t-1} + \zeta_\tau Bond_{t-1} + \varrho_\tau \pi^e_{t-1} + \varepsilon_{\tau,t}, \quad (1)$$

$$\tau \in (0,1)$$

where r_t^{green} refers to the return on the green investment fund, while $COVID19_t$ is an indicator of the COVID-19 pandemic. We use four measures of COVID-19, namely the Stringency Index, Economic Support Index, and the number of reported Confirmed Deaths obtained from the Blavatnik School of Government, Oxford University, and the Covid−19 Government Response Tracker. In practice, we use averages of these indicators for the following countries: Australia, Canada, Denmark,

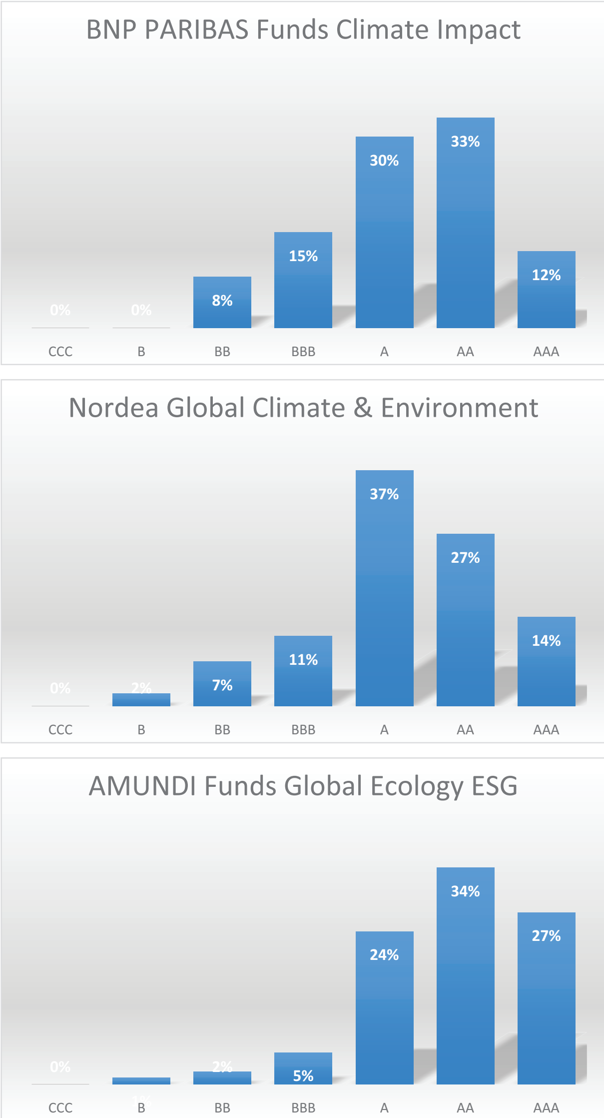

Fig. 1. Green investment funds: MSCI ESG rating distribution of fund holdings.

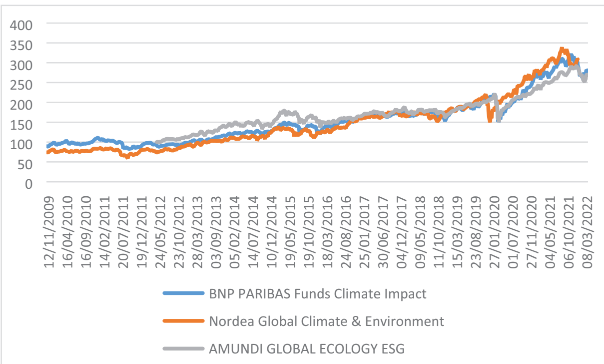

Fig. 2. Green investment fund dynamics, prices.

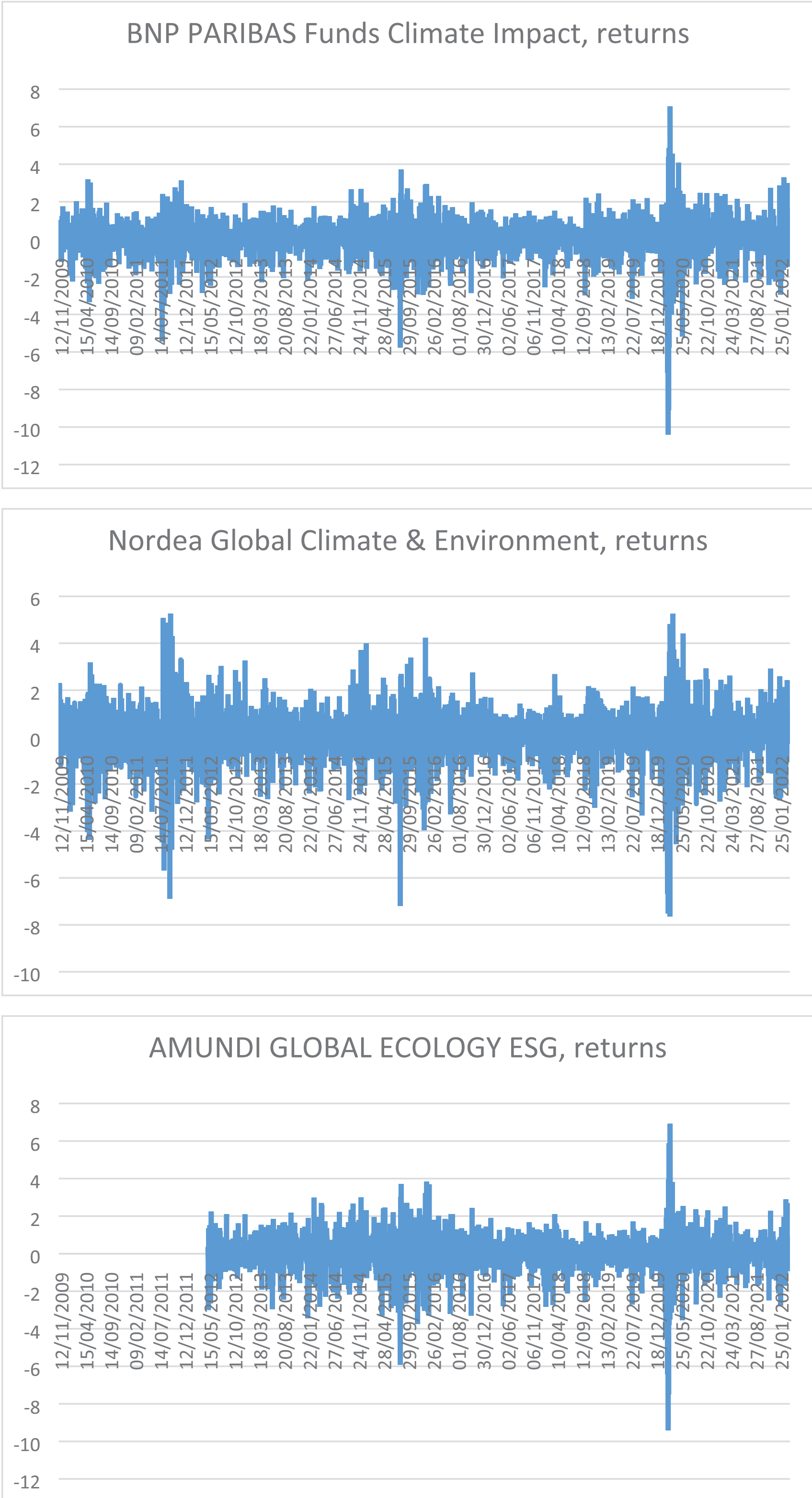

Fig. 3. Green investment fund dynamics, returns.

Fig. 4. COVID-19 indices.

Germany, France, Japan, Netherlands, Norway, Spain, Taiwan, the United Kingdom, and the United States. These are countries in which most of the leading companies in climate change solutions are headquartered. Finally, we also employ the Infectious Disease Equity Market Volatility (ID-EMV) index of Baker et al. (2020). As shown in Table 3, all four COVID-19

Table 1
Correlations among green investment fund returns.

	BNP PARIBAS	Nordea	AMUNDI
BNP PARIBAS	1		
Nordea	0.70***	1	
AMUNDI	0.87***	0.70***	1

This table gives the estimated correlations among the three green investment fund returns of interest. Sample period: Daily data over Nov 12, 2009- Mar 31, 2022 (May 14, 2012-Mar 31, 2022 for AMUNDI). (***) indicates statistical significance at the 1% level.

Table 2
Descriptive statistics of green investment fund returns.

	BNP PARIBAS	Nordea	AMUNDI
Mean	0.036	0.044	0.039
Std. Dev.	0.992	1.111	0.995
IQR	1.015	1.170	1.008
Skewness	−0.972	−0.528	−0.792
Kurtosis	13.01	7.890	11.20
Jarque-Bera	13401***	3102***	7140***
Ljung-Box autocorrelation	7.723**	12.36***	2.819*
ARCH (p-values)	0.000	0.000	0.000
ADF (p-values)	0.000	0.000	0.000

This table gives the descriptive statistics of green investment fund returns. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

Table 3
Correlations among COVID-19 indicators.

	Economic Support	Stringency	Confirmed deaths	Infectious disease
Economic Support	1			
Stringency	0.97***	1		
Confirmed deaths	0.70***	0.78***	1	
Infectious disease	0.78***	0.80***	0.49***	1

This table gives the estimated correlations among the four COVID-19 indicators of interest. Sample period: Daily data over Nov 12, 2009- Mar 31, 2022. (***) indicates statistical significance at the 1% level.

indicators are generally highly correlated, so we introduce them into the regressions separately to establish their relative importance.[2]

As highlighted in the literature review section, our paper relates particularly to studies on the interaction between green assets and financial markets. We control for the general mood in financial markets as captured by the CBOE Volatility Index,VIX_t. Moreover, to account for the broader macroeconomic environment, we include the 10-year US Treasury Bond Rate, $Bond_t$, and Inflation Expectations among market participants, as proxied by the 10-year Breakeven Inflation Rate, π_t^e.

The parameter vector $(\alpha_\tau, \beta_\tau, \delta_\tau, \zeta_\tau, \varrho_\tau)$ is associated with the τ –quantile, whereas $\varepsilon_{\tau,t}$ is the error term allowed to have a different distribution across quantiles. To avoid simultaneity issues, all explanatory variables are lagged by one time period.[3]

Furthermore, to obtain a sufficiently detailed picture of the green fund return dynamics, we analyze a fine grid of quantiles, $\tau = (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9)$. This is to understand how far from the median we have to be until the behavior of the green asset return differs.

The above quantile function is estimated by minimizing a weighted sum of absolute residuals, where the weights are functions of the quantile of interest. The coefficient estimates are computed using linear programming methods (for more details, see Koenker, 2005).

[2] We also investigated the Google Mobility Data but could not obtain a long daily frequency sample to fit our analysis.
[3] Introducing a second lag is not necessary as it does not qualitatively alter the results reported in Section 5. Thus, we maintain parsimony by settling with the first lag.

Table 4
Quantile regression BNP PARIBAS.

Panel A: COVID-19 measured by *economic support*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.001	0.002	0.001	0.001	0.001	0.0003	0.001	0.0003	−5E−05
	(0.369)	(1.352)	(0.478)	(0.630)	(0.849)	(0.249)	(1.016)	(0.255)	(−0.043)
VIX	−0.064***	−0.036***	−0.016***	−0.009**	0.003	0.018***	0.026***	0.039***	0.052***
	(−11.84)	(−3.817)	(−3.058)	(−2.117)	(0.667)	(3.466)	(6.973)	(7.808)	(12.20)
Long rate	0.225	1.342***	1.084***	0.955***	1.413***	0.749**	0.437	0.796*	0.405
	(0.282)	(2.576)	(3.355)	(2.649)	(3.440)	(2.007)	(1.260)	(1.777)	(0.557)
Breakeven	0.389***	0.075	−0.041	−0.081	−0.119**	−0.153***	−0.192***	−0.243***	−0.375***
Inflation	(3.414)	(0.895)	(−0.794)	(−1.389)	(−2.196)	(−2.813)	(−3.898)	(−3.334)	(−4.785)

Panel B: COVID-19 measured by *stringency*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Stringency	−0.002	0.001	8E−05	0.001	0.001	0.001	0.002	0.001	0.0004
	(−0.729)	(0.366)	(0.074)	(0.353)	(0.726)	(0.608)	(1.383)	(0.670)	(0.369)
VIX	−0.062***	−0.034***	−0.015***	−0.008*	0.003	0.018***	0.026***	0.038***	0.051***
	(−11.56)	(−3.853)	(−3.251)	(−1.899)	(0.731)	(3.541)	(7.063)	(7.503)	(12.44)
Long rate	0.642	1.348***	1.156***	0.987***	1.382***	0.791**	0.455	0.734	0.516
	(0.823)	(2.707)	(3.879)	(2.763)	(3.389)	(2.145)	(1.302)	(1.641)	(0.703)
Breakeven	0.374***	0.061	−0.033	−0.079	−0.120**	−0.152***	−0.191***	−0.232***	−0.391***
Inflation	(3.523)	(0.652)	(−0.652)	(−1.340)	(−2.303)	(−2.830)	(−3.964)	(−3.205)	(−4.807)

Panel C: COVID-19 measured by *confirmed deaths*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Confirmed deaths	−2E−06	−9E−07	−6E−07	−6E−07	−3E−07	2E−07	1E−06	1E−06	8E−07
	(−1.608)	(−1.060)	(−0.927)	(−0.851)	(−0.433)	(0.259)	(1.536)	(1.464)	(1.054)
VIX	−0.060***	−0.030***	−0.014***	−0.005	0.005	0.019***	0.027***	0.039***	0.051***
	(−11.07)	(−3.358)	(−3.529)	(−1.619)	(1.209)	(4.041)	(8.353)	(8.441)	(12.13)
Long rate	0.966	1.380***	1.175***	0.974***	1.397***	0.741*	0.488	0.771*	0.360
	(1.252)	(2.809)	(3.858)	(2.783)	(3.762)	(1.918)	(1.440)	(1.834)	(0.476)
Breakeven	0.452***	0.101	−0.016	−0.048	−0.123**	−0.153***	−0.209***	−0.270***	−0.409***
Inflation	(4.135)	(1.053)	(−0.302)	(−0.763)	(−2.240)	(−2.685)	(−4.010)	(−3.514)	(−4.566)

Panel D: COVID-19 measured by *infectious disease*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Infectious disease	−0.010	−0.004	−0.001	−0.0003	0.001	0.002	0.002	0.003	0.001
	(−1.338)	(−0.581)	(−0.400)	(−0.064)	(0.202)	(0.377)	(0.550)	(0.608)	(0.356)
VIX	−0.058***	−0.032***	−0.015***	−0.006	0.004	0.017***	0.027***	0.038***	0.050***
	(−11.34)	(−4.255)	(−3.508)	(−1.598)	(0.988)	(3.629)	(6.661)	(7.716)	(12.64)
Long rate	0.824	1.357***	1.191***	0.984***	1.367***	0.841**	0.534	0.724	0.418
	(1.071)	(2.772)	(4.095)	(2.681)	(3.455)	(2.250)	(1.519)	(1.607)	(0.566)
Breakeven	0.328***	0.089	−0.038	−0.074	−0.121**	−0.150***	−0.190***	−0.227***	−0.379***
Inflation	(3.004)	(0.918)	(−0.784)	(−1.265)	(−2.293)	(−2.699)	(−3.667)	(−3.024)	(−5.109)

This table shows the quantile regression results of the daily returns of the *BNP PARIBAS* green investment fund on a set of COVID-19 measures and other covariates. Sample period is Nov 12, 2009- Mar 31, 2022; *t*-ratios based on bootstrapped standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

4. Empirical results

4.1. Data and sample selection

Our empirical analysis uses data on three of the largest green investment funds, namely, *BNP PARIBAS Funds Climate Impact*, *Nordea Global Climate & Environment* and *AMUNDI Funds Global Ecology ESG*. As of May 31, 2022, these green investment funds had a total market capitalization of about 2.94bn USD, 10.66bn USD, and 3.23bn USD, respectively.[4]

Fig. 1 shows the ESG rating distribution of the fund holdings as created by MSCI, a leading provider of ESG ratings, for the green investment funds. The MSCI ESG Fund Ratings are designed to measure the ESG characteristics of a fund's underlying

[4] The data for BNP PARIBAS, Nordes and AMUNDI are obtained from:https://www.bnpparibas-am.es/inversor-particular/fundsheet/equity/bnp-paribas-funds-climate-impact-classic-c-lu0406802339/?tab=navhttps://www.nordea.es/es/private/funds/?tab=all-fundshttps://www.amundi.com/globaldistributor/product/view/LU1883319987.

holdings, ranking funds on a AAA to CCC rating scale. As can be seen, 45 % of BNP PARIBAS fund's holdings receive a rating of AAA or AA and 0 % receive a rating of B or CCC (ESG Laggards). For Nordea fund's holdings, the respective ratings are 41 % and 2 %, while for AMUNDI fund's holdings the figures are 61 % and 1 %, respectively. In sum, all three funds receive high ESG ratings, thus offering a critical tool to guide investment decisions.

We use daily end of day prices over the period from November 12, 2009, to March 31, 2022 (for AMUNDI the time span is shorter: May 14, 2012, to March 31, 2022). This sample gives rise to 3092 time series observations for the longer time span. This long sample is important in order to obtain precise estimates of our quantile regressions for the entire distribution of green asset returns.

Fig. 2 shows the evolution of the daily price indices of the three green funds over the years, while Fig. 3 plots the returns. As can be seen, there is a rapid growth in green investment funds, especially after 2020. Thus, the current study aims to uncover the effects of the COVID-19 pandemic on the dynamics of green funds.

The four COVID-19 measures (daily data) used here are plotted in Fig. 4. The Stringency index records the strictness of 'lockdown-style' policies that primarily restrict people's behavior. It is calculated using all ordinal containment and closure

Table 5
Quantile regression Nordea.

Panel A: COVID-19 measured by *economic support*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.008***	0.005***	0.005***	0.004***	0.002***	0.001	−0.001	−0.003***	−0.005**
	(3.848)	(3.868)	(4.326)	(4.306)	(4.078)	(0.541)	(−1.058)	(−2.858)	(−2.457)
VIX	−0.094***	−0.053***	−0.040***	−0.023***	−0.008*	0.006	0.019***	0.041***	0.074***
	(−8.775)	(−10.34)	(−7.175)	(−5.480)	(−1.772)	(1.054)	(4.212)	(7.195)	(7.181)
Long rate	3.434***	3.419***	3.883***	2.848***	2.149***	2.597***	2.898***	3.232***	2.995***
	(4.723)	(6.986)	(7.748)	(5.486)	(5.013)	(5.200)	(6.275)	(6.510)	(3.360)
Breakeven Inflation	0.057	0.005	−0.072	−0.049	−0.065	−0.129	−0.196***	−0.250***	−0.240**
	(0.542)	(0.072)	(−0.940)	(−0.757)	(−1.227)	(−1.604)	(−2.622)	(−3.578)	(−2.385)

Panel B: COVID-19 measured by *stringency*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Stringency	0.007***	0.005***	0.005***	0.004***	0.003***	0.001	−0.001	−0.003***	−0.003
	(3.117)	(3.630)	(3.633)	(3.829)	(4.100)	(0.542)	(−0.827)	(−2.992)	(−1.204)
VIX	−0.091***	−0.054***	−0.039***	−0.022***	−0.009**	0.006	0.019***	0.040***	0.071***
	(−8.822)	(−10.54)	(−7.266)	(−5.356)	(−2.104)	(1.091)	(4.238)	(7.289)	(6.742)
Long rate	3.421***	3.222***	3.996***	2.986***	2.182***	2.601***	2.828***	3.239***	3.151***
	(4.862)	(6.667)	(8.200)	(5.761)	(4.899)	(5.163)	(6.261)	(6.613)	(3.602)
Breakeven Inflation	0.064	−0.028	−0.089	−0.056	−0.100*	−0.130	−0.195***	−0.235***	−0.264**
	(0.587)	(−0.364)	(−1.096)	(−0.827)	(−1.791)	(−1.562)	(−2.669)	(−3.440)	(−2.552)

Panel C: COVID-19 measured by *confirmed deaths*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Confirmed deaths	3E−06**	3E−06***	2E−06***	2E−06***	1E−06**	−5E−09	−1E−06	−1E−06***	−1E−06
	(1.988)	(3.299)	(2.830)	(3.498)	(2.422)	(−0.010)	(−1.311)	(−2.750)	(−1.394)
VIX	−0.084***	−0.049***	−0.036***	−0.020***	−0.005	0.007	0.018***	0.037***	0.070***
	(−7.564)	(−9.514)	(−6.165)	(−5.187)	(−1.313)	(1.276)	(4.300)	(6.944)	(6.855)
Long rate	3.727***	3.403***	3.977***	2.807***	2.359***	2.533***	2.814***	3.373***	3.294***
	(5.316)	(6.923)	(8.631)	(5.471)	(5.141)	(5.271)	(6.138)	(6.998)	(3.915)
Breakeven Inflation	0.057	−0.055	−0.125	−0.126*	−0.139**	−0.130	−0.186**	−0.186**	−0.213**
	(0.509)	(−0.643)	(−1.506)	(−1.693)	(−2.043)	(−1.462)	(−2.494)	(−2.283)	(−1.975)

Panel D: COVID-19 measured by *infectious disease*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Infectious disease	0.019**	0.009	0.011**	0.009*	0.008**	0.004	0.001	−0.008*	−0.011
	(2.239)	(1.476)	(2.223)	(1.790)	(2.444)	(0.941)	(0.278)	(−1.916)	(−1.086)
VIX	−0.088***	−0.051***	−0.036***	−0.022***	−0.008*	0.006	0.017***	0.041***	0.071***
	(−9.594)	(−9.113)	(−7.199)	(−5.031)	(−1.826)	(1.017)	(3.706)	(6.122)	(6.635)
Long rate	3.586***	3.230***	4.049***	2.922***	2.268***	2.672***	2.859***	3.168***	3.300***
	(4.864)	(6.088)	(8.651)	(5.353)	(4.981)	(5.449)	(6.385)	(6.280)	(3.765)
Breakeven Inflation	0.122	0.025	−0.044	−0.016	−0.054	−0.133	−0.194***	−0.254***	−0.271***
	(1.131)	(0.315)	(−0.549)	(−0.236)	(−0.926)	(−1.618)	(−2.645)	(−3.550)	(−2.779)

This table shows the quantile regression results of the daily returns of the *Nordea* green investment fund on a set of COVID-19 measures and other covariates. Sample period is Nov 12, 2009- Mar 31, 2022; *t*-ratios based on bootstrapped standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

policy indicators, plus an indicator recording public information campaigns. The Economic Support index, which measures such as income support and debt relief, is calculated using ordinal economic policies indicators. We also employ the number of Confirmed Deaths. The data for these three measures are retrieved from the Blavatnik School of Government, Oxford University, and the Covid−19 Government Response Tracker. We also employ the Infectious Disease Equity Market Volatility (ID-EMV) index of Baker et al. (2020), which is a newspaper-based Infectious Disease Equity Market Volatility Tracker. As seen in Fig. 4, the first three indicators take the value of zero before the outbreak of the pandemic, and the Infectious Disease Equity Market Volatility is generally zero (or approximately zero) for the period before the COVID-19 episode. Thus, running the models for the period prior to COVID-19 would not actually provide any useful information about the effect of the pandemic on green asset returns.

Table 1 shows the correlation estimates between green investment fund returns, while Table 2 reports the descriptive statistics. The descriptive statistics are broadly similar to those of other financial assets, with excess kurtosis implying that large returns occur more often than expected and negative skewness indicating that large returns are often negative. Moreover, the green funds suffer from autocorrelation and ARCH effects, which are two issues that we deal with in the robustness section. All three data series are stationary (In Table 2 we report the *p*-values of the ADF test).

Table 6
Quantile regression AMUNDI.

Panel A: COVID-19 measured by *economic support*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.012***	0.007***	0.003**	0.001	4E−05	−0.002*	−0.003***	−0.005***	−0.009***
	(5.147)	(4.207)	(2.428)	(0.951)	(0.038)	(−1.724)	(−2.616)	(−4.318)	(−6.906)
VIX	−0.079***	−0.052***	−0.024***	−0.005	0.003	0.024***	0.033***	0.046***	0.074***
	(−5.595)	(−5.776)	(−2.791)	(−0.845)	(0.640)	(3.556)	(3.913)	(7.269)	(7.923)
Long rate	0.343	0.074	0.311	0.143	−0.056	0.270	0.185	0.024	0.574
	(0.368)	(0.109)	(0.454)	(0.297)	(−0.131)	(0.680)	(0.376)	(0.046)	(0.796)
Breakeven	0.259**	0.028	0.0001	0.012	−0.033	−0.036	−0.116*	−0.085	−0.121
Inflation	(2.577)	(0.334)	(0.001)	(0.253)	(−0.674)	(−0.808)	(−1.678)	(−1.318)	(−1.103)

Panel B: COVID-19 measured by *stringency*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Stringency	0.009***	0.006***	0.003**	0.001	0.0001	−0.002	−0.003**	−0.006***	−0.010***
	(3.636)	(3.778)	(2.100)	(0.823)	(0.114)	(−1.544)	(−2.104)	(−4.255)	(−6.467)
VIX	−0.067***	−0.047***	−0.022***	−0.004448	0.003732	0.023532	0.030418	0.046393	0.076407
	(−5.106)	(−4.733)	(−2.596)	−0.669339	0.653165	3.608673	3.630295	6.763979	8.468743
Long rate	0.637	0.138	0.391	0.126	−0.055	0.264	0.192	0.064	0.203
	(0.651)	(0.205)	(0.586)	(0.260)	(−0.130)	(0.655)	(0.392)	(0.127)	(0.267)
Breakeven	0.275**	0.020	−0.0002	0.013	−0.034	−0.016	−0.095	−0.078	−0.021
Inflation	(2.295)	(0.257)	(−0.002)	(0.274)	(−0.675)	(−0.363)	(−1.298)	(−1.201)	(−0.170)

Panel C: COVID-19 measured by *confirmed deaths*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Confirmed deaths	1E−06	2E−06**	4E−07	1E−07	−6E−08	−7E−07	−1E−06	−2E−06***	−4E−06***
	(1.163)	(2.170)	(0.427)	(0.194)	(−0.092)	(−0.894)	(−1.364)	(−2.926)	(−4.737)
VIX	−0.049***	−0.039***	−0.012*	−0.002	0.004	0.020***	0.023***	0.04***	0.072***
	(−4.881)	(−3.959)	(−1.809)	(−0.437)	(0.741)	(3.751)	(3.381)	(5.697)	(7.451)
Long rate	1.017	0.139	0.540	0.123	−0.051	0.313	0.056	−0.019	0.352
	(1.188)	(0.205)	(0.890)	(0.251)	(−0.116)	(0.703)	(0.122)	(−0.040)	(0.472)
Breakeven	0.331***	0.016	0.045	0.020	−0.023	−0.007	−0.093	−0.045	−0.002
Inflation	(3.020)	(0.177)	(0.501)	(0.385)	(−0.406)	(−0.136)	(−1.143)	(−0.554)	(−0.015)

Panel D: COVID-19 measured by *infectious disease*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Infectious disease	0.015*	0.012**	0.002	0.001	−0.001	−0.007*	−0.009**	−0.017***	−0.027***
	(1.941)	(2.243)	(0.423)	(0.185)	(−0.380)	(−1.882)	(−2.075)	(−3.312)	(−4.510)
VIX	−0.063***	−0.041***	−0.012*	−0.002	0.005	0.024***	0.028***	0.047***	0.074***
	(−5.402)	(−4.399)	(−1.650)	(−0.408)	(0.891)	(3.951)	(3.528)	(6.052)	(7.015)
Long rate	0.327	0.151	0.509	0.099	−0.019	0.344	0.223	−0.056	0.231
	(0.406)	(0.208)	(0.827)	(0.204)	(−0.044)	(0.856)	(0.489)	(−0.112)	(0.317)
Breakeven	0.388***	0.081	0.052	0.033	−0.020	−0.035	−0.151***	−0.133**	−0.249**
Inflation	(4.195)	(0.829)	(0.600)	(0.645)	(−0.409)	(−0.760)	(−2.820)	(−2.142)	(−2.386)

This table shows the quantile regression results of the daily returns of the *AMUNDI* green investment fund on a set of COVID-19 measures and other covariates. Sample period is May 14, 2012- Mar 31, 2022; *t*-ratios based on bootstrapped standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

4.2. Baseline results

The results are shown in Tables 4–6. Generally speaking, the main findings highlight that after controlling for the broader macroeconomic environment and financial market volatility, the COVID-19 pandemic has had a significant effect on the returns of green funds. Moreover, this effect is rather heterogeneous and varies across quantiles. For example, for Nordea (see Table 5) and AMUNDI (see Table 6), economic support is generally associated with an increase in the returns at the lower quantiles (corresponding to negative returns). Still, at the upper quantiles (corresponding to positive returns), economic support has a negative impact (see Panel A). Similarly, stringency due to COVID-19 is linked to an increase in the returns at the lower quantiles (for the two aforementioned green funds), while for AMUNDI in addition we find a positive effect at the upper quantiles (see Panel B). Notice that the coefficient estimates across Panels A-B are of around the same magnitude, which is expected given the high correlation between economic support and stringency (shown in Table 3).

Further, we report that the relationship between confirmed deaths and green assets is not as strong as for the other two COVID-19 indicators and mainly shows up at the lower quantiles (see Panel C of the tables). This indicates that agents per-

Table 7
Quantile regression BNP PARIBAS – post 2016 Robustness.

Panel A: COVID-19 measured by *economic support*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.007***	0.007***	0.003*	0.002	3E−07	−0.001	−0.0001	−0.002	−0.002
	(2.722)	(3.506)	(1.670)	(1.076)	(0.0001)	(−1.063)	(−0.091)	(−1.144)	(−1.324)
VIX	−0.088***	−0.064***	−0.030**	−0.011	0.013	0.029***	0.033***	0.050***	0.067***
	(−8.105)	(−5.237)	(−2.454)	(−0.985)	(1.171)	(5.084)	(5.186)	(6.461)	(5.431)
Long rate	1.457	−0.410	0.152	0.043	−0.359	−0.113	−0.352	0.098	−0.398
	(1.333)	(−0.451)	(0.224)	(0.060)	(−0.486)	(−0.162)	(−0.671)	(0.154)	(−0.382)
Breakeven	0.016	−0.095	−0.193**	−0.211**	−0.175	−0.085	−0.125	−0.074	−0.204
Inflation	(0.092)	(−0.651)	(−2.444)	(−2.253)	(−1.780)	(−0.922)	(−1.345)	(−0.613)	(−1.482)

Panel B: COVID-19 measured by *stringency*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Stringency	0.005	0.005***	0.002	0.002	0.001	−0.001	0.000	−0.001	−0.001
	(1.418)	(2.869)	(1.492)	(0.846)	(0.271)	(−0.884)	(0.210)	(−0.442)	(−0.670)
VIX	−0.086***	−0.058***	−0.025**	−0.009	0.011	0.028***	0.031***	0.048***	0.064***
	(−7.323)	(−4.499)	(−2.346)	(−0.857)	(1.003)	(4.827)	(5.509)	(6.002)	(5.863)
Long rate	0.906	−0.246	0.134	0.196	−0.257	−0.121	−0.380	0.108	−0.176
	(0.843)	(−0.275)	(0.191)	(0.267)	(−0.340)	(−0.166)	(−0.741)	(0.171)	(−0.171)
Breakeven	0.041	−0.119	−0.224**	−0.240**	−0.186*	−0.082	−0.134	−0.090	−0.238
Inflation	(0.198)	(−0.750)	(−2.341)	(−2.332)	(−1.709)	(−0.833)	(−1.379)	(−0.697)	(−1.534)

Panel C: COVID-19 measured by *confirmed deaths*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Confirmed deaths	−1E−06	1E−06	−1E−08	−1E−07	−1E−06	−6E−07	4E−07	7E−07	1E−06
	(−0.921)	(0.918)	(−0.008)	(−0.112)	(−0.773)	(−0.528)	(0.452)	(0.583)	(1.157)
VIX	−0.065***	−0.047***	−0.016*	0.000	0.016**	0.027***	0.032***	0.043***	0.050***
	(−6.694)	(−3.406)	(−1.746)	(0.032)	(2.029)	(5.079)	(6.641)	(5.991)	(5.195)
Long rate	0.512	0.082	0.332	0.151	−0.074	−0.020	−0.380	−0.028	−0.236
	(0.490)	(0.092)	(0.481)	(0.212)	(−0.103)	(−0.026)	(−0.709)	(−0.045)	(−0.238)
Breakeven	0.445*	−0.022	−0.108	−0.177	−0.074	−0.083	−0.140	−0.207	−0.478**
Inflation	(1.788)	(−0.127)	(−0.885)	(−1.344)	(−0.582)	(−0.693)	(−1.309)	(−1.341)	(−2.291)

Panel D: COVID-19 measured by *infectious disease*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Infectious disease	−0.005	0.004	0.001	−0.002	−0.003	−0.007	−0.004	−0.005	−0.004
	(−0.589)	(0.642)	(0.152)	(−0.341)	(−0.509)	(−1.400)	(−0.711)	(−0.800)	(−0.741)
VIX	−0.063***	−0.044***	−0.017*	0.001	0.016*	0.031***	0.037***	0.050***	0.063***
	(−6.375)	(−3.754)	(−1.925)	(0.090)	(1.765)	(4.750)	(5.246)	(6.226)	(6.380)
Long rate	0.857	−0.040	0.280	0.200	−0.107	−0.248	−0.259	0.164	−0.806
	(0.781)	(−0.044)	(0.397)	(0.274)	(−0.144)	(−0.349)	(−0.467)	(0.250)	(−0.812)
Breakeven	0.251*	0.066	−0.106	−0.176*	−0.145	−0.082	−0.100	−0.120	−0.242*
Inflation	(1.662)	(0.429)	(−1.186)	(−1.906)	(−1.299)	(−0.925)	(−1.102)	(−1.005)	(−1.892)

This table shows the quantile regression results of the daily returns of the *BNP PARIBAS* green investment fund on a set of COVID-19 measures and other covariates. Sample period is January 4, 2016- Mar 31, 2022; *t*-ratios based on bootstrapped standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

Table 8
Quantile regression Nordea – post 2016 robustness.

Panel A: COVID-19 measured by *economic support*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.011***	0.008***	0.007***	0.005***	0.003***	0.002*	0.001	−0.001	−0.003
	(4.209)	(4.322)	(3.693)	(3.761)	(2.944)	(1.867)	(0.425)	(−0.886)	(−1.080)
VIX	−0.109***	−0.066***	−0.048***	−0.027***	−0.012*	0.002	0.014	0.036***	0.070***
	(−7.294)	(−7.608)	(−4.429)	(−3.496)	(−1.747)	(0.269)	(1.605)	(3.542)	(4.917)
Long rate	3.417***	3.023***	2.397**	1.089	0.848	0.944*	1.538**	2.597***	1.788
	(3.257)	(3.494)	(2.418)	(1.522)	(1.606)	(1.852)	(1.991)	(3.634)	(1.443)
Breakeven	−0.033	−0.035	−0.064	−0.081	−0.098	−0.215**	−0.289***	−0.321***	−0.394***
Inflation	(−0.197)	(−0.327)	(−0.585)	(−0.895)	(−1.476)	(−2.281)	(−3.536)	(−3.458)	(−2.766)

Panel B: COVID-19 measured by *stringency*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Stringency	0.008***	0.007***	0.007***	0.005***	0.004***	0.003**	0.001	−0.001	−0.001
	(2.961)	(4.262)	(3.163)	(3.515)	(2.961)	(2.072)	(0.626)	(−0.533)	(−0.194)
VIX	−0.099***	−0.061***	−0.049***	−0.028***	−0.012*	0.001	0.013	0.034***	0.060***
	(−7.274)	(−7.851)	(−4.146)	(−3.942)	(−1.694)	(0.179)	(1.572)	(3.486)	(4.166)
Long rate	3.489***	2.985***	2.062**	1.119	0.916*	0.931*	1.595**	2.845***	2.384*
	(3.343)	(3.300)	(2.084)	(1.578)	(1.713)	(1.783)	(2.049)	(3.803)	(1.916)
Breakeven	−0.015	−0.062	−0.118	−0.085	−0.148*	−0.278**	−0.301***	−0.332***	−0.478***
Inflation	(−0.077)	(−0.543)	(−0.878)	(−0.858)	(−1.938)	(−2.495)	(−3.238)	(−3.272)	(−3.241)

Panel C: COVID-19 measured by *confirmed deaths*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Confirmed deaths	2E−06	3E−06**	2E−06	3E−06***	2E−06**	2E−06**	1E−06	8E−07	1E−06
	(1.138)	(2.487)	(1.528)	(3.693)	(2.287)	(1.963)	(0.718)	(0.655)	(0.465)
VIX	−0.087***	−0.051***	−0.033***	−0.022***	−0.009	0.003	0.013*	0.028***	0.052***
	(−6.484)	(−6.576)	(−3.162)	(−3.776)	(−1.339)	(0.399)	(1.687)	(3.179)	(3.547)
Long rate	3.817***	2.766***	2.053**	1.557**	0.948*	1.006**	1.603**	2.778***	2.780**
	(3.775)	(2.946)	(2.011)	(2.200)	(1.868)	(2.146)	(2.141)	(3.636)	(2.232)
Breakeven	0.129	−0.099	−0.072	−0.221*	−0.246**	−0.387***	−0.368**	−0.423***	−0.581***
Inflation	(0.672)	(−0.627)	(−0.467)	(−1.950)	(−2.014)	(−2.605)	(−2.479)	(−3.002)	(−3.888)

Panel D: COVID-19 measured by *infectious disease*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Infectious disease	0.017**	0.013*	0.008	0.008	0.007	0.010*	0.008	0.000	−0.006
	(2.051)	(1.854)	(1.453)	(1.361)	(1.503)	(1.893)	(1.220)	(0.024)	(−0.576)
VIX	−0.091***	−0.056***	−0.033***	−0.020***	−0.007	0.001	0.008	0.030***	0.064***
	(−9.173)	(−7.100)	(−3.154)	(−3.034)	(−1.236)	(0.121)	(0.953)	(2.837)	(4.797)
Long rate	3.814***	2.491**	1.899*	1.306*	0.914	0.931*	1.258	2.872***	2.242*
	(3.653)	(2.427)	(1.770)	(1.743)	(1.632)	(1.754)	(1.642)	(3.739)	(1.877)
Breakeven	0.183	0.131	0.087	0.017	−0.067	−0.179*	−0.272***	−0.343***	−0.462***
Inflation	(1.085)	(1.043)	(0.801)	(0.175)	(−0.848)	(−1.886)	(−3.013)	(−3.712)	(−3.176)

This table shows the quantile regression results of the daily returns of the *Nordea* green investment fund on a set of COVID-19 measures and other covariates. Sample period is January 4, 2016- Mar 31, 2022; *t*-ratios based on bootstrapped standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

ceive that economic support and stringency measures are more relevant for green asset markets as opposed to the effect of confirmed deaths. Furthermore, we find that the infectious disease equity market volatility implies a negative link, but mainly for AMUNDI and at the upper quantiles (see Panel D of the tables). Nevertheless, for the BNP PARIBAS green funds, surprisingly, none of the COVID-19 indicators is found to have had a significant effect at any of the quantiles (see Table 4).

Turning to the rest of the regressors, long-term bond rates ($Bond_t$) appear to have a positive effect, confirming the negative relationship between interest rates and bond prices (put differently, the positive relation between interest rates and bond returns).[5] Equity market volatility measured by the VIX_t has a negative effect at the lower quantiles of returns, while for positive returns the effect is positive. Thus, when green fund returns are large and positive, then the larger the risk, the larger the return. This confirms the positive risk-return relationship that we would expect from asset pricing models such as CAPM. However, when green fund returns are negative, the VIX_t has a negative impact, the reason being that during the pandemic

[5] We also employed the short-rate as measured by the 3-month Treasury bill, but this turned out to be less informative than the 10-year US Treasury bond rate.

there is stronger fear in financial markets, so agents would need an extra premium to hold green assets (a similar result was found for US market portfolios by Aslanidis et al., 2021). As expected, breakeven inflation implies a negative connection with green asset returns, but mainly at the upper quantiles.

One may wonder whether the use of a long time span (2009–2012) with a health crisis period towards the end of the sample actually weakens the significant effect of COVID-19 on the returns of green funds. In the next section, we deal with this question by examining the robustness of our results when we re-focus the analysis to the post−2016 period, a shorter period but without any major macroeconomic or financial turmoil.

4.3. Robustness

In this section, we check the robustness of our results by accounting for the role of global shocks, such as the effect of financial turbulent periods on the relationship under study. To this end, we adjust our sample to isolate periods of financial turmoil by focusing our analysis on the period after 2016 (from Jan 4, 2016, to Mar 31, 2022) and rerun all previous quantile

Table 9
Quantile regression AMUNDI – post 2016 robustness.

Panel A: COVID-19 measured by *economic support*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.012***	0.007***	0.004**	0.001	0.0002	−0.001	−0.002*	−0.004***	−0.006***
	(4.816)	(4.416)	(2.011)	(1.174)	(0.160)	(−0.955)	(−1.746)	(−3.558)	(−3.553)
VIX	−0.084***	−0.058***	−0.027**	−0.008	0.004	0.022**	0.032***	0.043***	0.062***
	(−5.653)	(−5.654)	(−2.161)	(−0.979)	(0.589)	(2.550)	(3.590)	(6.441)	(6.014)
Long rate	0.626	0.524	0.138	0.002	−0.380	0.365	0.214	−0.740	−0.615
	(0.512)	(0.803)	(0.182)	(0.004)	(−0.635)	(0.636)	(0.310)	(−1.159)	(−0.713)
Breakeven	0.017	0.014	−0.044	−0.008	−0.040	−0.034	−0.056	−0.054	−0.112
Inflation	(0.116)	(0.126)	(−0.433)	(−0.116)	(−0.520)	(−0.484)	(−0.716)	(−0.568)	(−1.112)

Panel B: COVID-19 measured by *stringency*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Stringency	0.009***	0.007***	0.002	0.001	0.0003	−0.001	−0.002	−0.004***	−0.006***
	(3.154)	(3.742)	(1.375)	(1.054)	(0.231)	(−0.866)	(−1.285)	(−2.763)	(−2.801)
VIX	−0.072***	−0.052***	−0.019*	−0.008	0.004	0.021***	0.029***	0.040***	0.061***
	(−4.765)	(−4.607)	(−1.766)	(−0.978)	(0.580)	(2.649)	(3.346)	(5.561)	(5.372)
Long rate	2.117	0.548	0.552	0.054	−0.373	0.378	0.234	−0.706	−0.708
	(1.609)	(0.785)	(0.741)	(0.085)	(−0.610)	(0.643)	(0.367)	(−1.059)	(−0.880)
Breakeven	0.031	−0.024	−0.005	−0.017	−0.040	−0.032	−0.068	−0.034	−0.030
Inflation	(0.151)	(−0.230)	(−0.043)	(−0.204)	(−0.475)	(−0.404)	(−0.757)	(−0.361)	(−0.233)

Panel C: COVID-19 measured by *confirmed deaths*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Confirmed deaths	1E−06	2E−06	3E−07	4E−07	−4E−07	−3E−07	−1E−06	−1E−06	−1E−06
	(0.607)	(1.621)	(0.311)	(0.421)	(−0.427)	(−0.245)	(−0.975)	(−1.363)	(−1.556)
VIX	−0.050***	−0.038***	−0.012	−0.003	0.006	0.017**	0.026***	0.033***	0.050***
	(−4.995)	(−3.762)	(−1.411)	(−0.446)	(0.918)	(2.435)	(3.396)	(5.006)	(5.737)
Long rate	2.313**	0.720	0.494	−0.092	−0.405	0.410	0.123	−0.539	−0.891
	(2.308)	(0.925)	(0.726)	(−0.131)	(−0.680)	(0.690)	(0.195)	(−0.814)	(−1.063)
Breakeven	0.318	0.009	0.031	−0.010	0.027	−0.032	−0.019	−0.044	−0.065
Inflation	(1.232)	(0.071)	(0.251)	(−0.101)	(0.228)	(−0.259)	(−0.145)	(−0.334)	(−0.399)

Panel D: COVID-19 measured by *infectious disease*

	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Infectious disease	0.006	0.010*	−0.0002	−0.0003	−0.003	−0.006	−0.008*	−0.010*	−0.012**
	(0.707)	(1.667)	(−0.039)	(−0.056)	(−0.868)	(−1.612)	(−1.784)	(−1.872)	(−2.339)
VIX	−0.054***	−0.041***	−0.010	−0.001	0.008	0.023***	0.030***	0.040***	0.055***
	(−4.935)	(−4.274)	(−1.309)	(−0.204)	(1.221)	(3.466)	(3.917)	(4.918)	(7.085)
Long rate	2.071*	0.800	0.503	−0.054	−0.461	0.372	0.213	−0.562	−0.961
	(1.732)	(1.080)	(0.766)	(−0.080)	(−0.762)	(0.614)	(0.335)	(−0.828)	(−1.310)
Breakeven	0.434***	0.139	0.064	0.019	−0.019	−0.032	−0.112*	−0.157	−0.219**
Inflation	(2.934)	(1.176)	(0.651)	(0.256)	(−0.312)	(−0.462)	(−1.764)	(−1.540)	(−2.302)

This table shows the quantile regression results of the daily returns of the *AMUNDI* green investment fund on a set of COVID-19 measures and other covariates. Sample period is January 4, 2016- Mar 31, 2022; *t*-ratios based on bootstrapped standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

regressions. Basically, this sample excludes the last part of the global financial crisis period (recall that for BNP PARIBAS and Nordea, our baseline results are obtained for the period of November 2009-March 2022) and the period of the European sovereign debt crisis from 2009 to about the mid−2010 s.

The robustness results are reported in Tables 7−9. As can be seen, our main findings strongly hold and in several cases are even more clear-cut. Specifically, the COVID-19 indicators have a positive effect, being significant mainly at the lower quantiles. As opposed to the previous results, for the BNP PARIBAS fund, the effect now turns out to be more pronounced and statistically significant. Additionally, the results for the control variables (long-term bond rates, equity market volatility, and breakeven inflation) remain very similar to the baseline results reported in Tables 4−6.

As mentioned previously (Section 4.1), taking a sample split approach (before vs after the pandemic) would not actually provide any useful information about the effect of the pandemic on green asset returns as the COVID-19 indicators are generally zero for the period before the pandemic. Still, for the period after COVID-19, we have obtained results that look similar to our baseline results (these results are available upon request).

Some authors may argue for a positive relationship between green assets and oil prices as a result of the substitution effect (see e.g., Kumar et al., 2012; Managi and Okimoto, 2013; Sadorsky, 2012). To take into consideration the oil market, we employ the CBOE crude oil ETF volatility index as a different measure of market volatility from the CBOE Volatility Index,VIX_t. We find that the CBOE crude oil ETF volatility turns out to be less informative than VIX_t (results are available upon request). Moreover, we extend our quantile regression analysis to include crude oil price returns as an additional explanatory variable. The models are run for the case when economic support is used as a measure of COVID-19, and the results are

Table 10
Quantile regression extensions robustness.

Panel A: *BNP PARIBAS*									
	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.002	0.002	0.0005	0.001	0.001	0.001	0.001	0.0003	−0.0002
	(0.968)	(1.192)	(0.430)	(0.653)	(0.961)	(0.431)	(1.334)	(0.256)	(−0.191)
VIX	−0.064***	−0.036***	−0.016**	−0.010*	0.003	0.015***	0.025***	0.039***	0.052***
	(−8.734)	(−3.656)	(−2.541)	(−1.915)	(0.492)	(2.997)	(6.388)	(7.461)	(9.649)
Long rate	−0.180	1.446**	1.029***	0.935**	1.513***	0.774**	0.539	0.790**	0.554
	(−0.240)	(2.559)	(2.652)	(2.314)	(2.983)	(1.997)	(1.455)	(2.091)	(0.838)
Breakeven	0.307***	0.089	−0.054	−0.083	−0.118*	−0.126**	−0.192***	−0.242***	−0.372***
Inflation	(2.697)	(1.061)	(−0.931)	(−1.420)	(−1.849)	(−2.046)	(−3.152)	(−2.942)	(−4.881)
Oil price returns	0.039*	0.027*	0.006	0.001	−0.005	−0.013	−0.005	0.001	−0.001
	(1.945)	(1.668)	(0.655)	(0.138)	(−0.510)	(−1.433)	(−0.900)	(0.103)	(−0.052)
Panel B: *Nordea*									
	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.008***	0.005***	0.005***	0.004***	0.002***	0.001	−0.001	−0.003***	−0.006***
	(4.139)	(3.954)	(4.662)	(4.239)	(3.436)	(0.553)	(−1.580)	(−3.004)	(−2.594)
VIX	−0.093***	−0.053***	−0.041***	−0.023***	−0.008*	0.008	0.020***	0.041***	0.072***
	(−8.450)	(−9.982)	(−6.519)	(−4.325)	(−1.688)	(1.367)	(4.247)	(5.868)	(6.494)
Long rate	3.084***	3.272***	3.906***	2.901***	2.188***	2.509***	2.769***	3.167***	3.422***
	(3.641)	(6.425)	(6.975)	(5.888)	(5.363)	(4.312)	(5.557)	(6.749)	(3.896)
Breakeven	0.093	−0.013	−0.065	−0.053	−0.081	−0.156*	−0.242***	−0.213***	−0.252**
Inflation	(0.798)	(−0.158)	(−0.793)	(−0.757)	(−1.239)	(−1.914)	(−3.070)	(−3.044)	(−2.528)
Oil price returns	0.035*	0.018*	0.005	−0.001	0.003	0.010	0.013	0.018*	0.003
	(1.726)	(1.790)	(0.378)	(−0.051)	(0.438)	(1.060)	(1.612)	(1.772)	(0.206)
Panel C: *AMUNDI*									
	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Economic support	0.012***	0.006***	0.003**	0.001	0.0001	−0.002	−0.004***	−0.006***	−0.010***
	(5.108)	(4.317)	(2.265)	(1.066)	(0.108)	(−1.568)	(−2.848)	(−5.172)	(−6.958)
VIX	−0.076***	−0.051***	−0.024***	−0.005	0.003	0.023***	0.035***	0.047***	0.074***
	(−5.452)	(−5.518)	(−2.815)	(−0.850)	(0.515)	(3.197)	(4.177)	(7.753)	(8.112)
Long rate	0.394	−0.523	0.028	0.194	0.020	0.308	0.145	0.294	0.612
	(0.416)	(−0.817)	(0.041)	(0.362)	(0.044)	(0.594)	(0.253)	(0.544)	(0.781)
Breakeven	0.230*	0.045	−0.008	0.013	−0.027	−0.042	−0.101	−0.057	−0.149
Inflation	(1.795)	(0.493)	(−0.089)	(0.214)	(−0.438)	(−0.777)	(−1.305)	(−0.783)	(−1.540)
Oil price returns	0.031*	0.021	0.009	−0.001	−0.002	−0.009	−0.005	−0.011	−0.012
	(1.693)	(1.046)	(0.635)	(−0.123)	(−0.272)	(−1.119)	(−0.550)	(−0.990)	(−0.698)

This table shows the quantile regression results of the daily returns of green investment funds on a set of COVID-19 measures and other covariates. Sample period is Nov 12, 2009- Mar 31, 2022 (for *AMUNDI* is May 14, 2012- Mar 31, 2022); t-ratios based on bootstrapped standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

Table 11
Quantile autoregression.

Panel A: *BNP PARIBAS*									
	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
AR(1)	0.162***	0.159***	0.102***	0.094***	0.064**	0.048*	0.011	−0.015	0.030
	(4.258)	(5.2881)	(3.171)	(3.647)	(2.181)	(1.860)	(0.536)	(−0.512)	(1.160)
Economic support	0.001	0.001	0.0003	0.001	0.001	0.0004	0.001	0.0002	−0.0002
	(0.511)	(1.092)	(0.273)	(0.515)	(0.757)	(0.366)	(1.036)	(0.199)	(−0.204)
VIX	−0.059***	−0.036***	−0.018***	−0.006	0.003	0.018***	0.025***	0.038***	0.054***
	(−8.653)	(−5.592)	(−3.378)	(−1.310)	(0.530)	(3.518)	(6.834)	(8.382)	(10.33)
Long rate	−0.091	0.544	0.484	0.604	1.042**	0.285	0.504	0.893**	0.216
	(−0.147)	(0.951)	(1.120)	(1.450)	(2.205)	(0.651)	(1.320)	(2.169)	(0.326)
Breakeven	0.412***	0.095	−0.025	−0.063	−0.091	−0.130**	−0.188***	−0.237***	−0.368***
Inflation	(3.951)	(1.303)	(−0.391)	(−1.047)	(−1.465)	(−2.224)	(−3.444)	(−3.653)	(−4.854)
Oil price returns	0.024	0.010	0.004	−0.005	−0.010	−0.013**	−0.005*	0.003	−0.005
	(1.626)	(0.546)	(0.450)	(−0.715)	(−0.708)	(−2.302)	(−1.765)	(1.116)	(−0.283)
Panel B: *Nordea*									
	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
AR(1)	0.172***	0.071*	0.023	0.015	0.006	0.008	−0.029	−0.032	−0.037
	(3.348)	(1.777)	(0.789)	(0.665)	(0.317)	(0.299)	(−1.273)	(−1.160)	(−1.077)
Economic support	0.007***	0.006***	0.005***	0.004***	0.002***	0.001	−0.002*	−0.003**	−0.005***
	(3.314)	(3.523)	(4.257)	(4.187)	(2.782)	(0.452)	(−1.805)	(−2.351)	(−2.811)
VIX	−0.091***	−0.054***	−0.038***	−0.023***	−0.008	0.007	0.019***	0.039***	0.069***
	(−7.118)	(−8.426)	(−6.683)	(−4.354)	(−1.603)	(1.126)	(4.825)	(6.111)	(5.331)
Long rate	2.730***	3.102***	3.702***	2.839***	2.179***	2.477***	2.967***	3.364***	3.255***
	(3.513)	(6.256)	(7.335)	(5.428)	(4.667)	(4.591)	(5.581)	(6.475)	(3.803)
Breakeven	0.156	−0.007	−0.057	−0.048	−0.075	−0.158**	−0.229***	−0.229***	−0.248***
Inflation	(1.280)	(−0.085)	(−0.718)	(−0.714)	(−1.204)	(−2.192)	(−3.604)	(−3.483)	(−2.796)
Oil price returns	0.021	0.013	0.001	−0.0002	0.003	0.009*	0.013**	0.021	0.010
	(0.803)	(0.967)	(0.112)	(−0.016)	(0.578)	(1.659)	(2.195)	(1.417)	(0.549)
Panel C: *AMUNDI*									
	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
AR(1)	0.200***	0.177***	0.124***	0.087***	0.051*	0.046	0.021	−0.017	0.024
	(6.283)	(4.471)	(3.910)	(3.487)	(1.886)	(1.507)	(0.705)	(−0.686)	(0.609)
Economic support	0.010***	0.005***	0.003**	0.001	−0.0001	−0.002	−0.004***	−0.006***	−0.010***
	(7.758)	(3.690)	(2.038)	(0.439)	(−0.138)	(−1.407)	(−3.422)	(−5.692)	(−6.922)
VIX	−0.061***	−0.044***	−0.019*	−0.001	0.005	0.023***	0.035***	0.047***	0.077***
	(−11.44)	(−4.042)	(−1.792)	(−0.128)	(0.930)	(3.317)	(5.769)	(10.36)	(6.731)
Long rate	−0.445	−0.840	−0.666	−0.354	−0.216	0.147	0.067	0.323	0.646
	(−0.599)	(−1.351)	(−0.941)	(−0.728)	(−0.454)	(0.301)	(0.129)	(0.594)	(0.834)
Breakeven	0.228**	0.106	0.044	0.024	−0.011	−0.041	−0.098	−0.050	−0.146*
Inflation	(2.323)	(1.069)	(0.592)	(0.410)	(−0.204)	(−0.744)	(−1.469)	(−0.724)	(−1.731)
Oil price returns	0.032	0.016	0.004	−0.009	−0.008	−0.009	−0.006	−0.011	−0.015
	(1.523)	(0.828)	(0.404)	(−0.977)	(−0.812)	(−1.089)	(−1.302)	(−0.775)	(−0.892)

This table shows the quantile regression results of the daily returns of green investment funds on a set of COVID-19 measures and other covariates. Sample period is Nov 12, 2009- Mar 31, 2022 (for *AMUNDI* is May 14, 2012- Mar 31, 2022); *t*-ratios based on Huber heteroskedasticity-consistent standard errors are in parentheses. (***), (**), and (*) indicate 1%, 5% and 10% significance levels, respectively.

reported in Table 10. As seen, our baseline findings are qualitatively unaltered, with crude oil market returns being mildly significant in only a few cases.

Finally, we recall that the descriptive statistics in Table 2 show that the raw data on green fund returns suffer from significant autocorrelation and ARCH effects. We deal with these issues by including the lagged value of the dependent variable and by adopting Huber heteroskedasticity-consistent standard errors for our parameter estimates. The updated results for these quantile autoregressions are reported in Table 11 for the case when economic support is used as the measure of COVID-19. As can be seen, the AR(1) term is not everywhere significant (mainly at the lower quantiles), with the main conclusions of the present research being qualitatively unchanged.

5. Summary and concluding remarks

This paper broadens previous studies on green securities by examining how the dynamics of the entire distribution of green investment funds have been affected by COVID-19. As mentioned before, the pandemic can lead to a long-term shift in the costs of equity, which can greatly affect the green securities market.

The empirical findings can be listed as follows. We show that the influence of COVID-19 on green assets is significantly more substantial when the green asset returns are negative (at the lower quantiles) than when they are positive (at the higher quantiles). This is an important result showing that the effect of the pandemic is more pronounced when the green asset market is weak, which can serve as essential information for investors and policymakers.

We account for the broader macroeconomic environment and show that long-term interest rates have the expected positive coefficient, with breakeven inflation having a negative connection but mainly at the upper quantiles. Equity market volatility is found to have a negative effect when the green fund returns are negative, while for positive returns the effect is positive.

Our analysis has a number of implications for investors as well as policymakers. In particular, policymakers who have set tight targets in achieving goals related to a low-carbon economy should take into consideration the new green financial instruments. Green assets might offer greater diversification against brown assets, suggesting that green investors adhere to their environment-friendly investments and avoid the financial risk against brown assets, particularly during economically fragile periods such as the COVID-19 period. Policy intervention might be necessary in order to set up adequate incentives for both the demand and the supply side, and thus ultimately further enhance the market for green securities. Overall, policymakers and individual investors may draw significant inspiration from this study for planning and policy-drafting purposes as well as decision-making.

CRediT authorship contribution statement

Maria-Eleni K. Agoraki: Conceptualization, Data curation, Investigation, Writing – review & editing. **Nektarios Aslanidis:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Georgios P. Kouretas:** Methodology, Formal analysis, Writing – review & editing.

Declaration of Competing Interest

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

References

Aslanidis, N., Christiansen, C., Savva, C.S., 2021. Quantile risk-teturn trade-off. J. Risk Financ. Manage. 14, 249.
Aswani, J., Raghunandan, A., Rajgopal, S., 2021. Are carbon emissions associated with stock returns? Unpublished working paper. Fordam University.
Baker, M., Bergstresser, D., Serafeim, G., Wurgler, J., 2022. The pricing and ownership of U.S. green bonds. Ann. Rev. Financ. Econ., forthcoming 14 (1), 415–437.
Baker, S.R., Bloom, D., Davis, S.J., Kost, K.J., Sammon, M.C., Viratyosin, T., 2020. The unprecedented stock market reaction to COVID-19. Rev. Asset Pricing Stud. 10, 742–758.
Barber, B.M., Morse, A., Yasuda, A., 2021. Impact investing. J. Financ. Econ. 139, 162–185.
BlackRock, 2020. Global sustainable investing survey.
BNP Paribas, 2019. The ESG global survey.
Bolton, P., Kacperczyk, M., 2021. Do investors care about carbon risk? J. Financ. Econ. 142, 517–542.
Bolton, P., Kacperczyk, M., 2022. Global pricing of carbon-transition risk. J. Financ. forthcoming.
Fatica, S., Panzica, R., Rancan, M., 2021. The pricing of green bonds: Are financial institutions special? J. Financ. Stab. 54, 100873.
Flammer, C., 2021. Corporate green bonds. J. Financ. Econ. 142, 499–516.
Global Sustainable Investment Review, 2021. Global Sustainable Investment Alliance.
Goodell, J.W., 2020. COVID-19 and finance: Agendas for future research. Financ. Res. Lett. 101512.
Hammoudeh, S., Noomem Ajmi, A., Mokni, K., 2020. Relationship between green bonds and financial and environmental variables: A novel time-varying causality. Energy Econ. 92, 104941.
Hsu, P., Li, K., Tsou, C., 2022. The pollution premium. J. Financ., fortcoming.
Koenker, R., 2005. Quantile regression. Cambridge University Press.
KPMG, 2021. Survey of Corporate Responsibility Reporting.
Kumar, S., Managi, S., Matsuda, A., 2012. Stock prices of clean energy firms, oil and carbon markets: a vector autoregressive analysis. Energy Econ. 34 (1), 215–226.
Managi, S., Okimoto, T., 2013. Does the price of oil interact with clean energy prices in the stock market? Jpn. World Econ. 27, 1–9.
Mealy, S., Brusseler, M., Kammourieh, S., 2021. Mapping the political economy of the global financial ecosystem. E3G, Interim Report.
OECD, 2017. Mobililising the debt capital markets for a low carbon transition. OECD publishing, Paris.
OECD, 2021. Setting a structural agenda for a green economic recovery from COVID-19. Working Paper-version November.
Pastor, L., Stambaugh, R.F., Taylor, L.A., 2021. Sustainable investing in equilibrium. J. Financ. Econ. 142, 550–571.
Pastor, L., Stambaugh, R.F., Taylor, L.A., 2022. Dissecting green returns. J. Financ. Econ. 146, 403–424.
Reboredo, J.C., 2018. Green bond and financial markets: Co-movement, diversification and price spillover effects. Energy Econ. 74, 38–50.
Reboredo, J.C., Ugolini, A., 2020. Price connectedness between green bond and financial markets. Econ. Model. 88, 25–38.
Sadorsky, P., 2012. Correlations and volatility spillovers between oil prices and the stock prices of clean energy and technology companies. Energy Econ. 34, 248–255.
Shackleton, M., Yan, J., Tao, Y., 2022. What drives a firm's ES performance? Evidence from stock returns. J. Bank. Financ. 136, 106304.
Tang, D.Y., Zhang, Y., 2020. Do shareholders benefit from green bonds? Finance 61, 101427.
Zerbib, O.D., 2019. The effect of pro-environmental preferences on bond prices: Evidence from green bonds. J. Bank. Financ. 98, 39–60.