

Can unconventional monetary policy contribute to climate action?

Alice Eliet-Doillet*, Andrea Maino^{†‡}

September 2022

ABSTRACT

The challenge of climate mitigation and adaptation is first and foremost a financing one. In this paper, we investigate how central banks can redirect financial flows toward decreasing the environmental footprint of firms. We focus on the July 2021 *Monetary Policy Strategy Review* of the European Central Bank, which unexpectedly dedicated a whole workstream to climate change. We find that this announcement had a significant effect on green bonds: ECB-eligible green bonds' Yield-to-Maturity decreased compared to equivalent conventional bonds. Firms incorporated in the Eurozone reacted by increasing the amount of green bonds issued, particularly in the investment-grade segment. In contrast, we find that the announcement did not boost the probability of signing a Net-Zero commitment for Eurozone-incorporated firms, raising questions about whether central bank policies can influence firms' longer-term policies.

Keywords: Climate Change, Central Banks, Green Bonds, Carbon Emissions, Quantitative Easing, Monetary Policy

JEL classification: Q58, E52, E58, G12

*Swiss Finance Institute and EPFL, alice.eliet-doillet@epfl.ch

[†]Swiss Finance Institute and University of Geneva, andrea.maino@unige.ch

[‡]We are grateful to Ruediger Fahlenbrach, Rajna Gibson Brandon and Fabio Trojani. We have also received helpful comments and discussions from Nolwenn Allaire, Federico Carlini, Ella D.S. Patelli, Andreas Fuster, Erwan Morellec, Julien Pinter and Natalia Rostova. We thank participants at the Nova PhD Pitch Perfect, the JRC Summer School on Sustainable Finance and the UniL Finance PhD Workshop as well as the ECB for selecting the paper for the "Young Economist Prize" in Sintra, 2022. Remaining mistakes are our own.

1 Introduction

The latest report from the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2022) provides a stark reminder of the consequences of climate change. The IPCC also highlights that securing sufficient public and private funds to finance climate mitigation and adaptation remains critical. Green finance, defined broadly as financing public and private investments with environmental benefits, represents an important instrument to achieve this goal.

In this context, central banks have started adopting policies to scale up green finance, with the premise that some targeted instruments can facilitate or accelerate the transition to a low-carbon economy. With their standard-setting abilities, central banks also hope to contribute to increasing the quantity and transparency of firms' environmental disclosures.

In this paper, we examine how effective central banks are at shaping incentives to redirect capital toward green finance. We focus on the European Central Bank (ECB) which is leading by example as it announced in its *Monetary Policy Strategy Review* (MPSR), on July 8, 2021 (henceforth, "ECB announcement"), its action plan to incorporate climate criteria into its unconventional monetary policy operations. This intention was reaffirmed on September 19, 2022, as the ECB revealed which criteria will be used to tilt its corporate bond purchases (henceforth, "ECB implementation").

Assessing the effectiveness of the ECB announcement is particularly important as numerous central banks have expressed their interest in supporting policies to scale up green finance (Dikau and Volz, 2021), but also given that badly planned climate targets could backfire and harm central banks' reputation (Hansen, 2021). As new knowledge and analytical tools will need to be acquired, such climate targets could also prove to be costly for central banks, a fortiori if they come into conflict with inflation targets (Boneva et al., 2021).

Altogether, we find that central banks can stimulate green bond issuance. Following the ECB announcement, Eurozone-incorporated firms increased cumulative green bond issuance by USD 0.140 billion, compared to firms in Europe but outside the Eurozone. However, less than half of the additional increase comes from externally verified green bonds, which have received a third-party review of the green credentials of use of proceeds. We then examine whether central banks can also affect the long-term environmental policies of corporations. We find that the additional green bond issuance was not complemented with some new Net-Zero commitments by Eurozone-incorporated firms. Overall, our paper provides the first empirical evidence that central banks can contribute to catalyzing the adoption of green financial instruments. From our results, it also appears that stringent standards will need to be set in

order to boost the development of high-quality green bonds and to link green bond financing to some longer-term firm-level decarbonization plans.

The ECB is expected to implement these measures from October 2022. However, the forward-looking nature of financial markets suggests that investors might already have reacted, similarly to the case of the Corporate Sector Purchase Programme (CSPP) announcement in 2016 (Todorov, 2020).

We focus on two scenarios that were prevailing at the time of the *Monetary Policy Strategy Review*: on the one hand, green bonds could be expected to play a preferred role as their proceeds finance climate-friendly projects, and they were shown to be an effective instrument to signal and carry out a company's effort towards carbon emissions reduction (Flammer, 2021). On the other hand, the green bond market, while flourishing, remains small and juvenile, in particular due to the lack of oversight and standardization (Deschryver and de Mariz, 2020). The ECB could also exclude specific firms and/or sectors based on climate criteria and thus reduce the overall carbon footprint of its CSPP portfolio holding (Papoutsis et al., 2021). However, pure divestment (for example without repurchase of green bonds in those sectors) would not help brown segments of the economy undergo their transition to sustainable practices.

Both approaches contrast with the current implementation of the CSPP, which since its inception in 2016 is based on sectoral amounts issued, an approach often referred to as "Market neutral". "Market neutrality" has an important drawback: as the ECB conducts purchases in proportion to the amount of bonds outstanding, sectors where a high share of capital is funded by bonds are over-represented, leaving the ECB portfolio tilted towards high emission sectors (Papoutsis et al., 2021). Under the "Market neutrality" principle, green bonds are not excluded from the CSPP but bought in proportion to the market value of outstanding bonds, and by turning a blind eye to their "greenness". In contrast with this "Market neutrality" paradigm, Executive Board Member Isabel Schnabel has argued in favor of a "best-in-class" approach, which *"would explicitly recognize that a supposedly "neutral" market allocation may be suboptimal in the presence of externalities"*¹.

We find strong evidence of the role of the ECB announcement on the Eurozone green bond market: eligible green bonds' Yield-to-Maturities decreased by 4 bps relative to eligible conventional bonds, and as much as 6 bps when focusing on prime bonds. The effect is sizable considering that it amounts to a fourth of the drop observed at the time of the CSPP announcement (Todorov, 2020; Bremus et al., 2021). We also study conventional bonds' reaction conditional on the carbon footprint of their issuer. We find that the Yield-to-Maturities of conventional bonds issued by the highest carbon emitters decreased

¹<https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210614~162bd7c253.en.html>

following the ECB announcement. In addition, we do not find a significant price reaction when comparing conventional bonds issued by the highest and lowest carbon emitters in each sector. We interpret these effects on the conventional bond market as suggestive of market investors remaining cautious regarding the ECB abandoning "Market neutrality".

We next turn to supply-side effects and study whether the reduction in the cost of green debt financing has led to a change in the green bond issuance behavior of firms. We compare issuers incorporated in the Eurozone to issuers in Europe but outside the Eurozone and find that Eurozone firms substantially increased their cumulative green bond issuance following the ECB announcement. The effect is concentrated on investment-grade green bonds and due to seasoned green bond issuers. We also examine what proportion of the increase is due to green bonds with an external review, which is given by third-party reviewers after an assessment of the issuer's plans, and less prone to "greenwashing" (Flammer, 2021). We find that less than half of the measured increase in issuance comes from externally reviewed green bonds.

Finally, we investigate whether the ECB announcement has incentivized firms to take long-term and forward-looking sustainability commitments beyond the medium-term decision to issue green bonds. We focus on Net Zero commitments (NZC) signed with the Science Based Target Initiative (SBTi). NZCs are targets that signatories adopt to achieve science-based and within value-chain decarbonization trajectories. Formally, we test whether Eurozone-incorporated firms are likely to also establish an NZC after the ECB announcement. We do not find a significant effect following the ECB announcement. Instead, we find that government initiatives, such as Great Britain hosting COP26, appear more impactful. This finding raises questions about the extent to which central bank policies can influence firms' incentives beyond the medium-term horizon such as in the decision of issuing green bonds.

Related Literature Our paper is directly related to the literature studying the effects of asset purchase programmes, in particular those that target corporations. De Santis and Zaghini (2019) find that direct corporate bond purchases by the ECB decrease all (i.e. for the most part conventional) eligible bond yields. They also find that spreads have decreased not only for eligible bonds but also to a lesser extent for non-eligible ones, due to some spill-over effects. Bremus et al. (2021) analyse the effects of the same programme but concentrate on green bonds. They find that the yields of eligible green bonds have significantly declined compared to non-eligible green bonds. Along with some price effects, Todorov (2020) studies the impact of large-scale bond purchases on corporate debt issuance and uncovers an increase both in the absolute number and in the notional amount of newly issued eligible bonds after the CSPP announcement. He also finds that the effect is more pronounced for credit-constrained firms, which benefit the most from the decreased cost of debt financing. Furthermore, Grosse-Rueschkamp et al. (2019) show that cheaper bond financing provided by central banks purchases led to a decrease in loan demand. They document that asset purchase programmes transmitted to the real economy via

banks which, faced with smaller loan demand from bond issuing firms, were able to provide additional lending to firms.

Second, our paper is also related to the literature studying the preferential demand for assets with high environmental benefits or scores. [Pastor et al. \(2020\)](#) provide a theoretical framework in which heterogeneous investors have tastes for green assets. In equilibrium, asset prices are affected by the dispersion of green investors in the economy. Expected returns arise from a two-factor model in which green assets have negative loadings on the ESG factors (i.e. in equilibrium expected returns in green assets are lower because they provide a hedge against undiversifiable climate risk). However, unexpected shifts in demand for green assets positively impact equilibrium expected returns and green assets can still outperform brown assets. In line with this theoretical insight, a greening of the asset purchase programmes represents a sizable demand shift in the Eurosystem financial market and should be incorporated into asset prices in equilibrium. [Hong et al. \(2021\)](#) evaluate the welfare implications of sustainable mandates, according to which investors need to hold a positive fraction of green firms in their portfolio. They find that this type of mandate allows green firms to attract a lower cost of financing, which in turn allows them to invest in decarbonization capital. They compare this type of welfare-maximizing mandate to the planner's solution. They obtain that while the two solutions are not identical, in both cases the ratio of decarbonization-to-productive capital rises over time, and the decarbonization and welfare levels are comparable. Focusing on the case of the U.S. equity portfolio of the Swiss National Bank (SNB), [Fahlenbrach and Jondeau \(2021\)](#) further explore how in practice institutional investors can reduce the carbon footprint of their portfolio. In particular, they show that a within-sector "best-in-class" approach only has a limited impact on carbon emissions, as emissions stem from relatively few sectors of the economy. Such an approach can be effective only if coupled with an exclusion of some of the highest carbon emitters.

Third, our paper is related to the literature on corporate green bonds and green project financing. [Flammer \(2021\)](#) shows that green bonds are an effective instrument to signal a firm's commitment to reduce carbon emissions. She also finds that green bonds do not attract better pricing compared to similar bonds. Nevertheless, the shift in demand for sustainable finance instruments from central banks could be a new catalyst for the development of sustainable related financing products. The paper by [Giovannardi et al. \(2021\)](#) is also directly related to our research. They evaluate the environmental benefits of green conventional monetary policy by focusing on the effect of giving preferential treatment, namely a lower haircut, to green bonds in the collateral framework. Using a DSGE model, the authors show that giving preferential treatment to green bonds in the collateral framework has effects similar to an environmental policy: it boosts the supply of green bonds, leading to an increase in green investment and a reduction of carbon emissions. However, due to increased risk-taking and leverage by green bond issuers, the welfare gains of this type of policy remain smaller than those stemming from a Pigouvian tax on emissions.

2 Hypothesis Development

1. Bond Price Reactions In the first part of the paper, we study whether the ECB "greening" announcement led to a decrease in the cost of bond financing for green projects and green firms. More precisely, we examine the effect of the announcement on the pricing of outstanding eligible corporate green and conventional bonds. Our analysis builds on previous work that has focused on the creation of the CSPP and found that it led to decreases in the Yield-to-Maturities of corporate bonds on secondary market transactions, for both conventional (Zaghini, 2017; Todorov, 2020) and green bonds (Bremus et al., 2021).

First, we focus on green bonds, which are used to signal a firm's commitment to effectively reduce its carbon emissions (Flammer, 2021). We expect eligible green bonds to experience a drop in their Yield-to-Maturities compared to eligible conventional bonds not affected by the ECB "greening" announcement. Such a drop would imply a lower cost of financing for green projects.

Hypothesis 1.a: Following the ECB announcement, Yield-to-Maturities of eligible green bonds decrease relative to eligible conventional bonds.

While green bonds are expected to play an important role in the environmental and energy transitions, they still lack oversight and the number of issuers is relatively limited. We extend our analysis to conventional bonds' reaction depending on the issuer's carbon emissions. More precisely, we evaluate the credibility given by investors to two scenarios that the ECB could follow in order to green its asset purchases. On the one hand, the ECB could tilt away from the most polluting companies in the Eurozone economy by implementing a global screening approach and thus depart from "Market neutrality". Under this scenario, we expect bonds issued by the top polluting firms to experience higher Yield-to-Maturities, which would suggest an increased cost of conventional bond financing for those firms.

Hypothesis 1.b: If this scenario gains credibility in the view of investors, one would observe a decrease in the demand for bonds issued by the top polluting firms. The ECB announcement would thus be followed by an increase in the Yield-to-Maturities of eligible conventional bonds issued by brown issuers, in contrast to similar bonds issued by green issuers.

Alternatively, the ECB could implement a "best-in-class" approach through a within-industry screening, i.e. tilt away from the most polluting companies in each sector. Under this scenario, we would see a significant market reaction between sector-specific long-short portfolios sorted on emission levels.

Hypothesis 1.c: If this scenario gains credibility in the view of investors, one would observe a shift in the demand for bonds within each sector, depending on the relative level of emissions of a firm. The ECB announcement would thus be followed by an increase in the Yield-to-Maturities of eligible conventional bonds issued by brown issuers, in contrast to similar bonds issued by the green issuers in the same sector.

2. Green Bonds Adoption In the second part of the paper, we focus on the role of the ECB announcement in boosting the issuance of green bonds in the Eurozone. We consider the announcement as an exogenous shock on the demand for green bonds. Higher demand for green bonds translates into lower Yield-to-Maturities and into higher incentives for firms to increase issuance. The exogeneity comes from the unexpected importance given to climate change issues within the recent *Monetary Policy Strategy Review* of the ECB, as detailed in Section 3.2.

Hypothesis 2.a: Following the ECB announcement, we expect a stronger increase in issuance of green bonds for issuers incorporated in the Eurozone, compared to non-Eurozone-incorporated issuers, which are not eligible.

However, as shown by [Kojien et al. \(2021\)](#), ECB purchases of eligible securities are accompanied by lower liquidity and lower Yield-to-Maturity, and it is possible that investors rebalance their portfolio towards non-eligible segments of green bonds which offer relatively higher Yield-to-Maturity. Those spill-over effects, documented for example by [Bremus et al. \(2021\)](#) in the case of CSPP creation, reduce Yield-to-Maturity in non-eligible segments of the bond market. It is therefore ex-ante not clear whether non-eligible green bonds issuance should be subdued to eligible green bond issuance given the increased incentive for both segments of the green bond market.

Hypothesis 2.b: Following the ECB announcement, we expect the increase in green bond issuance to be stronger in the segment of investment-grade green bonds.

Finally, we investigate what part of the effect can be attributed to green bonds with an external verification, conducted by an independent third-party to check the green credentials of the use of proceeds. [Flammer \(2021\)](#) shows that such verification reflects a stronger commitment towards the environment, and subsequently translates into some carbon emission reductions by the issuing firm. In addition, this type of external review will be one of the key add-ons of the "EU Green Bond Standard", which the ECB has recommended to become mandatory for newly issued green bonds². We thus expect new green bond issuances to predominantly tap the verified segment.

3. Real Effects In the final part of the paper, we study whether the announcement had some real effects on carbon emissions reductions. This aspect is particularly critical as it is still unclear whether green bond issuance can be linked to firm-level outcomes such as long-term decarbonization goals, which will be essential to building a resilient economy ([Mukhi et al., 2020](#)).

We focus on Net-Zero commitments (NZC), which are voluntary. They include both a near-term target and a long-term one- the latter meant to drive long-term business planning to reach Net-Zero by 2050 at the latest. This ambition also matches the one set by the European Commission to be "climate-neutral"

²<https://www.nordea.com/en/news/ecb-calls-for-mandatory-eu-green-bond-standard>

by 2050.

Such commitments are designed to induce companies to plan for a deep reduction in their absolute emissions and counterbalance the impact of any emissions that remain. For a firm the decision to sign a Net-Zero commitment might be driven by several factors. On the one hand, they might use it as a costly signal to inform investors, including the ECB, about their sustainability targets. The cost arises from a constraint to its investment policy. On the other hand, it is also possible that firms are compensated by raising cheaper financing, particularly in their green bond issuance, when combining those with a credible NZC. In the case of our study, signing such a commitment would also help firms to increase the likelihood of being included or their weight within the CSPP portfolio.

Hypothesis 3: Following the ECB announcement, we expect firms incorporated in the Eurozone to sign more Net-Zero commitments than firms incorporated outside the Eurozone.

In addition, while such commitments are associated with further reductions in emissions by the signatories, they are also typically signed by firms that already emit less (Bolton and Kacperczyk, 2022). Focusing on NZCs signed by brown firms, we finally test whether the ECB announcement has contributed to closing the discrepancy between brown and green firms' commitments, leading brown firms in the economy to likewise decarbonise.

3 Institutional Details

3.1 ECB Asset Purchase Programmes

In the aftermath of the Great Financial and Sovereign Debt crises in the Eurozone, the ECB implemented a package of non-standard monetary policy measures, the Asset Purchase Programme (APP), with the objective of supporting the monetary policy transmission mechanism to ensure price stability, and of putting a halt to the persistently weak inflation dynamics. The APP consists of four separate programmes targeting specific segments of the debt markets.

Corporate Sector Purchase Programme (CSPP) We focus on one particular programme, the CSPP, announced in April 2016 and implemented in June 2016. This programme targets bonds issued by non-bank corporations established in the euro area, and aims at stimulating credit provision for those corporations that have access to the bond market.

To be considered eligible under the CSPP, a debt instrument has to satisfy the following conditions:

- have a minimum rating of BBB- or equivalent,

- be denominated in euros,
- be issued by a non-credit corporation established in the euro area,
- have a remaining maturity of 6 months to 30 years at the time of purchase.

Purchases are, for now, guided by the principle of "Market neutrality" to avoid market distortions. According to this principle, purchases are based on outstanding amount issued in the eligible universe. In particular, the ECB does not discriminate based on industry sector composition. While there are no screening criteria based on environmental or social criteria, the ECB has already bought green bonds under the CSPP programme. As of the beginning of 2022, a total of 70 distinct green bonds have been purchased within the CSPP, as detailed in Figure A.1.

3.2 The *Monetary Policy Strategy Review* announcement

Since September 2020, ECB Executive Board Members have been increasingly vocal on the topic of climate change (see Figure 1). This topic was however restricted to occasional speeches. We focus instead on the *Monetary Policy Strategy Review* on July 8, 2021, which was directly related to the conduct of monetary policy. On that day, the ECB revealed its intention to address climate change risks by tilting its asset purchases away from heavy carbon-emitting companies. While no concrete implementation details were given, a parallel proposal by the European Commission for a "European Union Green Bond Standard"³(EU-GBS) gave some credibility to the ECB announcement in favour of green assets. The *Strategy Review* also included some forward-looking components and can thus be thought of as an important signal from the ECB on its aim to further incorporate climate change considerations in its future plan of action. Finally, the event was an important one, as it concluded the first *Strategy Review* conducted by the ECB since 2003. As it was unexpected that climate issues would be given such a central role (Reichlin et al., 2021), we consider the announcement to be a plausibly exogenous shock.

However, another relevant adjustment for bond markets was announced on that day, namely a new 2% inflation target, to which the ECB will apply a "symmetric" stance, meaning that positive and negative deviations of inflation would be equally undesirable. The announcement was perceived as more dovish by market observers⁴. Given the relevance of both components of the announcement, we control in our baseline specification for confounding effects originating from the change in the inflation target, by considering conventional bonds in the Eurozone as our control group.

The ECB had also pledged in its *Monetary Policy Strategy Review* to provide a follow-up on their climate action one year later. They did so on July 4, 2022, confirming their intention to tilt their corporate bond

³https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3405

⁴<https://www.ft.com/content/ab3b8c36-2199-4230-b9b3-b9e12c09d44b>

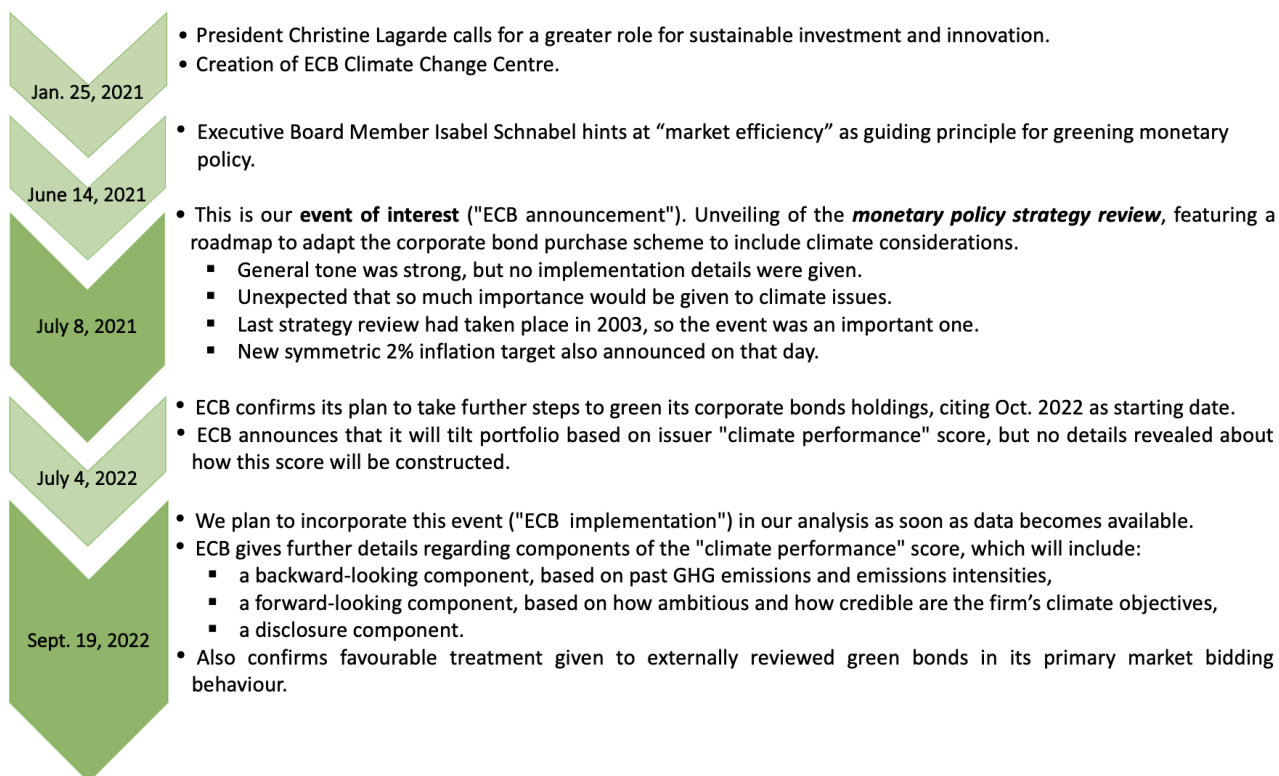


Figure 1: Timeline of ECB announcements regarding incorporation of climate change considerations into its monetary policy strategy. The full list of speeches is available at: https://www.ecb.europa.eu/home/search/html/climate_change.en.html.

portfolio towards issuers with a higher climate score, and announcing the starting date would be October 1, 2022. Detailed components of the climate score were eventually revealed on September 19, 2022. The score will comprise a backward-looking component (based on past emissions), a forward-looking component (based on how ambitious and credible a firm's climate objectives are), and a disclosure component. In addition, the ECB will give favorable treatment to externally reviewed green bonds in its primary market bidding behavior. We plan to include this last event in our analysis as soon as data becomes available.

4 Data

Sample The constituents of the Stoxx (Europe) 600 index make up our sample. They represent large, mid, and small capitalization companies across 17 countries in the European region. This choice is driven by the fact that those large 600 publicly traded stocks in Europe have similar capital structures, as well as comparable access to debt markets. In addition, among the 17 countries making up the index are some non-Eurozone ones, such as the United Kingdom, Sweden, and Switzerland which are not ECB-eligible and thus constitute suitable controls.

Data Sources Data on Stoxx 600 index constituents are from the *Compustat Global* index dataset which includes security level information on the constituents. From *Compustat Global*, we also retrieve yearly and quarterly accounting data. Security prices data are from the *Compustat Global Securities Daily* dataset and collected at a daily frequency. In addition, we obtain information on firms' greenhouse gas emissions (GHG) from *Refinitiv Asset4*. This dataset contains yearly frequency and firm-level information on Scope 1, Scope 2, and Scope 3 emissions. Finally, we collect data on firms' Net-Zero Commitments from the *Science-Based Targets initiative* website.

Daily Mid Yield-To-Maturity for the period between mid-February 2021 and mid-September 2021 are taken from *DataStream* using bond ISINs from the *Bloomberg Fixed Income* database. Among those bonds, we distinguish the green ones through Bloomberg's "Green bond" indicator. Externally verified green are identified through the *Climate Bonds Initiative* database. More details on green bonds and external verification can be found in Appendix [A.2](#).

Variable Definitions We measure the greenness of a firm through its **direct** CO2 equivalent emissions (i.e. **scope 1** emissions), generated by the company burning fossil fuels in its own production processes, and use 2019 as a base year.

We rely on two approaches to determine how green a firm is. In the first approach, we do not take into account the sector in which the firm operates. We compute the distribution of emissions in the entire sample of Stoxx600 firms and use the bottom and top quartiles of this distribution to respectively identify green and brown firms. In the second approach, we perform this procedure in each sector (defined through GICS industry group) and identify within each group which firms are green and brown using again respectively bottom and top quartiles. The rest of the variable definitions are available in Table [B.1](#) in the Appendix.

Descriptive Statistics Table [1](#) presents some descriptive statistics on bond issuance by Stoxx600 firms. These firms are major actors in the corporate bond market: they represent half of the total amount issued in euro-denominated corporate conventional bonds, and about a quarter of the total amount in euro-denominated corporate green bonds. They also issue larger tickets.

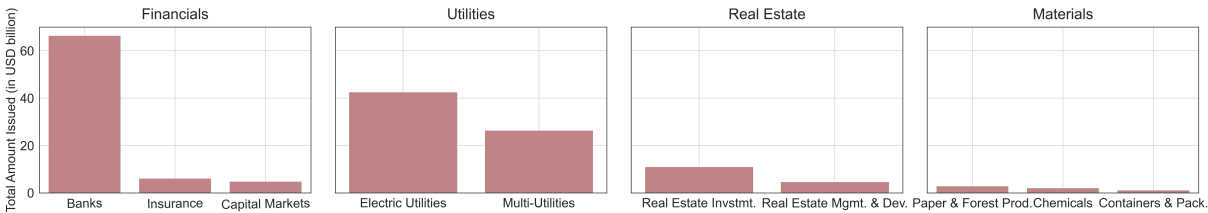


Figure 2: Aggregate euro-denominated green bond issuance (in USD billion) decomposed at the industry level for the top 4 issuing sectors: Financials, Utilities, Real Estate and Materials.

	Total Amount Issued			Total Amount Outstanding			Number of Bonds Issued		
	Stoxx600	All firms	Fraction Stoxx600	Stoxx600	All firms	Fraction Stoxx600	Stoxx600	All firms	Fraction Stoxx600
Green bonds	99	380	0.26	98	358	0.27	169	1042	0.16
All bonds	2390	4400	0.54	2260	4310	0.52	5476	75898	0.07

Table 1: Descriptive statistics for the amount and number of euro-denominated corporate conventional and green bonds. Data are from *Bloomberg Fixed Income database* and were retrieved in November 1st, 2021. All amounts are in USD billion.

	Mean	Sd	Min	p5	Median	p95	Max	Obs.
Size	9.69	1.84	4.59	6.88	9.47	13.05	15.14	687
Leverage	0.27	0.16	0.00	0.02	0.26	0.55	0.97	669
Credit Institutions	0.06	0.24	0.00	0.00	0.00	1.00	1.00	687
Net-Zero Committed	0.25	0.44	0.00	0.00	0.00	1.00	1.00	687
Scope 1 Emissions	3.0e+06	1.3e+07	0.00	126.37	34420.00	1.7e+07	1.7e+08	525
Scope 2 Emissions	6.1e+05	3.5e+06	0.00	453.30	53254.00	2.4e+06	7.3e+07	523
Scope 1 Intensity	176.21	588.84	0.00	0.23	10.91	930.93	6986.67	396
Scope 2 Intensity	43.68	103.75	0.00	0.39	12.83	202.51	1024.71	395
Amount euro-denominated green bonds (in USD billion)	0.26	1.14	0.00	0.00	0.00	1.47	15.26	687

Table 2: Descriptive Statistics for Stoxx600 firms. *Size* is the natural logarithm of the book value of total assets (in USD million). *Leverage* is defined as the ratio of debt (as defined by the addition of long term debt and debt in current liabilities) to the book value of total assets. *Intensities* are computed using the ratio of emissions to *Sales*.

The top 4 sectors in terms of aggregate green bond issuance are shown in Figure 2, with an additional decomposition at the industry level. The financial sector, and more particularly banks, are major players of the euro-denominated green bond market. Utility firms, which will be crucial in the transition, are also massively present in the market.

Green bonds (# distinct = 114)							
	Mean	Sd	Min	p5	p50	p95	Max
Yield-to-Maturity	0.18	0.39	-0.47	-0.38	0.07	0.91	1.29
Time to Maturity (in years)	6.70	3.96	1.13	1.49	5.86	13.40	20.26
Coupon	0.99	0.74	0.00	0.01	0.88	2.75	3.05
Amount Issued (in USD billions)	0.78	0.34	0.05	0.27	0.73	1.46	1.93

Conventional bonds (# distinct = 1607)							
	Mean	Sd	Min	p5	p50	p95	Max
Yield-to-Maturity	0.28	0.62	-0.70	-0.41	0.17	1.28	7.44
Time to Maturity (in years)	5.93	4.24	1.02	1.33	4.95	13.91	30.66
Coupon	1.40	1.21	0.00	0.00	1.13	4.00	8.13
Amount Issued (in USD billions)	0.65	0.67	0.00	0.00	0.57	1.70	6.52

Table 3: Bond-level summary statistics for both green and conventional bonds issued by Stoxx600 firms for which we have been able to retrieve Yield-to-Maturities on *DataStream*. Time-to-maturity is measured through years until maturity on 01/01/2021.

Some firm-level summary statistics are presented in Table 2 and some bond-level ones in Table 3. More details on the data can be found in Appendix B.

5 Empirical Design

5.1 Bond-level impact

In order to evaluate the impact of the ECB announcement on green bond prices, we use the following regression specification:

$$y_{it} = \beta(\text{Green bond} \cdot \text{Post})_{it} + \Gamma_w + \mu_i + \epsilon_{it}, \quad (5.1)$$

where y_{it} is the bid Yield-to-maturity of bond i on day t . Eligible green bonds issued by Stoxx600 corporations represent our treatment group, while our control group consists of eligible conventional bonds issued by Stoxx600 firms. This methodology allows us to rule out the confounding effects due to the monetary policy announcements not related to green issues that were made on that day. We have also tested (see Appendix C.1) against other control groups, namely SEK-denominated investment-grade (quasi-eligible) green bonds, to obtain estimates of the overall effect of the *Strategy Review*.

As we focus on the *Monetary Policy Strategy Review* announcement on July 8, 2021 in all of our regressions, the *Post* binary variable is equal to 1 if and only if the observation is posterior to that date. We also

follow [Bremus et al. \(2021\)](#) and include week fixed effects (denoted by Γ_w), some bond fixed effects (μ_i) and control for some time-varying factors at the country and the sector level through some country-by-month and sector-by-month fixed effects. Finally, we cluster standard errors at the bond level to robustify against serial correlation in the outcome ([Bertrand et al., 2003](#)) and we winsorize Yield-to-Maturity at the first and ninety-ninth percentiles.

To assess whether the ECB announcement also affected the cost of financing for green firms, we measure its impact on the Yield-to-Maturity of eligible conventional bonds issued by Stoxx600 corporations, depending on the greenness of the issuer. The corresponding regression specification is:

$$y_{it} = \beta(\text{Brown issuer} \cdot \text{Post})_{it} + \Gamma_w + \mu_i + \nu_f + \epsilon_{it}, \quad (5.2)$$

where ν_f are issuer fixed effects. Our treatment group comprises eligible conventional bonds issued by brown Stoxx600 corporations, while eligible conventional bonds issued by green Stoxx600 corporations constitute the control group. We identify brown and green issuers according to either a global screening or a sectoral screening, as detailed above in section 4.

5.2 Firm-level impact

We measure the firm-level impact of the announcement through two outcomes: (1) cumulative green bond issuance, and (2) the signature of a Net-Zero commitment. In both cases, our baseline treatment group is Stoxx600 firms incorporated in the Eurozone, while Stoxx600 firms incorporated in Europe but outside the Eurozone represent our control group.

First, we measure the impact of the ECB announcement on corporate green bond issuance by studying issuer-level weekly changes in cumulative green bond issuance:

$$y_{ft} = \beta(\text{Treat} \cdot \text{Post})_{ft} + \zeta t + X'_{ft}\eta + \Gamma_w + \nu_f + \epsilon_{ft}, \quad (5.3)$$

where y_{ft} represents the cumulative number of green bonds or the cumulative amount of green bonds outstanding issued by issuer f in week t , and X_{ft} is a vector of issuer-level time-varying characteristics, such as past cumulative green bond issuance. We also include a time trend, t , to account for the global growth in green bond issuance.

Second, we measure whether the announcement had an impact on the signature of a Net-Zero commitment. Observations are collected at the yearly frequency, and used to estimate a linear probability model:

$$y_{ft} = \beta(\text{Treat} \cdot \text{Post})_{ft} + X'_{ft}\eta + \nu_f + \gamma_c + \epsilon_{ft}, \quad (5.4)$$

where y_{ft} is a binary outcome, equal to 1 if the firm has signed a Net-Zero commitment in year t and 0 otherwise, and X_{ft} is a vector of time-varying firm-level characteristics. We also include some issuer (ν_f)

and country (γ_c) fixed effects, as well as some sector-by-year fixed effects.

6 Bond Price Reaction

In section 6.1 we focus on the effects of the ECB announcement on green bonds pricing in the secondary market. In section 6.2 we expand the analysis to conventional bonds pricing, conditional on firms direct emissions.

6.1 Green Bonds

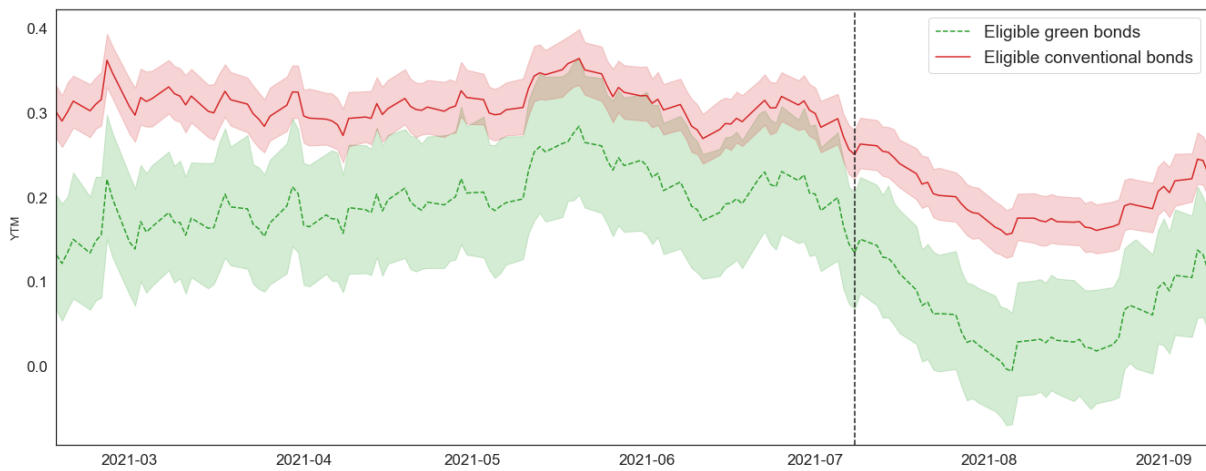


Figure 3: Mean and 95% confidence interval for Yield-to-Maturity of eligible green bonds (green dashed line) and eligible conventional bonds (red solid line). The vertical line represents the announcement of the conclusions of the *Monetary Policy Strategy Review* on July 8, 2021.

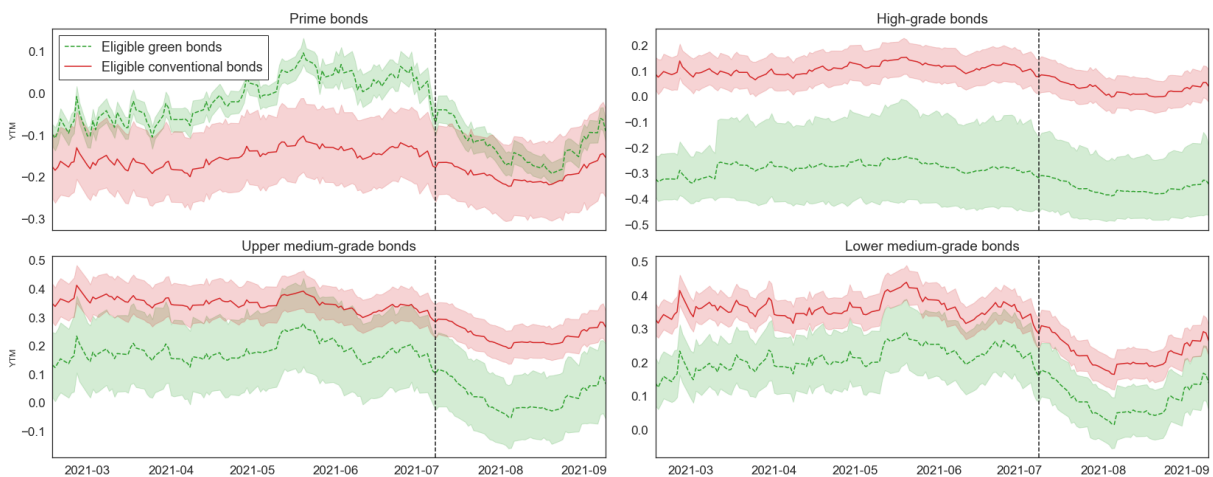


Figure 4: Mean and 95% confidence interval for Yield-to-Maturity of eligible green bonds (green dashed line) and eligible conventional bonds (red solid line). The vertical line represents the announcement of the conclusions of the *Monetary Policy Strategy Review* on July 8, 2021. Prime bonds correspond to a rating of AAA or equivalent. High-grade bonds correspond to a rating of AA or equivalent. Upper medium-grade bonds correspond to a rating of A or equivalent, and lower medium-grade correspond to a rating of BBB or equivalent.

First, we examine the effects of the ECB announcement on the Yield-to-Maturity of eligible green bonds. Eligible conventional bonds represent our preferred control group as they have similar credit worthiness and allow us to isolate the effect related to the "greening" component in the ECB announcement, thereby reducing concerns from confounding effects due to the announcement of changes to the inflation target of the ECB.

Figure 3 shows the evolution of the average Yield-to-Maturity for the treatment and control groups. We observe a sharper decrease in the average Yield-to-Maturity of eligible green bonds after the ECB announcement, relative to eligible conventional bonds. In Figure 4, the same variables are represented, but separated by rating buckets, from prime bonds (rated AAA or equivalent) to lower medium-grade bonds (rated BBB or equivalent).

We formally test for hypothesis H1.a in Table 4 and find that, following the ECB announcement, Yield-to-Maturity decreased on average by 3 to 4 bps for eligible green bonds compared to eligible conventional bonds. The effect is highly statistically significant and robust to considering different fixed effects in columns (2) to (4). We also investigate whether the effect was subject to some heterogeneity depending on the credit rating of the bond issue. In columns (5) to (8), we find that the effect is highly significant and higher in magnitude (approximately equal to 6 bps) for prime bonds, insignificant for high-grade bonds, and is highly statistically significant for upper medium and lower medium-grade bonds and ranging between 5 and 2 bps.

Taken together, these findings suggest that the announcement led to a significant reduction in the Yield-to-Maturity of eligible green bonds vis-à-vis conventional eligible ones. The magnitude of the effect is robust against fixed effect specifications and it amounts to a fourth of the magnitude estimated by [Bremus et al. \(2021\)](#) when studying the response of green bonds to the CSPP announcement in March 2016. In his work, also focused on the CSPP announcement, [Todorov \(2020\)](#) finds a reaction of about 30 bps. Despite the lower estimated magnitude, the effect is still sizable, given: (i) the low-interest rate environment at the time of the announcement, (ii) the fact that there is less space for monetary policy manoeuvring on green bonds, as they already trade at low Yield-to-Maturities.

6.2 Conventional Bonds

In this subsection, we focus on the effects on conventional bonds, in order to assess whether the announcement increased the cost of (conventional) bond financing for brown firms. Our treatment group is the set of eligible conventional bonds issued by brown firms, whereas our control group comprises eligible conventional bonds issued by green firms. In addition, we formally test for the two scenarios detailed in Section 2.1 using the two definitions of "greenness" provided in section 4 to construct the treatment and control groups.

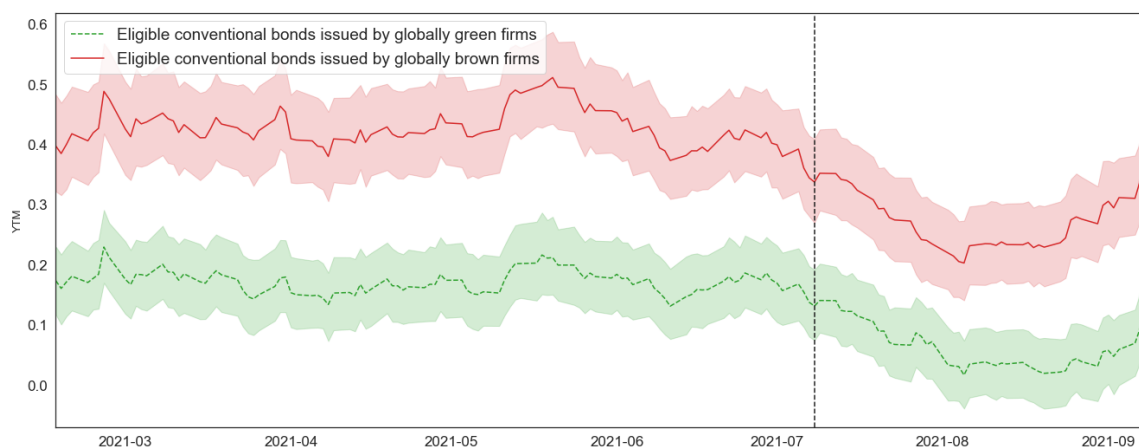
The first set is based on the top and bottom quartile of the distribution of emissions in the entire set of Stoxx600 firms. It allows us to test whether investors find credible that the worst performers (e.g. coal companies) would be excluded from the ECB portfolio and "Market neutrality" relaxed. The second set is instead based on the top and bottom quartile of the distribution of emissions in each sector, and allows to test for the credibility given to the ECB tilting its portfolio towards companies with the lowest emissions in each sector.

Figures 5a and 5b show the evolution of the average Yield-to-Maturity for the groups based respectively on emissions in the entire and sectoral distribution of emissions.

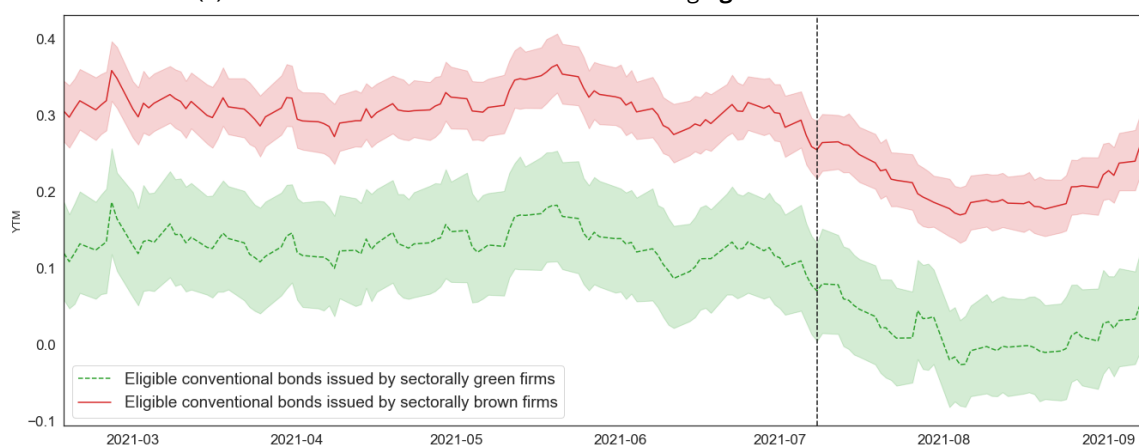
Results for the treatment and control groups based on the distribution of emissions of the entire set of Stoxx600 firms are presented in columns (1) to (5) of Table 5. We find that, following the ECB announcement, Yield-to-Maturity of eligible conventional bonds issued by brown issuers decreased on average by 2 bps to 5 bps compared to those of green issuers, depending on the fixed effects included in the regression. More specifically, from column (1) we find, in line with Figure 5a, that conventional bonds issued by brown firms trade at higher yields compared to those issued by green firms, as we see from the coefficient on the variable *Brown Issuer*, which is positive and highly significant. In addition, we obtain that the difference is significantly reduced following the ECB announcement as highlighted by the estimates of the interaction variable *Brown Issuer* \times *Post* which is negative and highly significant in columns (2) to (5). We interpret this finding as indicative of investors believing that the ECB will not implement a global screening approach based on emission levels, and will instead maintain its "Market neutrality" stance and keep the most polluting firms in its portfolio.

In column (6) to column (10) of Table 5, brown and green issuers are identified within each sector. In contrast with the previous specification, we do not find any differential effect of the ECB announcement between bonds issued by brown issuers and green issuers, as highlighted by the non significance of the estimate on *Brown Issuer* \times *Post*. This lack of significant reaction at industry level is indicative of investors not updating their belief in the "best-in-class" implementation by the ECB after the announcement.

Overall, we find that the ECB announcement has triggered significant market reaction also for conventional bonds, in particular for those issued by the most polluting firms. However, the effect on the Yield-to-Maturity on bonds issued by those firms is negative, and hints at a positive price reaction. We conclude that, with its greening announcement, the ECB did not manage to push up the price of conventional bond financing for the most polluting firms. Instead, our results suggest that, following the announcement, the "Market neutrality" principle remained highly credible in investors' view.



(a) Green and brown firms are identified through **global** level direct emissions.



(b) Green and brown firms are identified through **sectoral** level direct emissions.

Figure 5: Mean and 95% confidence interval for the Yield-to-Maturity of eligible conventional bonds issued by green firms (green dashed line) and eligible conventional bonds issued by brown firms (red solid line), depending on whether global or sectoral distribution of emissions were used to tag green and brown firms.

7 Green Bond Issuance

In this section, we examine whether lower secondary market Yield-to-Maturities for green bonds created incentives for firms incorporated in the Eurozone to increase green bond issuance (H2.a) and whether the effect was concentrated on the segment of investment grade bonds (H2.b). We also test for the role of external reviews in the observed issuance patterns.

Figure 6 shows the evolution, at the aggregate level, of the par of newly issued green bonds, and of the number of new green bond issuers. We can see that, after the ECB announcement, firms incorporated in the Eurozone have increased their green bond issuance, whereas growth from firms incorporated outside the Eurozone has been slower. We formally test whether, at the issuer level, the ECB announcement accelerated that growth, based on: (i) the country of incorporation of the issuer, (ii) whether the bond issue is investment-grade, and (iii) whether the bond issue has received an external review.

Table 6 shows the results of the estimation for the *Cumulative Number of Green Bonds Issued* at the firm-

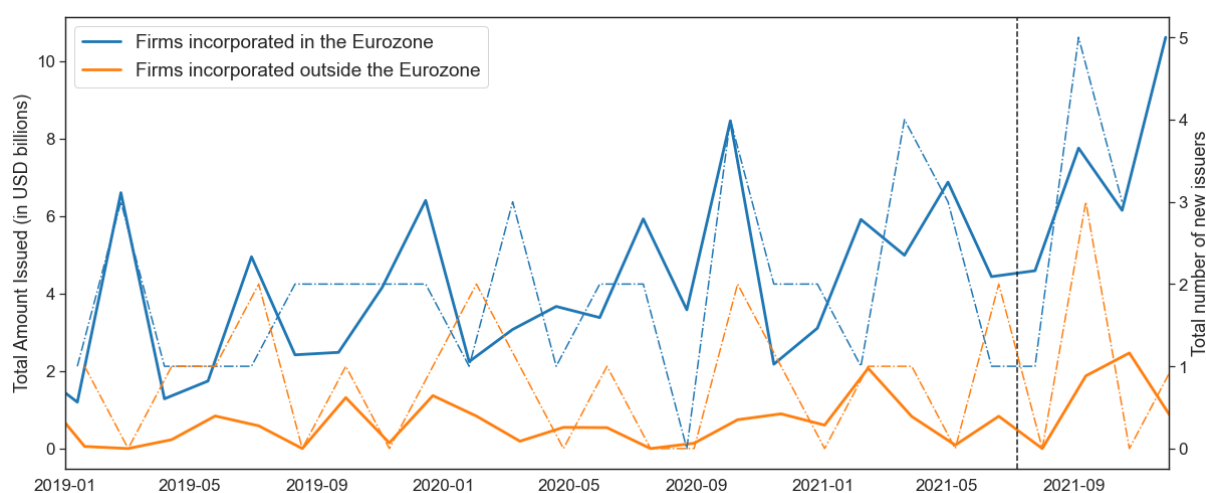


Figure 6: Total amount of green bonds issued over time (solid line) (in USD billions) and total number of new issuers (dashed line) for Stoxx600 firms in the Eurozone and in Europe but outside the Eurozone.

week level in Panel A and for the *Cumulative Par (in USD billion) of Green Bonds Issued* at the firm-week level in Panel B.

In all specifications, we include a time trend, to account for the fact that the green bond market is expanding. We also control for quarterly firm leverage and for the EU carbon price⁵, as high EU carbon prices would penalize high emissions and induce firms to undertake more green projects. Finally, in order to distinguish between first-time and seasoned green bond issuers, we include in some specifications control for the past cumulative green bond issuance (*Lagged Amount Issued*).

We obtain that, after the ECB announcement, the cumulative amount of green bond issuance increased more strongly for firms incorporated in the Eurozone, by about USD 0.14 billion. We examine whether the effect is concentrated on a specific segment of the green bond market by running the estimation on the subsample of investment-grade green bonds in columns (3) to (4) and on the non-investment-grade green bonds in columns (5) and (6). We find that Eurozone-incorporated firms increased the issuance of investment-grade green bonds by an average of USD 0.104 billion and that the effect is highly statistically significant (see Table 6, Panel B, column (3)). In column (4) we add an additional control for past cumulative green bond issuance in order to measure whether the effect on investment-grade green bond issuance stems from first-time green bond issuers. We find that the effect from unseasoned green bond issuers accounts for a small proportion of the total effect (around USD 0.022 billion), with a low statistical significance.

We further measure the increase in issuance stemming from the non-investment-grade segment of the green bond market in columns (5) and (6). We find that the effect is smaller in magnitude, but still highly significant for this type of bonds.

⁵We measure EU carbon prices using the price allowance permits traded in the EU ETS System. https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en

Finally, in Table 7, we focus on green bonds that have received an external review and measure what fraction of the increase in issuance comes from this type of bond. When comparing the treatment effect in column (1) in Panel (B) with the same column in Table 6, we obtain that less than half of the overall effect is due to externally reviewed green bonds, and mostly due to seasoned issuers. We find that the effect is again concentrated in the segment of investment-grade green bonds, as they account for the additional issuance of USD 0.044 billion.

In Appendix C.2, we robustify our results by using as dependent variable the ratio of cumulative green bond issuance over long term debt and total debt (Appendix C.2.1). We find again that the effect is highly significant, and concentrated in the investment-grade segment. We also test for some additional characteristics, separating the response of banks and non-banks issuers in the Eurozone and outside the Eurozone, and using eligible bond issuers as a control group. In both cases, the results are consistent with our main findings: the response to the ECB announcement is concentrated in the eligible segment of the green bond market. We finally test the extensive margin effect of the ECB announcement on first-time green bond issuance and find that there is no statistical significance at investment and non-investment-grade level. We conclude that the effect mostly originated from an increase in issuance in the investment-grade segment of the green bond market and from an increase in cumulative green bond issuance by seasoned issuers.

	All bonds							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Post x Green bond</i>	-0.022*	-0.041***	-0.032***	-0.029***	-0.063***	0.001	-0.053***	-0.014**
	(-1.77)	(-4.88)	(-4.95)	(-4.19)	(-8.25)	(0.03)	(-2.69)	(-2.10)
<i>Green bond</i>	-0.113***							
	(-2.69)							
<i>Post</i>	-0.110***							
	(-25.55)							
Number of distinct bonds	1721	1721	1721	1721	106	240	444	449
Adj. R-squared	0.009	0.970	0.972	0.973	0.957	0.988	0.971	0.986
Bond FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	No	No	No	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Table 4: Effect of the ECB green shift announcement on the Yield-to-Maturity of eligible green bonds issued by Stoxx600 corporations, compared to eligible conventional bonds issued by Stoxx600 corporations. The *Post* dummy is equal to one for any observation obtained after the ECB announcement on July 8, 2021. The treatment group comprises eligible green bonds, while eligible conventional bonds represent the control group.

	Greenness defined over full economy					Greenness defined at sector level				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Post x Brown Issuer</i>	-0.045*** (-3.05)	-0.046*** (-3.86)	-0.046*** (-3.86)	-0.023 (-1.08)	-0.024*** (-3.22)	0.013 (1.61)	0.001 (0.21)	0.001 (0.21)	0.001 (0.11)	0.005 (0.95)
<i>Brown Issuer</i>	0.255*** (5.42)					0.180*** (4.46)				
<i>Post</i>	-0.108*** (-8.79)					-0.112*** (-18.41)				
Number of distinct bonds	574	574	574	574	574	955	955	955	955	955
Adj. R-squared	0.048	0.967	0.967	0.969	0.969	0.024	0.976	0.976	0.978	0.979
Bond FE	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Week FE	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Issuer FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Country x Month FE	No	No	No	Yes	No	No	No	No	Yes	No
Sector x Month FE	No	No	No	No	Yes	No	No	No	No	Yes

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Table 5: Effect of the ECB green shift announcement on the Yield-to-Maturity of eligible conventional bonds issued by Stoxx600 firms, depending on the "greenness" of the issuer. The *Post* dummy is equal to one for any observation obtained after the ECB announcement on July 8, 2021. The treatment group comprises eligible conventional bonds issued by brown issuers, while eligible conventional bonds issued by green issuers represent the control group. Green and brown firms are either identified as the highest and lowest carbon emitters in the overall economy (columns (1) to (5)), or as the highest and lowest carbon emitters in each sector (columns (6) to (10)).

Panel A: Number of green bonds

	All green bonds			Investment-grade		Non-investment-grade	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post × Treated</i>	0.157** (2.54)	0.157** (2.53)	0.031 (0.61)	0.113*** (4.03)	0.020 (1.15)	0.103** (2.42)	0.076** (2.03)
<i>Quarterly Firm Leverage</i>	0.000*** (2.95)	0.000*** (2.82)	0.000** (2.17)	0.000*** (2.85)	0.000** (2.35)	0.000 (0.60)	-0.000 (-0.29)
<i>Lagged Amount Issued</i>			1.015*** (11.61)		0.752*** (9.03)		0.216** (2.45)
<i>Post</i>	-0.063** (-2.35)						
<i>Time trend</i>	0.008*** (5.87)						
<i>Carbon Price</i>	0.001 (1.55)						
<i>Lagged Carbon Price</i>	0.000 (0.66)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.902	0.902	0.931	0.934	0.965	0.668	0.682
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Par of green bonds (in USD billion)

	All green bonds			Investment-grade		Non-investment-grade	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post × Treated</i>	0.140*** (4.74)	0.140*** (4.73)	0.038*** (2.99)	0.104*** (4.26)	0.022* (1.74)	0.043*** (2.75)	0.022** (2.49)
<i>Quarterly Firm Leverage</i>	0.000*** (2.93)	0.000*** (2.77)	0.000* (1.76)	0.000** (2.51)	0.000 (1.45)	0.000* (1.90)	0.000 (0.37)
<i>Lagged Amount Issued</i>			0.825*** (24.40)		0.658*** (9.02)		0.164** (2.21)
<i>Post</i>	-0.063*** (-4.30)						
<i>Time trend</i>	0.004*** (5.09)						
<i>Carbon Price</i>	0.001 (1.61)						
<i>Lagged Carbon Price</i>	-0.000 (-0.09)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.928	0.928	0.972	0.939	0.971	0.620	0.665
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table 6: Panel (A) shows the estimates from regression 5.3 using cumulative number of green bonds issued at issuer-week level as the dependent variable, while in Panel (B) the dependent variable is the cumulative amount of green bond issued for each issuer-week. The *Post* dummy is equal to one for any observation obtained after the ECB announcement on July 8, 2021. The treatment sample comprises Stoxx600 which are incorporated in the Eurozone, whereas the control group is the set of issuers which are incorporated outside the Eurozone. Carbon prices are from the EU Emissions Trading System and we use six month lags. The time trend is monthly.

Panel A: Number of green bonds

	Extern. reviewed			Extern. reviewed and IG		Extern. reviewed and non-IG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post</i> × <i>Treated</i>	0.068** (2.02)	0.068** (2.01)	-0.017 (-0.59)	0.047*** (2.97)	-0.023** (-2.01)	0.053** (2.35)	0.040** (2.09)
<i>Quarterly Firm Leverage</i>	0.000*** (3.43)	0.000*** (3.30)	0.000*** (2.95)	0.000*** (2.77)	0.000** (2.06)	0.000 (1.34)	0.000 (0.60)
<i>Lagged Amount Issued</i>			0.683*** (8.63)		0.562*** (8.02)		0.100** (1.97)
<i>Post</i>	-0.030** (-2.16)						
<i>Time trend</i>	0.006*** (5.32)						
<i>Carbon Price</i>	-0.001** (-2.06)						
<i>Lagged Carbon Price</i>	-0.000 (-0.85)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.910	0.910	0.935	0.924	0.956	0.733	0.741
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Par of green bonds (in USD billion)

	Extern. reviewed			Extern. reviewed and IG		Extern. reviewed and non-IG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post</i> × <i>Treated</i>	0.059*** (3.71)	0.059*** (3.71)	-0.007 (-0.83)	0.044*** (3.37)	-0.016** (-2.12)	0.018** (2.22)	0.012** (2.28)
<i>Quarterly Firm Leverage</i>	0.000*** (2.96)	0.000*** (2.82)	0.000* (1.92)	0.000** (2.53)	0.000 (1.57)	0.000* (1.92)	0.000 (1.56)
<i>Lagged Amount Issued</i>			0.531*** (8.54)		0.482*** (7.58)		0.047 (1.41)
<i>Post</i>	-0.027*** (-3.59)						
<i>Time trend</i>	0.003*** (4.56)						
<i>Carbon Price</i>	-0.001** (-2.53)						
<i>Lagged Carbon Price</i>	-0.000 (-1.05)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.934	0.934	0.969	0.940	0.971	0.787	0.796
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table 7: Panel (A) shows the estimates from regression 5.3 using cumulative number of **externally reviewed** green bonds issued at issuer-week level as the dependent variable, while in Panel (B) the dependent variable is the cumulative amount of **externally reviewed** green bond issued for each issuer-week. The *Post* dummy is equal to one for any observation obtained after the ECB announcement on July 8, 2021. The treatment sample comprises Stoxx600 which are incorporated in the Eurozone, whereas the control group is the set of issuers which are incorporated outside the Eurozone. Carbon prices are from the EU Emissions Trading System and we use six month lags. The time trend is monthly.

8 Firm Commitments

In this section, we investigate the effect of the ECB announcement on firms’ Net-Zero commitments. More precisely, we test whether following the ECB announcement, firms incorporated in the Eurozone have signed more Net-Zero commitments, compared to firms outside the Eurozone that are not affected by the new ECB screening criteria.

A Net-Zero commitment is a public commitment that signatories establish with specialized NGOs. One major standard-setting NGO is the Science Based Targets Initiative (SBTi) which created standards for companies willing to reduce their carbon footprint and provides them with guidance. In effect, firms that sign a Net-Zero commitment⁶ align their emissions reduction targets with a carbon budget that corresponds to a 1.5-degree increase. Firms pledge for deep cuts in emissions within their value-chain (around 90%), with any residual emissions to reach NZ being compensated using carbon removals.

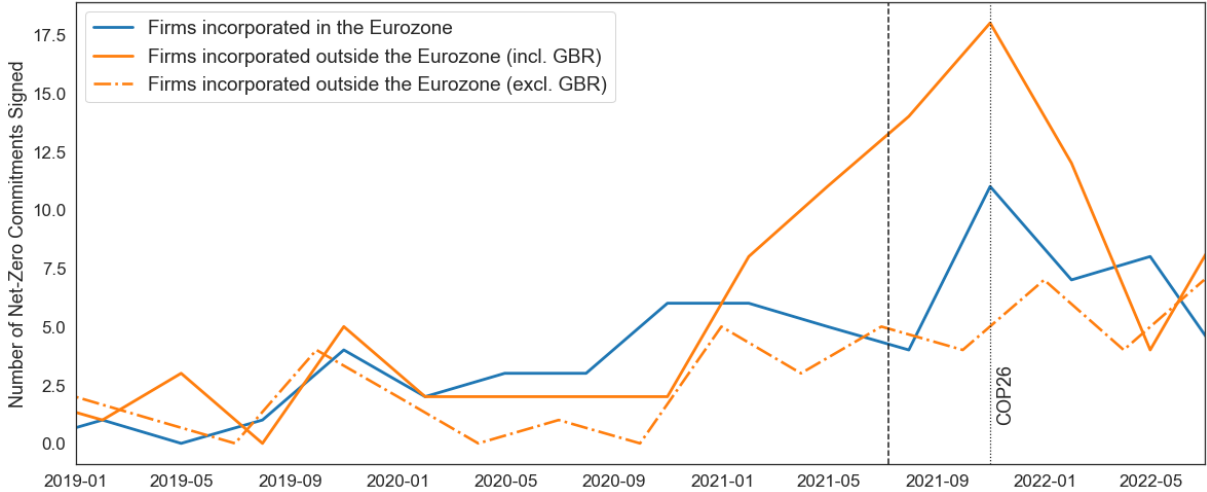


Figure 7: Total number of new Net-Zero commitment signatories for Stoxx600 firms in the Eurozone and in Europe but outside the Eurozone. For Stoxx600 firms outside the Eurozone, we also single out Great Britain, where COP26 was held in November 2021.

First, we examine the trend in Net-Zero commitments signed by Stoxx600 firms in the sample (see Figure 7). Since the creation of the SBTi standard in 2018, the number of signatories has grown quickly. The trajectories for firms in the Eurozone and outside the Eurozone are mostly parallel, except for the period before the COP26 in Great Britain, where the acceleration in the signature of Net-Zero commitments was very strong. Net-Zero commitments have also gained popularity with signatories from a wide range of sectors in the economy (see Figure B.6).

In Table 8, we formally test whether the probability of signing a Net-Zero commitment increases for firms

⁶To set, submit and disclose a target, SBTi has developed a precise procedure that firms need to follow, which includes several steps requiring SBTi validation to ensure that the signatories are aligned with the standard requirements. <https://sciencebasedtargets.org/step-by-step-processcommit>

incorporated in the Eurozone following the ECB announcement (H3). We use a linear probability model where the dependent variable takes value 1 if a firm has signed a Net-Zero commitment in a given year. In contrast with our results on green bond issuance in the previous section, we do not find any evidence for an increase in the probability of firms signing an Net-Zero commitment following the ECB announcement. In columns (1) to (3), we test for different fixed-effects specifications, control for firm size and whether the firm has previously issued green bonds. In all specifications, the estimate for the *Post x Treated* variable remains insignificant. Interestingly, in column (3) we add a control variable for the UK hosting COP26 in 2021 in Glasgow, and find that the indicator variable is highly significant. On that account, firms incorporated in Great Britain have signed more Net-Zero commitments in the year of COP26.

One major drawback of Net-Zero commitments, documented by [Bolton and Kacperczyk \(2022\)](#), is that signatories tend to be firms that already emit less. On the contrary, carbon-intensive companies and sectors are more reluctant to become signatories. This type of firm is however most likely to benefit from signing such a commitment if the ECB includes it in its criteria, as brown firms predominantly tap the eligible segment ([Papoutsis et al., 2021](#)). In columns (4) and (5) and then in columns (6) and (7) we estimate the same model but focus on the subset of globally brown firms and sectorally brown firms respectively. Similarly to our previous results, we do not find any significant increase in the probability of signing a Net-Zero commitment from brown firms incorporated in the Eurozone after the ECB announcement.

In summary, our findings indicate that the ECB announcement has not been able to couple the increase in green bond issuance with an increase in Net-Zero commitments. Brown firms that are typically beneficiaries of the CSPP, and will be critical to reach Net-Zero, have not changed their signing behavior following the ECB announcement.

9 Conclusion

We shed light on the role central banks can play in fostering the transition to a low-carbon economy. We focus on the recent announcement by the European Central Bank in its *Monetary Policy Strategy Review* in July 2021. The announcement includes a road map to incorporate climate considerations within its monetary policy operations while remaining within the boundaries of its mandate.

We find that, following this announcement: (i) eligible green bonds reacted with a statistically and economically significant reduction in Yield-to-Maturities when compared to eligible conventional bonds, (ii) in contrast, there was no increase in the cost of conventional bond financing for brown firms.

On the supply side, we obtain that firms incorporated in the Eurozone increased green bond issuance more strongly than firms in Europe but outside the Eurozone. The effect is more pronounced for investment-

	All firms			Globally brown firms			Sectorally brown firms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
<i>Post × Treated</i>	0.019 (0.95)	0.029 (1.46)	0.008 (0.42)	0.017 (0.27)	0.011 (0.17)	0.017 (0.34)	0.033 (0.62)		
<i>Amount of GB issued (in USD billion) in previous year</i>	-0.002 (-0.04)	-0.011 (-0.28)	-0.008 (-0.20)	-0.064 (-0.66)	-0.071 (-0.74)	0.007 (0.08)	0.002 (0.02)		
<i>Has issued GB (0/1) in previous year</i>	-0.044 (-1.03)	-0.037 (-0.88)	-0.035 (-0.86)	0.034 (0.28)	0.038 (0.32)	0.009 (0.08)	0.011 (0.11)		
<i>Log(assets) in previous year</i>	0.004 (0.24)	0.006 (0.33)	0.003 (0.16)	-0.022 (-0.24)	-0.040 (-0.43)	-0.073 (-0.74)	-0.087 (-0.86)		
<i>Year=2020</i>	0.020* (1.92)								
<i>Year=2021</i>	0.096*** (6.22)								
<i>COP25 taking place in Spain</i>			0.050 (0.89)		0.210 (1.39)		0.233 (1.05)		
<i>COP26 taking place in Great Britain</i>			0.147*** (3.77)		0.063 (0.59)		-0.058 (-0.71)		
Observations (Issuer-Year)	2632	2632	2632	437	437	504	504		
Adj. R-squared	-0.049	-0.046	-0.029	-0.165	-0.162	-0.123	-0.120		
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Sector x Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes		

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table 8: Effect of the ECB green shift announcement on Net-Zero commitments by Stoxx600 firms. Energy firms (GICS sector 10) are excluded. COP25 and COP26 are dummies equal to 1 in case a COP event happened in the country on year of observation. The *Post* dummy is equal to one for any observation obtained after the ECB announcement on July 8, 2021.

grade green bonds and seasoned green bond issuers. Furthermore, we test whether issuers favored externally reviewed green bonds, signaling their alignment with strong environmental objectives. We obtain that less than half of the overall increase in cumulative green bond issuance stems from externally reviewed green bonds. Our results thus suggest that central banks will need to incorporate stringent criteria to ensure that they boost the development of high-quality green bonds.

We finally investigate whether the announcement also contributed to spreading the adoption of firm-level decarbonization plans by focusing on Net-Zero commitments. In contrast with our previous results, we find no evidence of an increase in the probability of signing a Net-Zero commitment for Eurozone firms after the ECB announcement.

Overall, our findings provide evidence of the positive effect on green bond issuance of including green considerations within monetary policy operations. One caveat is that specific requirements on external verification are necessary to increase the transparency and the environmental benefits of those issuances. It would also be critical to link cheaper green project financing to some actual firm-level long-term decarbonization plans. To date, and according to our results, this link appears to be weak.

References

- B. Becker, D. Bergstresser, and G. Subramanian. Does Shareholder Proxy Access Improve Firm Value? Evidence from the Business Roundtable Challenge. Working Paper 17797, National Bureau of Economic Research, Feb. 2012. Series: Working Paper Series.
- M. Bertrand, E. Duflo, and S. Mullainathan. How much should we trust differences-in-differences estimates? page 32, June 2003.
- P. Bolton and M. T. Kacperczyk. Firm Commitments, June 2022.
- L. Boneva, G. Ferrucci, and F. P. Mongelli. To Be or Not to Be “Green”: How Can Monetary Policy React to Climate Change? *SSRN Electronic Journal*, 2021.
- F. Bremus, F. Schuetze, and A. Zaklan. The Impact of ECB Corporate Sector Purchases on European Green Bonds. *SSRN Electronic Journal*, 2021. ISSN 1556-5068.
- R. A. De Santis and A. Zaghini. *Unconventional monetary policy and corporate bond issuance*. Publications Office, LU, Nov. 2019.
- P. Deschryver and F. de Mariz. What Future for the Green Bond Market? How Can Policymakers, Companies, and Investors Unlock the Potential of the Green Bond Market?, 2020.

- S. Dikau and U. Volz. Central bank mandates, sustainability objectives and the promotion of green finance | Elsevier Enhanced Reader, 2021.
- T. Ehlers and F. Packer. Green bond finance and certification. Sept. 2017.
- R. Fahlenbrach and E. Jondeau. Greening the Swiss National Bank's Portfolio. *SSRN Electronic Journal*, 2021.
- E. F. Fama and K. R. French. The Cross-Section of Expected Stock Returns, 1992.
- C. Flammer. Corporate green bonds. *Journal of Financial Economics*, 142(2):499–516, Nov. 2021.
- F. Giovanardi, M. Kaldorf, L. Radke, and F. Wicknig. The Preferential Treatment of Green Bonds, May 2021.
- B. Grosse-Rueschkamp, S. Steffen, and D. Streitz. A capital structure channel of monetary policy. *Journal of Financial Economics*, 133(2):357–378, Aug. 2019.
- L. P. Hansen. Central banking challenges posed by uncertain climate change and natural disasters, Sept. 2021.
- H. G. Hong, N. Wang, and J. Yang. Welfare Consequences of Sustainable Finance, Dec. 2021.
- IPCC. IPCC, 2022: Summary for Policymakers. 2022.
- R. S. Koijen, F. Koulischer, B. Nguyen, and M. Yogo. Inspecting the mechanism of quantitative easing in the euro area | Elsevier Enhanced Reader, 2021.
- N. Mukhi, S. Rana, S. Mills-Knapp, and E. Gessesse. World Bank Outlook 2050 Strategic Directions Note: Supporting Countries to Meet Long-Term Goals of Decarbonization. Strategy Note, World Bank, Washington, DC, June 2020.
- M. Papoutsis, M. Piazzesi, and M. Schneider. How unconventional is green monetary policy? page 55, Oct. 2021.
- L. Pastor, R. F. Stambaugh, and L. A. Taylor. Sustainable Investing in Equilibrium. page 54, June 2020.
- L. Reichlin, K. Adam, W. J. McKibbin, M. McMahon, R. Reis, G. Ricco, and B. Weder di Mauro. The ECB strategy: The 2021 review and its future, 2021.
- K. Todorov. Quantify the quantitative easing: Impact on bonds and corporate debt issuance. *Journal of Financial Economics*, 135(2):340–358, Feb. 2020.
- A. Zaghini. The CSPP at work: Yield heterogeneity and the portfolio rebalancing channel | Elsevier Enhanced Reader, Dec. 2017.
- O. D. Zerbib. Is There a Green Bond Premium? The yield differential between green and conventional bonds. page 67, 2019.

A Additional Institutional Details

A.1 The CSPP

The Corporate Sector Purchase Program (CSPP) represents one of the Asset Purchase Programmes (APP) created by the European Central Bank (ECB) in the aftermath of the Great Financial Crisis. The CSPP was initiated in 2016 and targeted investment-grade euro-denominated corporate bonds from non-bank issuers located in the euro area. As of December 2021, EUR 308 billion are held in the CSPP portfolio. This amount also includes securities purchased as part of the Pandemic Emergency Purchase Program (PEPP), which was started in March 2020 in response to the COVID-19 shock. The PEPP included purchases of private and public sector securities for a total cap of EUR 1850 billion.

A.2 Green bonds

Green bonds are debt financial instruments directed at financing firms' green projects/assets. Differently from conventional bonds, they have a "use-of-proceeds" structure in which investors' capital is directly channeled into the stated projects/assets in the green bond prospectus. Generally, funds are "earmarked" compared to general corporate funds to provide transparency to green bond investors that funds are solely directed towards the intended target.

The financial industry has developed ad-hoc green bond frameworks and taxonomies for issuers and investors for what defines green bonds and green assets/projects to increase standardization and transparency in the market. At their discretion, issuers can reference in their bond documentation that the bond is green and indicate whether the "green" label is referenced to a particular green bond framework or principle.

Multiple market standards are available for issuers to indicate adherence to particular definitions of "green". The ICMA Green Bonds Principles (GBP) are among the first and most widely referenced by green bonds issuers. The core components of the GBP are the following:

1. *Use of Proceeds*: GBP eligible green projects/assets need to provide environmental benefits. The GBP considers only broad eligible environmental categories to which projects need to adhere: climate change mitigation, climate change adaptation, natural resource conservation, biodiversity conservation, and pollution prevention and control;
2. *Process for Project Evaluation and Selection*: issuers need to clearly communicate to investors in relation to: (i) the environmental objective targeted by the green bond, (ii) evaluation process of environmental sustainability by the issuer, (iii) complementary information regarding the use of proceeds including social and environmental risks;
3. *Management of Proceeds*: related to the operation details of the separation of funds compared to general corporate funds;

4. *Reporting*: issuers need to provide updated reporting on the use of proceeds and update them at least annually.

Externally reviewed green bonds

Adherence to Green Bond Principles relies on voluntary compliance, and is subject to broadly defined requirements.

In order to aim for more transparency, issuers can commission an external review on the green credentials of the use of proceeds. Those external reviews can be of the following form:

1. **Second-Party-Opinions (SPO)**: They provide an assessment of the issuer's plans by analysing the "greenness" of eligible projects/assets, and by checking compliance with the green bond reporting framework. They are given by ESG providers.
2. **Green bond rating**: Some of the ESG providers that provide Second-Party Opinions also give a rating to the sustainability and ESG components of bond issuance, ranging for example in the case of CICERO from red (non-green bond) to dark green.
3. **Green bond assurance**: They provide an independent verification of the robustness of the issuance as well as, in contrast to a SPO, a legally binding assessment of green bond disclosure.
4. **Climate Bonds Initiative certification**: This type of review follows some stricter standards, in agreement with the Climate Bonds Standards. The requirements are split into both some pre-issuance and post-issuance criteria. If, during the years after issuance, a certified bond fails to meet the post-issuance criteria, the certification will be repealed.

Green bond evaluation vs credit ratings

Green bond ratings and labels need not be confused with opinion on an issuer environmental risk exposure. An important point in relation to green bonds is whether these instruments provide themselves a hedge against environmental risks for investors. These environmental related risks are categorized by the Task Force on Climate-related Financial Disclosures (TCFD) in Transition Risks, i.e. risks stemming from policy/regulatory or technology shocks, and physical risks, i.e. risks originating from natural disasters and change in climate patterns such as global warming. To the extent that green bond issuers are less exposed to environmentally related risks, investing in green bonds could provide a hedge against these shocks. However, green bonds per-se provide a rather limited risk management device in that respect. On the one hand, majority of green bonds are claims to the overall issuers' operations and the green label per-se does not provide an opinion to an issuer exposure to those risks. Furthermore, by the fact that the majority of green bond corporate issuers are in sectors such as energy and industrials, which are notable more exposed to environmental credit risk, investing in green bonds from issuers in

these sectors potentially provides considerable environmental risk exposure (Ehlers et al., 2017). On the other hand, issuance of green bonds signals an issuer's commitment to reducing its climate risks exposure which is in line with the finding of Flammer (2020) of investor's positive reaction to a firm's announcement of green bond issuance.

Green bonds in the CSPP

As part of the CSPP program, the ECB has purchased green bonds⁷. However, in its original implementation, the CSPP purchases follow the principle of "market neutrality", according to which net purchases are guided by the proportion of market value of all eligible bonds by economic sector and rating groups. By doing so, the portfolio allocation does not include any screening based on environmental or other criteria, and thus green bonds are purchased turning a blind eye to their "greenness".

Between 2013 and 2018, total euro-denominated green investment grade issuance accounted for 24% of total global net green issuance. In mid 2017, total euro-denominated net issuance's surpassed for the first time usd-denominated issuance's and accounted for approximately USD 60 billion. Regarding the total issuance of bonds in the Eurozone, euro-denominated green investment grades accounted for approximately 1% of total euro-denominated debt supply (ECB, 2018).

In the CSPP-eligible universe, green bonds account for 4% of the eligible universe. Interestingly, in terms of industry distribution, green bond issuances are more concentrated in carbon-intensive sectors such as utilities, infrastructure and real estate and transportation. These sectors taken together account for 35% of CSPP-eligible universe but 94% of CSPP-eligible green bond issuance (ECB, 2018).

Figure A.1 shows the cumulative number of green bond ISINs included in the CSPP portfolio since its inception.

Finally, besides corporate green bonds, sovereign and supranational green bond issuances have also been purchased as part of the PSPP but account for less than 1% of PSPP-eligible universe as of 2018. Multilateral development banks such as the European Investment Bank and agencies like Kreditanstalt für Wiederaufbau have been issuing green bonds since early 2000 while governments' issuances have been increasing since 2020 and the first Eurozone issuance dates from 2017 with the French Treasury. As of 2018, the eurosystem holds 24% of outstanding sovereign and supranational euro-denominated green bonds issuance which is in line with the total PSPP holdings compared to the PSPP-eligible universe.

Variable name	Description	Source
Green bond	This variable is based on Bloomberg's "Green Bond" label, what tags green bonds if they are either (a) self-labelled this way by firms, or (b) if they are an environmental sustainability-oriented bond with commitment to deploy funds towards projects in the Green Bond Principles.	Bloomberg
Yield-to-maturity	The yield of a bond calculated until maturity.	Datastream
Carbon price	Sourced from the European Union Emissions Trading System (EU-ETS), the world's largest cap and trade greenhouse gas emissions market. Allowances for carbon emissions are first allocated considering EU directives for the maximum amount of greenhouse gases that can be emitted. Allowances for carbon emissions are then auctioned and traded.	Ember
Investment-grade bonds	Investment-grade bonds are identified either through a rating above BBB- or Baa, or due to the fact that we limited access to ratings, using the "ECB-eligible" label from Bloomberg, which constitute a subset of investment-grade green bonds.	Bloomberg
Externally reviewed green bonds	Green bonds that have received either a Second-Party Opinion, a green bond rating, a green bond assurance or a CBI certification. Details about each category are given in Section A.2.	Climate Bonds Initiative
Banks	We identify as banks those firms whose GICS industry group is "Banks" (4010).	Compustat

Table B.1: Variable definitions and sources.

	Size	Leverage	Net-Zero Committed	# EUR green bonds	Scope 1 Emissions	Scope 1 Intensity	Bank	Brown firm (global scope 1)	Brown firm (sectoral scope 1)
Size	1								
Leverage	-0.0647*	1							
Net-Zero Committed	0.0928**	0.0668*	1						
# EUR green bonds	0.291***	-0.00199	0.0426	1					
Scope 1 Emissions	0.155***	-0.0295	0.0585	0.108**	1				
Scope 1 Intensity	0.140***	-0.0244	0.0393	0.147***	0.719***	1			
Bank	0.451***	-0.0989**	-0.0927**	0.222***	-0.0639	0	1		
Brown firm (global scope 1)	0.166***	0.0656*	0.0752**	0.0858**	0.398***	0.397***	-0.124***	1	
Brown firm (sectoral scope 1)	0.320***	0.0399	0.0558	0.108***	0.316***	0.293***	0.0143	0.412***	1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: Correlation table between different firm-level characteristics, such as emission levels, number of green and conventional bonds issued and "greenness" of the firm, for the set of Stoxx600 firms.

	Mean	Sd	Minimum	p5	Median	p95	Maximum
Yield-to-Maturity	0.28	0.62	-0.70	-0.41	0.17	1.28	7.44
Time to Maturity (in years)	5.93	4.24	1.02	1.33	4.95	13.91	30.66
Coupon	1.40	1.21	0.00	0.00	1.13	4.00	8.13
Amount Issued (in USD billions)	0.65	0.67	0.00	0.00	0.57	1.70	6.52

(a) Characteristics of eligible conventional bonds issued by Stoxx600 corporations (control group).

	Mean	Sd	Minimum	p5	Median	p95	Maximum
Yield-to-Maturity	0.18	0.39	-0.47	-0.38	0.07	0.91	1.29
Time to Maturity (in years)	6.70	3.96	1.13	1.49	5.86	13.40	20.26
Coupon	0.99	0.74	0.00	0.01	0.88	2.75	3.05
Amount Issued (in USD billions)	0.78	0.34	0.05	0.27	0.73	1.46	1.93

(b) Characteristics of eligible green bonds issued by Stoxx600 corporations (treatment group).

Table B.3: Bond-level descriptive statistics for our first set of treatment and control groups, based on whether the bond is green or conventional. Time-to-Maturity is computed as years until maturity on 01/01/2021.

	Mean	Sd	Minimum	p5	Median	p95	Maximum
Yield-to-Maturity	0.80	0.74	-0.47	-0.30	0.69	2.25	3.87
Time to Maturity (in years)	4.81	3.20	1.13	1.71	3.86	10.41	19.14
Coupon	1.20	0.67	0.01	0.25	1.13	2.50	3.20
Amount Issued (in USD billions)	0.25	0.27	0.02	0.03	0.10	0.75	1.01
GBP-denominated	0.08	0.27	0.00	0.00	0.00	1.00	1.00
SEK-denominated	0.61	0.49	0.00	0.00	1.00	1.00	1.00
EUR-denominated	0.31	0.46	0.00	0.00	0.00	1.00	1.00
Received External Review	0.69	0.46	0.00	0.00	1.00	1.00	1.00

(a) Characteristics of the green bonds issued by Stoxx600 firms incorporated outside the Eurozone (control group).

	Mean	Sd	Minimum	p5	Median	p95	Maximum
Yield-to-Maturity	0.29	0.60	-0.52	-0.36	0.10	1.45	2.91
Time to Maturity (in years)	6.69	3.66	1.41	1.85	5.82	12.19	20.26
Coupon	1.12	0.85	0.00	0.01	1.00	3.00	3.50
Amount Issued (in USD billions)	0.78	0.41	0.03	0.13	0.72	1.49	2.85
GBP-denominated	0.01	0.09	0.00	0.00	0.00	0.00	1.00
SEK-denominated	0.02	0.15	0.00	0.00	0.00	0.00	1.00
EUR-denominated	0.97	0.18	0.00	1.00	1.00	1.00	1.00
Received External Review	0.56	0.50	0.00	0.00	1.00	1.00	1.00

(b) Characteristics of the green bonds issued by Stoxx600 firms incorporated in the Eurozone (treatment group).

Table B.4: Bond-level descriptive statistics for our second set of treatment and control groups, based on whether the issuer is incorporated in the Eurozone. Time-to-Maturity is computed as years until maturity on 01/01/2021.

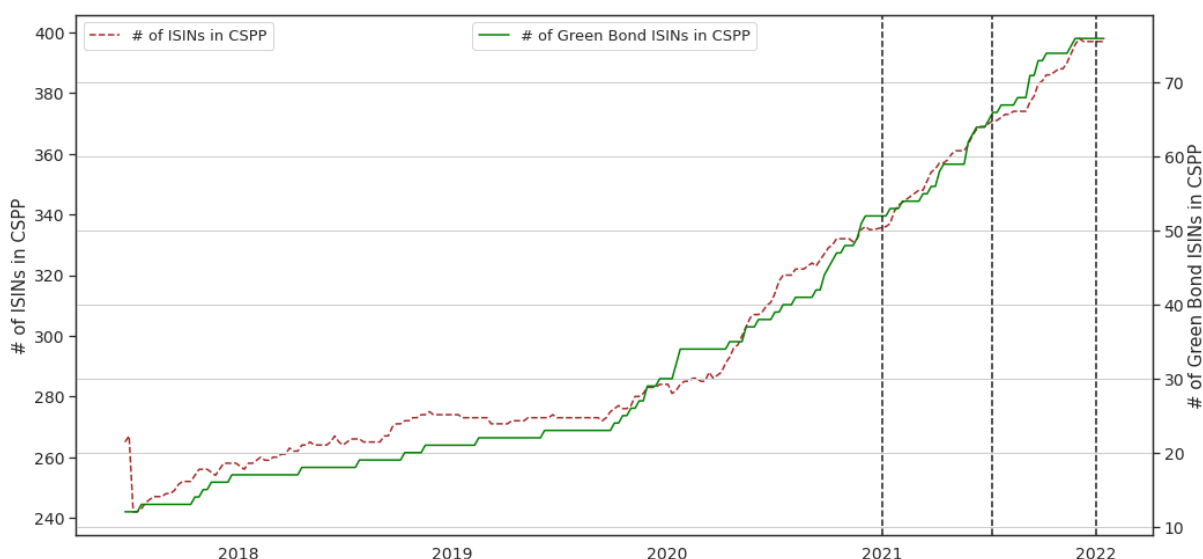


Figure A.1: Number of green bonds included in the CSPP (green line, RHS) and the number of ISINs included in the CSPP program (red dashed line, LHS) between 2017 and 2022. Source: ECB website.

B Additional Data Details

B.1 Descriptive statistics

In Table B.2, we present a correlation matrix for some of the firm-level variables used in our analysis. One striking fact is that those firms issuing more green bonds are predominantly big firms, and also tend to be brown. This suggests that brown firms may be fueling the growth in issuance of EUR-denominated corporate green bonds in our sample.

From Table B.3, we observe that eligible conventional bonds have on average, in secondary market transactions, a higher Yield-to-Maturity than green bonds⁸. From Table B.4, we obtain that the firms incorporated in the Eurozone issue larger green bond tickets, at a lower average Yield-to-Maturity than firms incorporated outside the Eurozone and include a lower proportion of externally reviewed bonds.

B.2 Corporate green bonds

Figure B.2 shows the strong growth experienced by corporate green bonds since 2017, with a majority of issuance from Financial and Utility firms. We focus on Stoxx600 issuers and display the Amount issued in eligible and non-eligible green bonds for each BICS Level 1 sector in Figure B.4, and the top EUR-denominated corporate green bond issuers in Figure B.5.

⁷In 2018 the ECB published an economic bulletin on the green bonds purchased in the CSPP. See: https://www.ecb.europa.eu/pub/economic-bulletin/focus/2018/html/ecb.ebbox201807_01.en.html

⁸This finding is in line with a large body of literature studying the "greenium", i.e. the premium difference in Yield-to-Maturity between "comparable" green and conventional bonds. These papers find that evidence of "greenium" in secondary market transaction is absent while some find some evidence on "greenium" in primary market transactions. See, among others, Ehlers and Packer (2017) and Zerbib (2019).

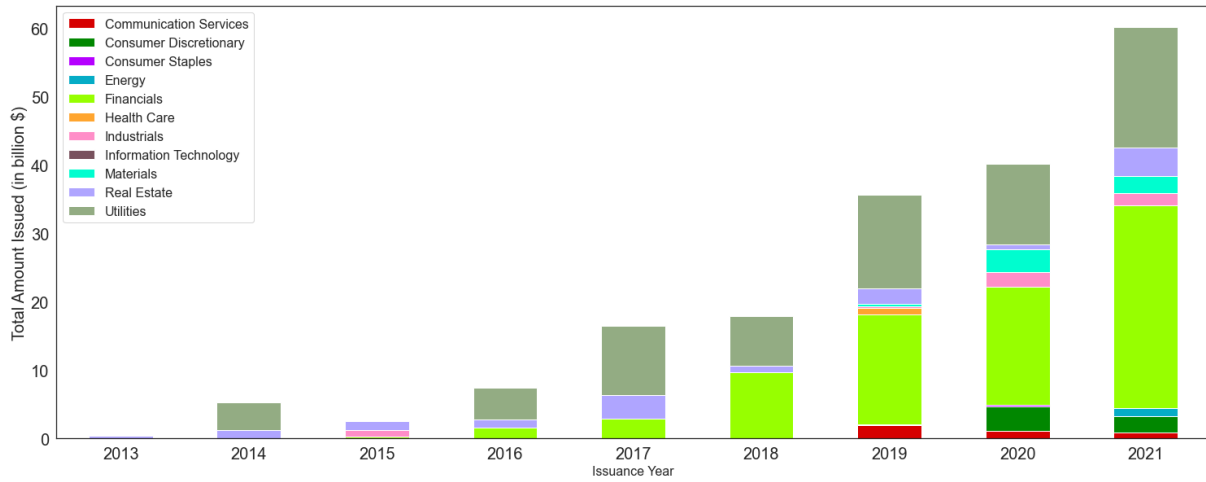


Figure B.2: Total amount of euro-denominated green bonds issued by Stoxx600 firms (in USD billion), by year and by GICS sector.

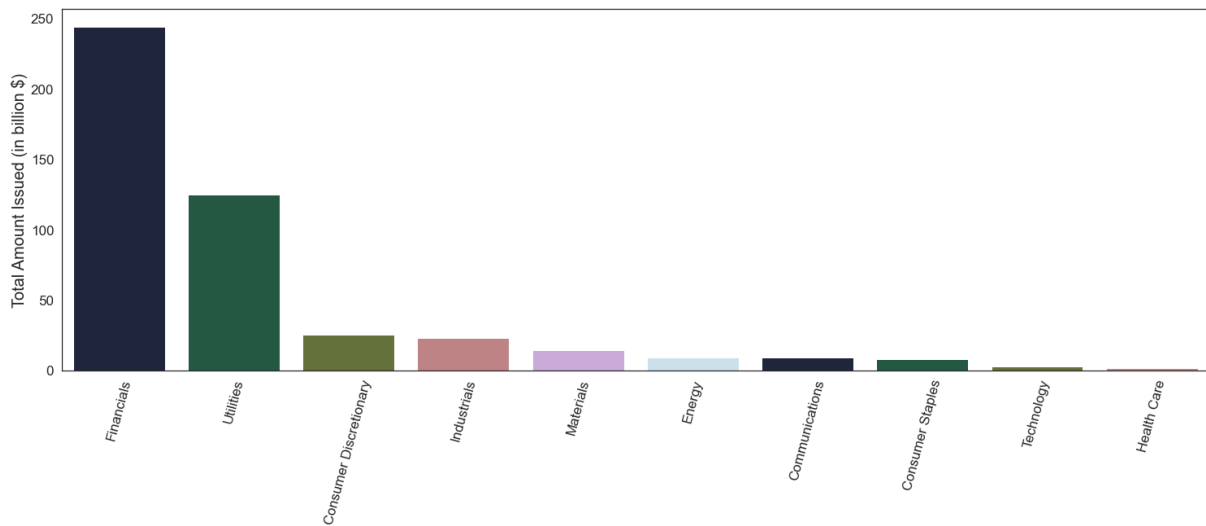


Figure B.3: Aggregate amount of euro-denominated green bonds issued (in USD billion) between 2017 and 2021, by BICS Level 1.

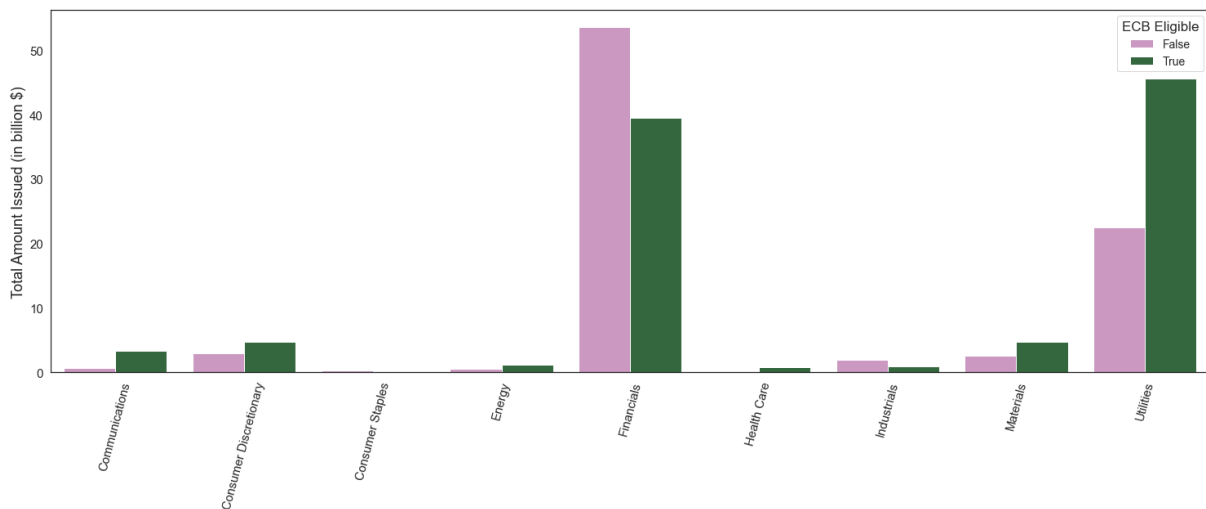


Figure B.4: Aggregate amount of euro-denominated green bonds issued (in USD billions) by Stoxx600 corporations between 2017 and 2021, by BICS Level 1 and eligibility status.

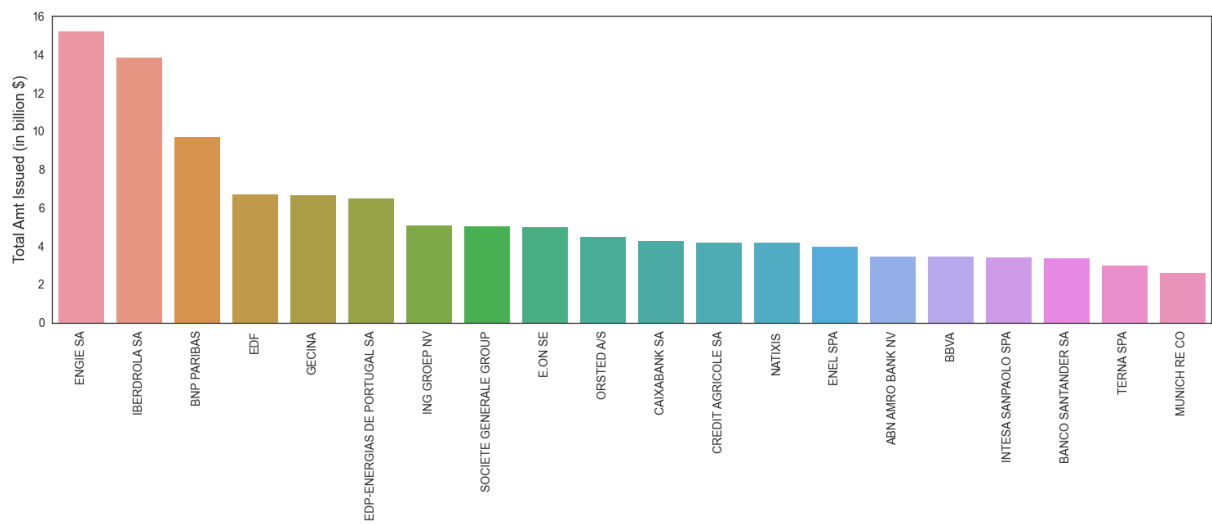


Figure B.5: Aggregate amount of euro-denominated green bonds issued (in USD billions) by the top green bond issuers among the Stoxx600 corporations.

B.3 Net-Zero Commitments

Figure B.6 shows the strong growth experienced by Net-Zero commitments since their inception in 2016. Many sectors of the economy are represented, and in contrast to green bonds, financial firms do not take as massive importance.

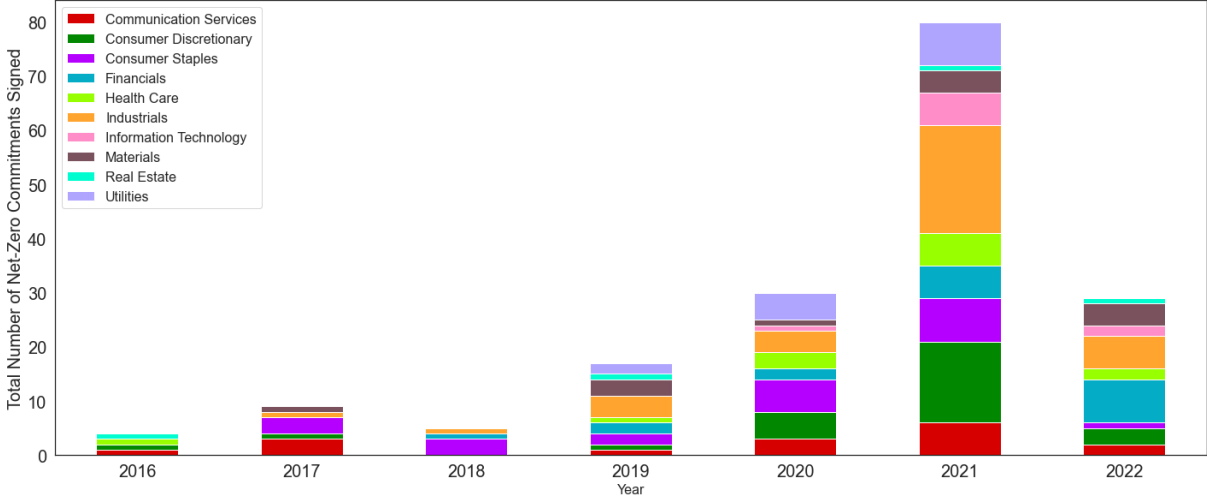


Figure B.6: Total number of Net-Zero commitments from Stox600 firms, by year and by GICS sector.

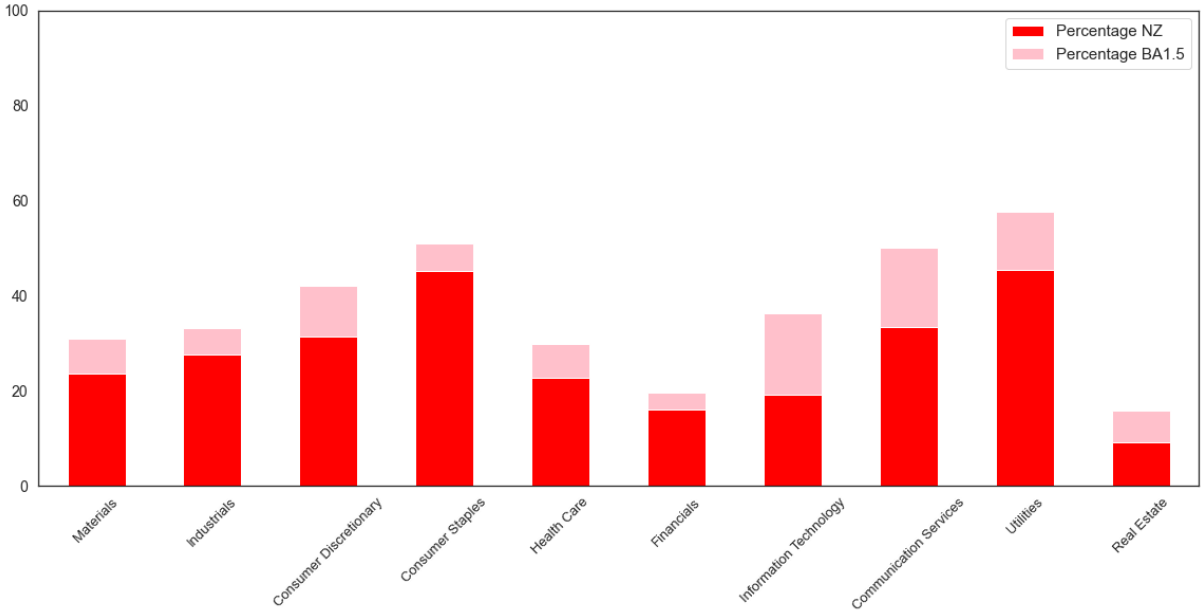


Figure B.7: Percentage of Net-Zero committed firms out of the total number of Stox600 firms, by GICS sector.

C Additional Results

C.1 Bond Price Reaction

Price reaction of green bonds depending on the "greenness" of the issuer: In Table C.5, we estimate our baseline regression 5.1, for different subsets of issuers. We differentiate brown issuers and non-brown issuers, based on either the full distribution of emissions (Columns (1) and (2)) or the sector-level distribution of emissions (Columns (3) and (4)). We find that green bonds issued by brown issuers have experienced a smaller drop in their Yield-to-Maturity, but that the drop is still significant, and amounts to approximately 3bp.

	Greenness defined over full economy		Greenness defined at sector level	
	(1) Brown issuers	(2) Non-brown issuers	(3) Brown issuers	(4) Non-brown issuers
<i>Post x Green bond</i>	-0.027*** (-3.38)	-0.042*** (-3.95)	-0.023** (-2.02)	-0.037*** (-4.12)
Number of distinct bonds	396	1325	828	893
Adj. R-squared	0.992	0.967	0.981	0.969
Bond FE	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Table C.5: Effect of the ECB green shift announcement on the Yield-to-Maturity of eligible green bonds issued by Stoxx600 corporations, compared to eligible conventional bonds issued by Stoxx600 corporations, and depending on the "greenness" of the issuer.

Overall effect of the announcement: In this section, we try to measure the overall effect on the *Monetary Policy Strategy Review*, i.e. the cumulative effect of the "greening" announcement and the new inflation target. In order to estimate this overall effect, we use the same treatment group, but our control group is instead based on Quasi-eligible (i.e. investment-grade) SEK-denominated green bonds. The time series of the average Yield-to-Maturity for this set of treatment and control groups are plotted on Figure C.8. In Table C.6, we report the associated magnitudes. They amount to about 12bps, and vary widely with the "greenness" of the issuer.

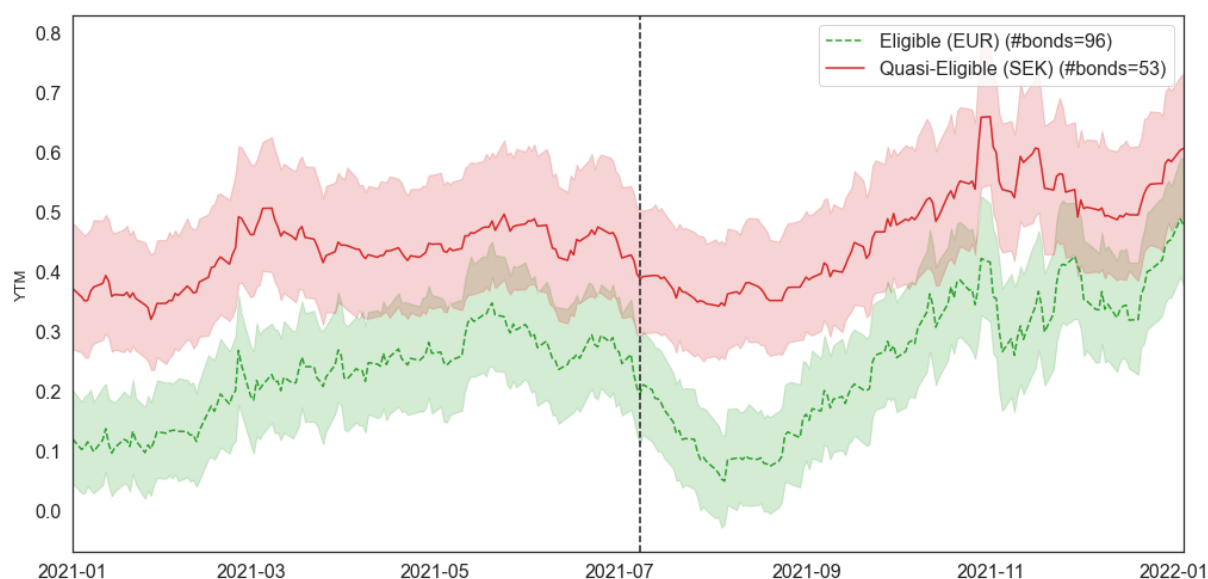


Figure C.8: Mean and 95% confidence interval for the yield-to-Maturity of eligible bonds (green dashed line) and quasi-eligible green bonds (red solid line). Quasi-eligible green bonds are investment-grade SEK-denominated green bonds. The vertical dashed line indicates the announcement of the conclusions of the *Monetary Policy Strategy Review*.

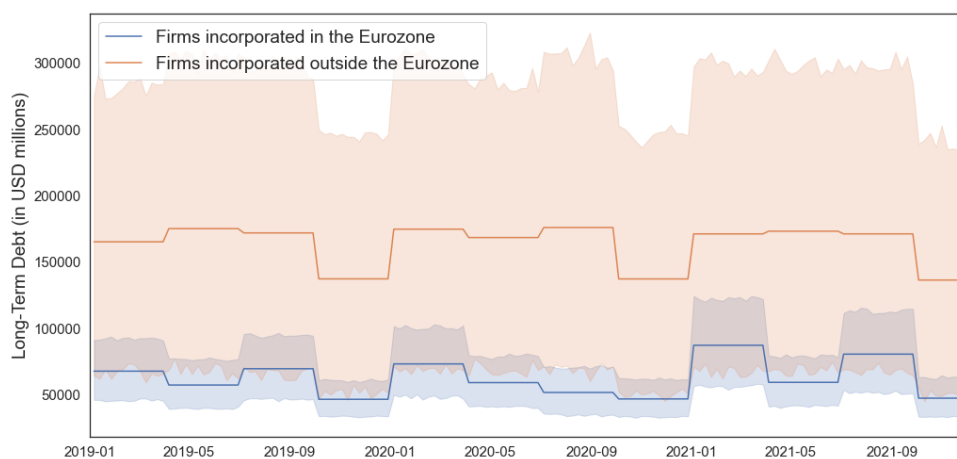
C.2 Green Bonds Adoption

C.2.1 Using the ratio of Cumulative Green Bond over Long-term Debt

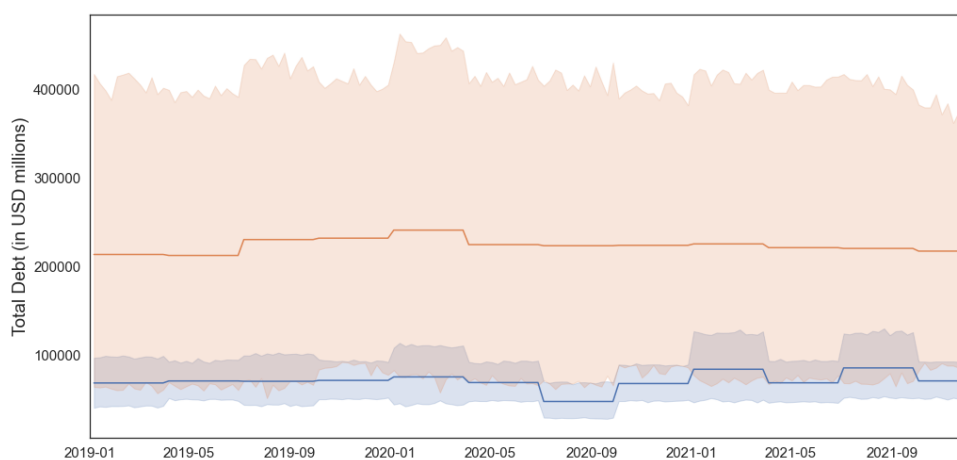
In Table C.7, in order to verify whether the announcement led firms to increase the amount of green bonds in their total debt, we check whether firms incorporated in the Eurozone increased their ratio of Cumulative Green Bonds Issuance compared to firms incorporated outside the Eurozone, using as denominator some quarterly accounting data on Long-Term Debt (DLTTQ) and Total Debt (DLTTQ+DLCQ). We find that, the share of Cumulative Green Bond Issuance over Long-Term Debt and Total Debt significantly increased for firms incorporated in the Eurozone, and that the effect is concentrated in investment-grade green bonds (Columns (3) and (4)). Given that the accounting data on Long-Term Debt is scattered (see Figure C.9), we rely on the results in Section 7 for our baseline specification.

C.2.2 Measuring the fraction of the increase in green bond issuance that can be attributed to Net-Zero committed firms

Using the same methodology, we estimate what fraction of the additional increase in green bond issuance in the Eurozone can be attributed to firms that have signed a Net-Zero commitment. Estimates are shown in Table C.8. We find that the ECB announcement did not lead to an additional boost in green bond issuance from firms with Net-Zero commitments (Panel B), hinting at a persistent disconnect between projects financed through green bonds and the elaboration of firm-level long-term decarbonization plans.



(a) Mean and 95% confidence interval for quarterly long-term debt (DLTTQ).



(b) Mean and 95% confidence interval for quarterly total debt, i.e. long-term debt and debt in current liabilities (DLTTQ + DLCQ).

Figure C.9

C.2.3 Decomposition of the effect between bank and non-bank corporations

In Table C.9, we investigate whether the increase in Cumulative Green Bond Issuance is homogeneous among sectors. We distinguish between banks, which are not eligible to the CSPP, and non-bank corporations. We find that, after the announcement, there has been no significant increase in Green Bond Issuance for banks incorporated in the Eurozone compared to banks incorporated outside the Eurozone. In contrast, there is a highly significant increase in the amount of Cumulative Green Bonds Issuance for non-bank corporations incorporated in the Eurozone, even though the effect is mostly driven by historical green bond issuers (Panel B, Columns (2) and (3)).

C.2.4 Using treatment/control groups based on ECB eligibility

We also study the differential reaction between eligible and non-eligible bond issuers. The treatment group in this specification are eligible bond issuers, i.e. firms that have in the past issued either a green or a conventional eligible bond, whereas the control group are non-eligible bond issuers.

Table C.10 shows the results of the DiD estimation for the dependent variable of *Cumulative Outstanding Number of Bonds* at firm-week level in Panel (A) and the DiD estimation of the *Cumulative Outstanding Par (in USD billion) of Bonds* at firm-week level in Panel (B). Column (2) shows that the interaction term is not significant in terms of number of new issued green bonds in Panel (A), while it is positive and significant for the par of newly issued green bonds in Panel (B). We interpret this finding as indicative of a statically significant increase, following the ECB-announcement, in the amount of green bonds issued by eligible bond issuers. The effect in terms of par issuance is concentrated in the investment-grade segment, suggesting that ECB eligible bond issuers tap the green bond segment that is eligible for the CSPP.

C.2.5 Did the announcement lead to an increase in first-time green bond issuance?

Figure C.10 depicts the green bond issuances that have been made by Stoxx600 firms since the inception of the green bond market in 2013. Among Stoxx600 firms, real estate companies such as Gecina and Unibail-Rodamco-Westfield were the first companies to issue green bonds, in the years 2013 and 2014. Utility companies also rapidly took some importance in the green bond market, with for example Engie and Iberdrola issuing green bonds as early as 2014. This Figure also details which green bonds received a Second-Party-Opinion.

C.3 Stock Prices Reaction

We study the effect of the ECB announcement on stock market returns using an event study analysis. We compute Cumulative Abnormal Returns (CAR) for the cross sections of Stoxx600 firms following the global three-factor model of Fama and French (1992) to estimate the model expected returns. First, we collect data on European Market Excess Return, HML and SMB factors from French data library available from Kenneth French's website⁹. We estimate the model by regressing each stock return on the global three-factor model which provides the coefficient of interest for each firm f in our sample:

$$R_{ft} = \alpha_f + \beta_{1f}R_m + \beta_{2f}R_{SMB} + \beta_{3f}R_{HML} + \epsilon_{ft}, \quad (\text{C.1})$$

where R_{ft} is the stock return for firm f on day t , R_m is the excess return on the market factor, R_{SMB} is the return on the size factor and R_{HML} is the return on the value factor. We winsorize all three beta estimates at the fifth and ninety-fifth percentiles, as in Becker et al. (2012). The parameters are used to compute the market implied returns and the Abnormal Returns as the difference between the daily

⁹https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

realized return and global three-factor model implied returns:

$$\hat{R}_{ft} = \hat{\alpha}_f + \hat{\beta}_{1f}R_m + \hat{\beta}_{2f}R_{SMB} + \hat{\beta}_{3f}R_{HML} \quad (\text{C.2})$$

$$AR_{ft} = R_{ft} - \hat{R}_{ft}. \quad (\text{C.3})$$

Finally, we set a narrow event window of one day before and one day after the event, and sum the Abnormal Returns over the event window to obtain the Cumulative Abnormal Returns for each stock:

$$CAR_f = \sum_j AR_{fj} \mathbb{1}(j \in [-1, +1]) \quad (\text{C.4})$$

In this subsection, we examine the stock price reaction to assess whether stock markets also responded to the ECB announcement. The event study results are reported using sorted portfolios based on firm characteristics. First, we sort firms depending on whether they have issued an eligible green bond. Kernel densities of the CARs for each group are reported in Panel (a) of Figure C.11. The two groups present very similar distributions. In Column (1) of Table C.12, we further test whether there is a significant difference in the average and median CAR of the firms sorted on that characteristic. We obtain that both are non significant, suggesting that there was no strong reaction based on a firm having an eligible green bond. When we instead sort firms based on emissions, we obtain that the stock market reaction of green firms is positive (Panel (b) of Figure C.11). Column (2) of Table C.12 shows the average and median CAR when sorting firms based on that characteristic. The positive sign and strong significance for both tests suggests that investors interpret the announcement as being on average more positive for greener firms. We find that a portfolio which is long the bottom quartile of emissions and short the top quartile of emissions earns an average 0.8% (and median reaction of 0.6%) excess return around the announcement date. To benchmark our results, we compare to [Flammer \(2021\)](#)'s result on CAR following green bond issuance. She finds that average CAR in the [-5, 10] window around the event accounts for 0.7% of stock returns.

	All firms			Greenness defined over full economy			Greenness defined at sector level		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
					Brown Issuers	Non-brown Issuers	Brown Issuers	Non-brown Issuers	
<i>Eligible</i> × <i>Post</i>	0.124 (1.32)	-0.128*** (-4.56)	-0.122*** (-4.17)	-0.122*** (-4.20)	-0.006 (-0.31)	-0.203*** (-4.64)	-0.132** (-2.33)	-0.119*** (-3.47)	
<i>Eligible</i>	-0.421*** (-2.71)								
<i>Post</i>	-0.143 (-1.59)								
Number of distinct bonds	111	111	111	111	47	53	31	69	
Adj. R-squared	0.077	0.844	0.837	0.836	0.860	0.833	0.748	0.857	
Bond FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Country x Month FE	No	No	Yes	No	No	No	No	No	
Sector x Month FE	No	No	No	Yes	Yes	Yes	Yes	Yes	

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Table C.6: Effect of the ECB green shift announcement on the Yield-to-Maturity of eligible green bonds, compared to quasi-eligible (investment-grade, SEK-denominated) green bonds.

Panel A: Ratio of Cumulative Green Bond Issuance over Long-Term Debt (DLTTQ)

	All green bonds		Investment-grade		Non-investment-grade	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Post × Treated</i>	0.012*** (3.61)	0.008*** (2.89)	0.009*** (3.42)	0.006*** (2.78)	0.005** (2.47)	0.004** (2.17)
<i>Quarterly Firm Leverage</i>	0.000*** (3.09)	0.000** (2.53)	0.000** (2.51)	0.000** (2.05)	0.000 (1.52)	0.000 (1.04)
<i>Lagged Amount Issued</i>		0.029*** (6.15)		0.022*** (5.58)		0.007** (2.16)
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.912	0.919	0.925	0.931	0.861	0.863
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Ratio of Cumulative Green Bond Issuance over Total Debt (DLTTQ+DLCQ)

	All green bonds		Investment-grade		Non-investment-grade	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Post × Treated</i>	0.012*** (3.57)	0.008*** (2.96)	0.008*** (3.02)	0.005** (2.45)	0.005*** (2.61)	0.004** (2.35)
<i>Quarterly Firm Leverage</i>	0.000*** (2.90)	0.000** (2.31)	0.000*** (2.70)	0.000** (2.16)	0.000 (1.24)	0.000 (0.78)
<i>Lagged Amount Issued</i>		0.024*** (5.18)		0.017*** (4.91)		0.007** (2.07)
Observations (Issuer-Week)	89322	89322	89322	89322	89322	89322
Adj. R-squared	0.881	0.889	0.898	0.905	0.812	0.815
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table C.7: Panel (A) shows the estimates from regression 5.3 using the ratio of cumulative green bond issuance over long-term debt at issuer-week level as the dependent variable, while in Panel (B) the dependent variable is the ratio of cumulative green bond issuance over total debt for each issuer-week. The treatment sample comprises Stoxx600 which are incorporated in the Eurozone, whereas the control group is the set of issuers which are incorporated outside the Eurozone. Carbon prices are from the EU Emissions Trading System and we use six month lags. The time trend is monthly.

Panel A: Number of green bonds issued by Net-Zero committed firms							
	From NZ firms			From NZ firm and IG		From NZ firm and and non-IG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post × Treated</i>	0.012 (0.50)	0.012 (0.50)	-0.044*** (-2.66)	0.005 (0.32)	-0.037** (-2.38)	0.019 (1.28)	0.005 (0.62)
<i>Quarterly Firm Leverage</i>	0.000** (2.52)	0.000** (2.47)	0.000* (1.68)	0.000** (2.36)	0.000 (1.53)	0.000 (0.67)	-0.000 (-0.53)
<i>Lagged Amount Issued</i>			0.460*** (3.10)		0.339** (2.28)		0.111* (1.68)
<i>Post</i>	-0.007 (-0.56)						
<i>Time trend</i>	0.002*** (3.17)						
<i>Carbon Price</i>	-0.000 (-0.80)						
<i>Lagged Carbon Price</i>	0.001* (1.91)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.941	0.941	0.957	0.957	0.967	0.660	0.688
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Par of green bonds issued by Net-Zero committed firms (in USD billion)							
	From NZ firms			From NZ firm and and IG		From NZ firm and and non-IG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post × Treated</i>	0.028 (1.36)	0.028 (1.36)	-0.022** (-2.07)	0.011 (0.81)	-0.023** (-2.05)	0.021 (1.53)	0.005 (0.76)
<i>Quarterly Firm Leverage</i>	0.000** (2.23)	0.000** (2.13)	0.000 (0.51)	0.000** (2.14)	0.000 (0.85)	0.000 (0.85)	-0.000 (-0.94)
<i>Lagged Amount Issued</i>			0.407*** (3.11)		0.274** (2.02)		0.131* (1.85)
<i>Post</i>	-0.014 (-1.32)						
<i>Time trend</i>	0.002*** (2.76)						
<i>Carbon Price</i>	0.000 (0.06)						
<i>Lagged Carbon Price</i>	0.000 (1.37)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.954	0.954	0.969	0.971	0.979	0.612	0.649
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table C.8: Panel (A) shows the estimates from regression 5.3 using cumulative number of green bonds issued by firms that have signed a Net-Zero commitment, at issuer-week level, as the dependent variable, while in Panel (B) the dependent variable is the cumulative amount of green bond issued by firms that have signed a Net-Zero commitment, also for each issuer-week. The treatment sample comprises Stoxx600 which are incorporated in the Eurozone, whereas the control group is the set of issuers which are incorporated outside the Eurozone. Carbon prices are from the EU Emissions Trading System and we use six month lags. The time trend is monthly.

Panel A: Number of bonds								
	Non-Banks				Banks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Post × Treated</i>	0.104* (1.69)	0.100 (1.61)	0.110* (1.73)	0.008 (0.16)	0.683*** (3.94)	0.683*** (3.94)	0.646*** (3.26)	0.368** (2.40)
<i>Quarterly Firm Leverage</i>	0.000*** (3.46)	0.000*** (3.01)	0.000*** (2.79)	0.000** (2.11)	-0.006 (-0.09)	-0.006 (-0.09)	0.019 (0.23)	-0.030 (-0.50)
<i>Lagged Amount Issued</i>				1.094*** (9.22)				0.669*** (7.45)
Observations (Issuer-Week)	90116	90116	90116	90116	5968	5968	5968	5968
Adj. R-squared	0.899	0.900	0.900	0.928	0.924	0.924	0.925	0.950
Week FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Country x Month FE	No	No	Yes	Yes	No	No	Yes	Yes

Panel B: Par of bonds (in USD billions)								
	Non-Banks				Banks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Post × Treated</i>	0.095*** (3.56)	0.089*** (3.59)	0.100*** (3.60)	0.021** (2.11)	0.581*** (4.05)	0.581*** (4.05)	0.550*** (3.48)	0.272** (2.21)
<i>Quarterly Firm Leverage</i>	0.000*** (3.02)	0.000*** (2.62)	0.000*** (2.63)	0.000 (1.40)	0.006 (0.13)	0.006 (0.13)	0.043 (0.62)	-0.006 (-0.15)
<i>Lagged Amount Issued</i>				0.848*** (20.98)				0.666*** (12.31)
Observations (Issuer-Week)	90116	90116	90116	90116	5968	5968	5968	5968
Adj. R-squared	0.938	0.939	0.939	0.979	0.858	0.858	0.859	0.920
Week FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SectorMonthFE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
CountryMonthFE	No	No	Yes	Yes	No	No	Yes	Yes

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table C.9: Panel (A) shows the estimates from regression 5.3 using cumulative number of green bonds issued at issuer-week level as the dependent variable, while in Panel (B) the dependent variable is the cumulative amount of green bond issued for each issuer-week. Stoxx600 firms are separated in non-banks and banks (GICS industry group 4010). The treatment sample comprises Stoxx600 which are incorporated in the Eurozone, whereas the control group is the set of issuers which are incorporated outside the Eurozone. Carbon prices are from the EU Emissions Trading System and we use six month lags. The time trend is monthly.

Panel A: Number of green bonds

	All green bonds			Investment-grade		Non-investment-grade	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post × Treated</i>	0.387*** (4.40)	0.387*** (4.39)	0.158** (2.23)	0.260*** (6.11)	0.090*** (3.59)	0.160** (2.27)	0.112* (1.77)
<i>Quarterly Firm Leverage</i>	0.000*** (3.25)	0.000*** (3.11)	0.000** (2.37)	0.000*** (3.07)	0.000** (2.50)	0.000 (0.88)	-0.000 (-0.09)
<i>Lagged Amount Issued</i>			0.998*** (11.63)		0.743*** (8.83)		0.208** (2.40)
<i>Post</i>	-0.092*** (-4.42)						
<i>Time trend</i>	0.008*** (5.88)						
<i>Carbon Price</i>	0.001 (1.55)						
<i>Lagged Carbon Price</i>	0.000 (0.66)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.904	0.904	0.931	0.936	0.965	0.670	0.683
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Par of green bonds (in USD billion)

	All green bonds			Investment-grade		Non-investment-grade	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Post × Treated</i>	0.267*** (5.99)	0.267*** (5.99)	0.080*** (4.15)	0.206*** (5.55)	0.057*** (2.83)	0.064*** (2.67)	0.027** (2.02)
<i>Quarterly Firm Leverage</i>	0.000*** (3.23)	0.000*** (3.06)	0.000* (1.95)	0.000*** (2.74)	0.000 (1.60)	0.000** (2.12)	0.000 (0.53)
<i>Lagged Amount Issued</i>			0.818*** (24.07)		0.653*** (8.86)		0.162** (2.18)
<i>Post</i>	-0.067*** (-5.22)						
<i>Time trend</i>	0.004*** (5.09)						
<i>Carbon Price</i>	0.001 (1.60)						
<i>Lagged Carbon Price</i>	-0.000 (-0.09)						
Observations (Issuer-Week)	96084	96084	96084	96084	96084	96084	96084
Adj. R-squared	0.929	0.929	0.972	0.940	0.971	0.622	0.665
Week FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector x Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table C.10: Panel (A) shows the estimates from regression 5.3 using cumulative number of green bonds issued at issuer-week level as the dependent variable, while in Panel (B) the dependent variable is the cumulative amount of green bond issued for each issuer-week. The treatment sample comprises issuers which have issued an eligible bond, whereas the control group is the set of issuers which have never had an eligible bond. Carbon prices are from the EU Emissions Trading System and we use six month lags. The time trend is monthly.

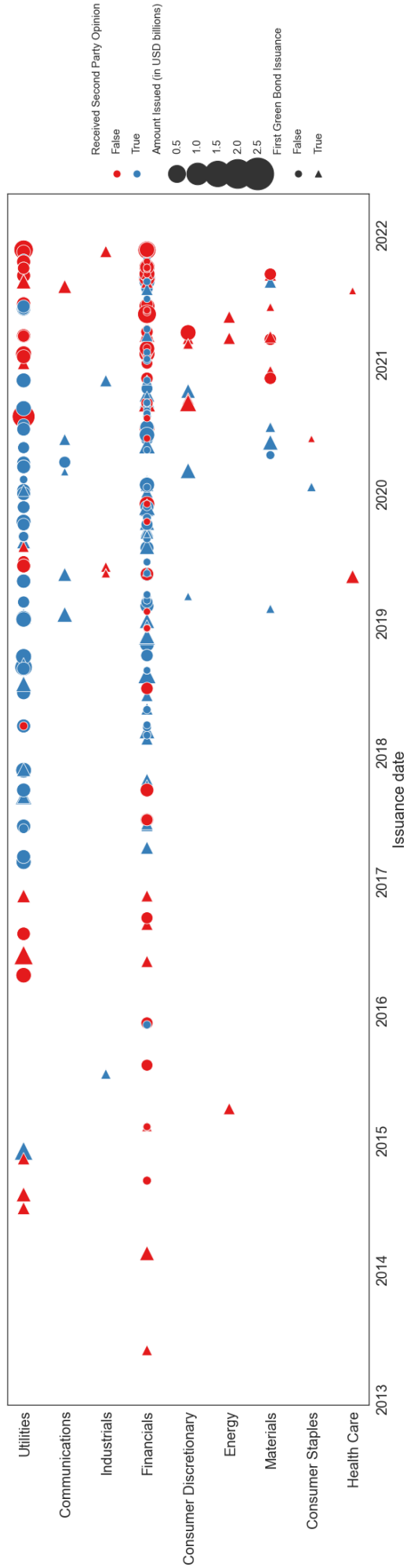
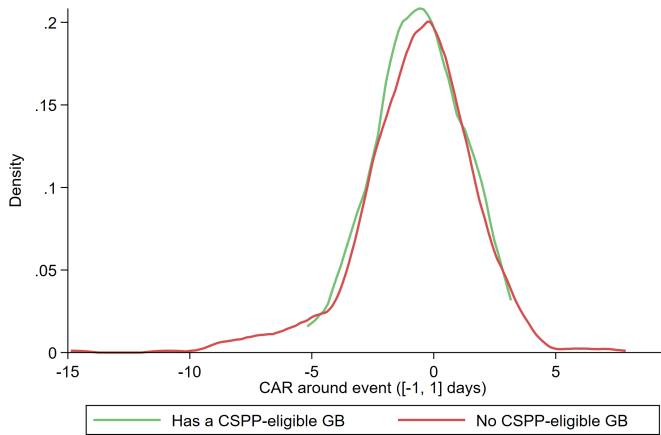


Figure C. 10: Green bond issuances by Stoxx600 firms, depending on the sector of the issuer.

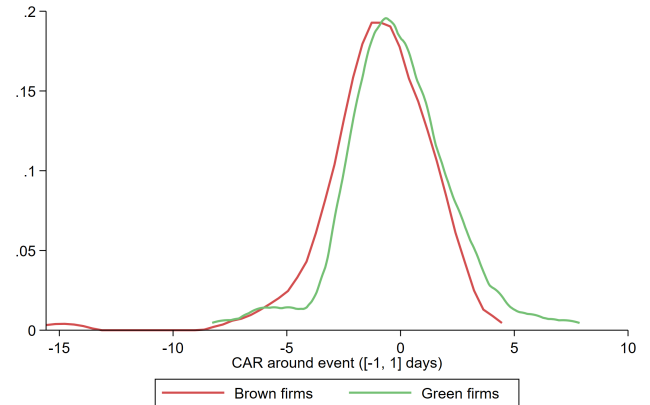
	All green bonds		Investment-grade		Non-investment-grade	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Post</i>	-0.0009 (-1.16)		-0.0006 (-0.76)		-0.0002 (-1.16)	
<i>Treated</i>	0.0002 (0.93)		0.0003 (1.14)		0.0000 (0.05)	
<i>Post × Treated</i>	-0.0001 (-0.47)	-0.0004 (-0.81)	-0.0002 (-0.54)	-0.0005 (-1.26)	-0.0001 (-0.84)	0.0001 (0.48)
<i>Carbon Price</i>	0.0000 (1.10)		0.0000 (0.81)		0.0000 (0.95)	
<i>Age</i>	-0.0000** (-2.02)		-0.0000** (-2.36)		0.0000* (1.86)	
<i>Log(assets)</i>	0.0003*** (3.36)	-0.0003 (-0.52)	0.0002*** (3.26)	-0.0003 (-0.60)	0.0000 (0.63)	-0.0000 (-0.32)
<i>Materials</i>	0.0012*** (2.65)		0.0012*** (2.65)		-0.0000 (-0.07)	
<i>Industrials</i>	0.0003* (1.67)		0.0002 (1.29)		0.0001 (0.88)	
<i>Consumer Discretionary</i>	0.0003* (1.81)		0.0003* (1.75)		-0.0000 (-0.09)	
<i>Consumer Staples</i>	0.0003 (0.97)		0.0000 (0.28)		0.0002 (1.00)	
<i>Health Care</i>	0.0002 (1.35)		0.0002 (1.21)		0.0000 (0.34)	
<i>Financials</i>	0.0007* (1.85)		0.0006* (1.72)		0.0002 (0.84)	
<i>Information Technology</i>	0.0003* (1.75)		0.0003 (1.61)		0.0000 (0.25)	
<i>Communication Services</i>	0.0010* (1.72)		0.0010* (1.70)		0.0000 (0.34)	
<i>Utilities</i>	0.0012* (1.74)		0.0012* (1.74)		-0.0000 (-0.17)	
<i>Real Estate</i>	0.0005 (1.39)		0.0002 (1.13)		-0.0000 (-0.64)	
<i>Direct emissions</i>	-0.0000*** (-2.97)	0.0000 (0.90)	-0.0000*** (-2.91)	0.0000 (0.59)	-0.0000 (-0.68)	0.0000* (1.85)
<i>Indirect emissions</i>	-0.0000 (-1.47)	-0.0038** (-2.31)	-0.0000 (-1.21)	-0.0039** (-2.39)	-0.0000 (-0.62)	0.0000 (0.42)
Observations (Issuer-Week)	51207	51207	51207	51207	51207	51207
R-squared	0.001	0.020	0.001	0.019	0.000	0.017
Week FE	No	Yes	No	Yes	No	Yes
Issuer FE	No	Yes	No	Yes	No	Yes
Sector x Month FE	No	Yes	No	Yes	No	Yes
Country x Month FE	No	Yes	No	Yes	No	Yes

Note: T-statistics are in parentheses. Significance levels are indicated by * < .1, ** < .05, *** < .01. Standard errors are clustered at the issuer level.

Table C.11: Estimates from a linear probability model for the issuer-week binary variable for first-time green bond issues. The reference category is the Oil/Gas/Coal sector (GICS sector 10).



(a) Depending on whether the firm has an eligible green bond. The green line represents the distribution of the CAR of firms that have an eligible green bond, while the red line is related to those firms that do not have an eligible green bond.



(b) Depending on the greenness of the firm (with respect to global emissions). The green line represents the distribution of green firms, while the red line is related to those brown firms.

Figure C.11: Kernel density plot related to the Cumulative Abnormal Returns computed for Stoxx600 firms around the symmetric event window.

	Firms with a CSPP eligible green bond vs firms with no CSPP eligible green bond	Green firms vs brown firms (wrt global scope 1 emissions)
Mean CAR	-0.105 (0.776)	0.817*** (0.009)
Median CAR	-0.156 (0.96)	0.623** (0.016)
Observations	658	236

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.12: T-test on the difference of the mean and median (Wilcoxon test) of portfolios formed on the criteria described in the table header. Units are percentage points. *p*-values are in parenthesis.