ECONSTOR
Make Your Publications Visible.

A Service of
ZBW
Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Grzegorczyk, Monika; Wolff, Guntram B.

Working Paper

Greeniums in sovereign bond markets

Bruegel Working Paper, No. 17/2022

Provided in Cooperation with:
Bruegel, Brussels

Suggested Citation: Grzegorczyk, Monika; Wolff, Guntram B. (2022) : Greeniums in sovereign bond markets, Bruegel Working Paper, No. 17/2022, Bruegel, Brussels

This Version is available at:
https://hdl.handle.net/10419/270471

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

WWW.ECONSTOR.EU

Mitglied der Leibniz-Gemeinschaft

WORKING PAPER | ISSUE 17/2022 | 29 SEPTEMBER 2022

GREENIUMS IN SOVEREIGN BOND MARKETS

MONIKA GRZEGORCZYK AND GUNTRAM WOLFF

The total market value of green bonds exceeded half a trillion dollars in 2021 and will increase to $1 trillion by the end of 2022. The growing European green sovereign bond market has a value of close to €147 billion at issuance. We study whether investors price green sovereign bonds differently to normal sovereign bonds. We do not expect to find a so-called 'greenium': the promise attached to green sovereign bonds is rather loosely defined and green and normal sovereign bonds are both backed by the full faith and credit of their respective governments. However, when systematically matching green and normal sovereign bonds using a number of criteria, including date of issuance and maturity, a small greenium can be measured. More research is needed to understand why rational investors do not arbitrage away this greenium.

Monika Grzegorczyk is a PhD Student at the European University Institute and was a research assistant at Bruegel.
Guntram Wolff is director of the German Council on Foreign Relations and was formerly director of Bruegel. The paper was largely written while both were at Bruegel.

bruegel

Recommended citation:
Grzegorczyk, M. and G. Wolff (2022) 'Greeniums in sovereign bond markets' *Working Paper* 17/2022, Bruegel

1 Introduction

The total market value of green bonds exceeded half a trillion dollars in 2021 and will increase to $1 trillion by the end of 2022 according to the Climate Bond Initiative (CBI, 2022). Large parts of the market consist of private institutions issuing green bonds. More recently, international institutions and governments, as well as the European Union with its Next Generation EU programme, have issued substantial amounts of green bonds (OECD, 2021).

Research shows different yields for green and standard bonds, but the literature is inconclusive on whether there is a systematic positive or negative premium, or 'greenium', on green bonds (MacAskill *et al*, 2021)[1]. Most of the literature focuses on privately issued green bonds, while the emerging market of green sovereign bonds has been barely studied. A recent exception is the study by Bolton *et al* (2022), which is inconclusive and does not find a systemic greenium.

In principle, it is difficult to understand why a green bond issued by a sovereign should be priced differently to any other bond issued by the same sovereign. Green bonds, as currently issued by governments, involve a rather loose promise by governments that the proceeds from the bond sale will be used to fund specific green projects or green current expenditures. However, given the relatively small size of green bond issuance, of around 1.6 percent of total debt stock in the EU[2], it is difficult to argue that these bonds fund projects that otherwise would not have been funded. Meanwhile, revenues in large public budgets are largely fungible. Moreover, none of the sovereign green bonds would result in penalty payments in case green promises are not kept. Instead, like a regular sovereign bond, the full faith and credit of the respective tax base stands behind the promise of repayment. For a rational marginal investor, possible price differences could thus be arbitraged away at a profit.

In this paper, we analyse whether green sovereign bonds are systematically priced differently to conventional sovereign bonds in the secondary markets. Almost no research has so far focused on the green sovereign bond market. The green bonds issued by the public and private sectors have the same fungibility and investor crowding. Yet, unlike private bonds, issuer prospectuses provided by national debt management agencies cannot tie the ultimate power of the legislature to defined expenditures (ie the green debt terms are by definition less credible).

[1] The discount is not the only or primary motivation for green bond purchases. Domínguez-Jiménez and Lehmann (2021) suggested it may be *"reputation building"*.
[2] The value is represented by the capital raised through the issuance of green bonds since 2018, divided by total sovereign debt securities for the end of June 2022.

We are the first to document a systematically lower yield for green sovereign bonds. Unlike Bolton *et al* (2022), we have been able to match green bonds exactly with conventional sovereign bonds on all other characteristics and have identified ten exact matches[3]. A possible explanation for this new empirical finding is the behavioural response of investors, which may be motivated by the reputational benefits of holding green bonds in their portfolios. Institutional investors may be a driver of this difference (Bachelet *et al*, 2019) but more research is needed on this.

We first review the literature, then describe the main characteristics of the European green sovereign bond market, before presenting our findings and conclusions.

2 Literature review

Green bonds attract a lot of attention in the broader policy discourse but there is no clear-cut definition on what constitutes a green bond. The literature also cannot establish systematic differences in yields between green and conventional bonds – the so-called greenium.

Different methods are used in the literature to investigate the existence of a greenium. The most popular approach is matching green and standard bonds based on common features. The most popular characteristics to match are the issuer, currency and maturity. Many researchers consider additional features, including rating, bond structure and coupon type (Annex A). Overall, it is difficult to compare the results as there is no consensus on which characteristics constitute a good match. More sophisticated methods, for instance Gianfrate and Peri (2019), use the propensity score matching technique to estimate the difference between returns at the issuance of green bonds and their conventional peers. Preclaw and Bakshi (2015) and Nanayakkara and Colombage (2018) used the option-adjusted spread (OAS) method. This method measures the difference in yield between a bond with an embedded option (ie callable, putable and convertible options), if one exists. Karpf and Mandel (2018) used linear mixed-effects models with random effects intercepts, while Baker *et al* (2018) and Fatica *et al* (2021) used the asset's pricing model (CAMP). The latter calculates expected stock market return based on market risk premium.

Results are not always aligned. Most authors confirm a negative yield premium (discount) on green bonds (Baker *et al*, 2018; Gianfrate and Peri, 2019; Kapraun and Scheins, 2019; Nanayakkara and

[3] For the broader sample of thirty sovereign issues, we had to rely on the less reliable yield interpolations, the approach chosen by Bolton *et al* (2022), and we also cannot establish a systemic greenium.

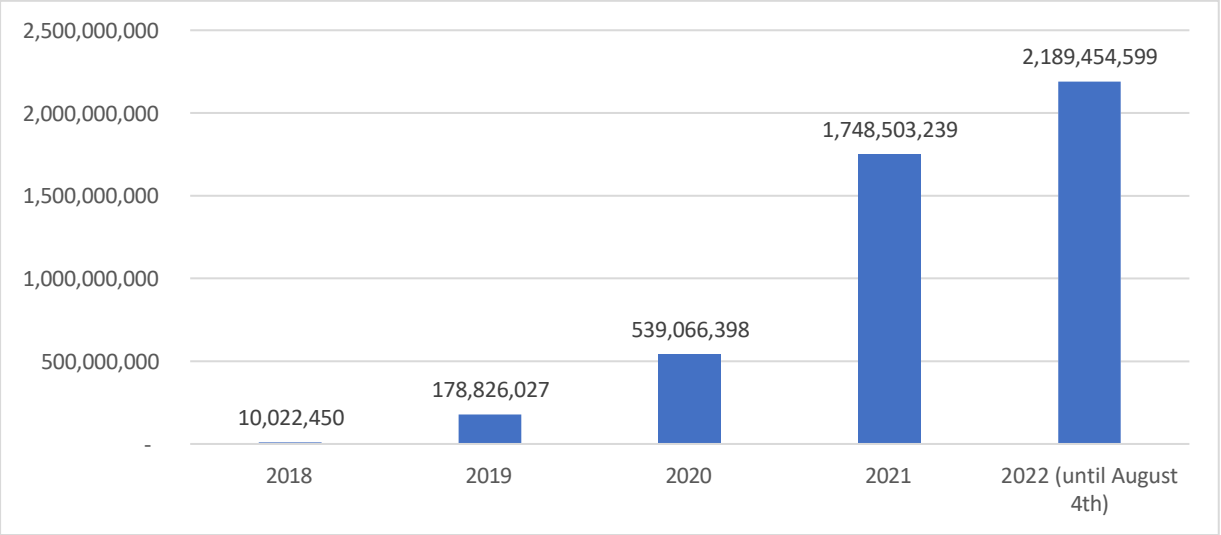
Colombage, 2018; Preclaw and Bakshi, 2015; Zerbib, 2018). The systemic literature review in MacAskill *et al* (2021) confirmed a growing consensus about the greenium. Bachelet *et al* (2019) divided issuers into institutional and private, and found that the premium is negative for the former and positive for the latter. They suggested that issuer characteristics and reputation are crucial in defining the green premium. Kapraun and Scheins (2019) found that the premium is higher for bonds issued by governments or supranational institutions.

MacAskill *et al* (2021) confirmed a consensus on the existence of a green premium in 56 percent of primary and 70 percent of secondary market studies. Moreover, CBI (2021H1) demonstrated that green bonds traded more frequently and therefore exhibited narrower bid/offer spreads on the secondary market. Hachenberg and Schiereck (2018) confirmed that secondary markets trade marginally tighter for the respective period than non-green bonds from the same issuers. Their analysis showed that trade for financial and corporate green bonds is tighter than comparable non-green bonds, while government green bonds trade marginally wider.

Finally, only a few studies have investigated the sub-sovereign and sovereign greenium on the bonds. Two studies (Karpf and Mandel, 2018; Partridge and Medda, 2019) examined the municipal bond market in the United States, finding evidence of a greenium in the secondary market. Another study by CBI (2021H2) compiled a dataset of 46 unique green bonds. They used German twins to show that the green curve is inside the yield curve on the day of issuance, which is evidence of a greenium. Moreover, they matched green and standard bonds for Spain, Hong Kong and Korea, for which results were mixed. Spain placed its green bond inside, while Hong Kong remained outside the yield curve. They could not identify the green bond yield for Korea.

There are few studies of sovereign green bonds in the EU. Doronzo *et al* (2021) studied a sample of 14 countries, mainly European, and found no evidence of the presence of a significant greenium. Compared to Doronzo *et al* (2021) we focus on EU countries and the European Union itself and we ensure an exact match between a green and a non-green sovereign bond. The research by Fatica *et al* (2021) indicated a significant negative premium for supranational institutions. Given the significant rise in green issuance in the EU (Figure 1), the EU sovereign greenium becomes an interesting topic to explore.

Figure 1: Volume of sovereign green bonds issued in the EU



Source: Bruegel based on Bloomberg.

3 Main characteristics of green bonds

Table 1 shows all European Union countries that issued green bonds according to the Bloomberg database. Bloomberg defines green bonds as "*fixed income instruments for which the proceeds will be applied towards projects or activities that promote climate change mitigation or adaptation, or other environmental sustainability purposes".* Moreover, all green bonds must apply proceeds to market-accepted green activities, consistent with green bond principles formulated by the International Capital Market Association.

In the EU, 14 countries have issued 28 green bonds of different maturity and outstanding amounts (as of 4 August 2022). The EU itself has issued three green bonds. In Europe, the maturity range is between three and 30 years[4].

[4] One of the characteristics of green bonds featured in the literature is that they are typically issued with longer maturities (Bank of France, 2019, p 7). Additionally, the French central bank (Bank of France, 2019) compared the characteristics of euro-area non-financial corporations (NFCs) that are issuers of green bonds, and other NFC bond issuers, and found that the average amount of green bond debt is bigger than standard debt, though, that is not the case for EU sovereign green bonds.

Table 1: Sovereign green bonds issued by EU countries

	Cumulative amount (€ billions)	No. issues	Min maturity (years)	Max maturity (years)	% total sovereign debt
Austria	4.0	1	-	27	1.2%
Belgium	10.4	1	-	15	2.1%
Denmark	1.5	1	-	10	1.8%
France	47.4	3	22	23	1.9%
Germany	32.5	4	5	29	1.5%
Hungary	2.7	9	3	30	2.6%
Ireland	6.8	1	-	12	4.2%
Italy	13.5	1	-	24	0.6%
Latvia	0.0	1	-	7	0.2%
Lithuania	0.1	1	-	10	0.3%
Netherlands	15.7	1	-	21	4.1%
Poland	3.0	3	8	30	1.5%
Spain	7.2	1	-	21	0.6%
Sweden	1.9	1	-	10	1.7%
Total (excl. EU and UK)	**146.9**	**29**	**Min: 3**	**Max: 30**	**Av: 1.7%**
EU	28.0	3	15	26	3.5%

Source: Bloomberg and ECB.

On average, green bonds in Europe constitute around 1.7 percent of sovereign debt for those countries that issue green bonds. The total issuance value is almost €147 billion. In nominal values, France issued the most green bonds, more than €47 billion, which is 1.9 percent of total government debt. Green bonds as a share of government debt are highest in Ireland, where they constitute 4.2 percent of total debt. France issued the biggest individual sovereign green bond in Europe in 2017, and the issuance has a value of almost €31 billion.

The EU has issued three green bonds, with an outstanding volume currently of €28 billion. The bonds issued amount to 3.5 percent of debt the EU plans to issue under NGEU (€800 billion). The EU green bonds were issued for 15, 21 and 26 years, and will mature in 2037, 2043 and 2048, respectively.

With the increase in green bond issuance, there was a concern about the liquidity premium of conventional bonds (*The Economist*, 2021)[5]. To address liquidity concerns, Germany has issued twinned bonds allowing investors to swap green bonds for conventional ones. More specifically,

[5] Unprofitable investment can be withdrawn before finishing the project, but once a ministry of finance creates a green bond programme and develops a 'green curve', it may be more difficult to withdraw specific actions. That can make a trade in sovereign green bonds more difficult and can undermine liquidity.

Germany started the issuance of green bonds at the end of 2020. Green bonds are twinned with identical conventional bonds and switching costs for investors are minimal[6].

Compared to the standard bonds issued with a promise to pay interest and principal repayment at maturity, green bonds also promise to deliver high transparency regarding the underlining green expenditures. German green bonds are aligned with the EU Green Bond Standard draft, which ensures alignment with the EU taxonomy, transparency, external review, and supervision by European Securities and Markets Authority (ESMA, 2020).

4 Results

In line with the methodology of CBI (2021H1), we used the matching method to explore the existence of premiums for sovereign green bonds. We matched sovereign green bonds with their standard counterparts based on the issuer type, currency and the same time to maturity[7]. Unlike the CBI (2021H1), we focused on the secondary market. We looked at the mid yield to maturity, whereas the CBI (2021H1) looked at the yield on the issue date, which reflects the price the green bond offered on the pricing date. Also, we created exact matches, meaning that the time to maturity of the green and standard bond is the same. Thus, as in the case of German green twin bonds, we created matched bonds. This exercise gave us ten matches (including four German twins) out of 28 sovereign green bonds issued in the EU.

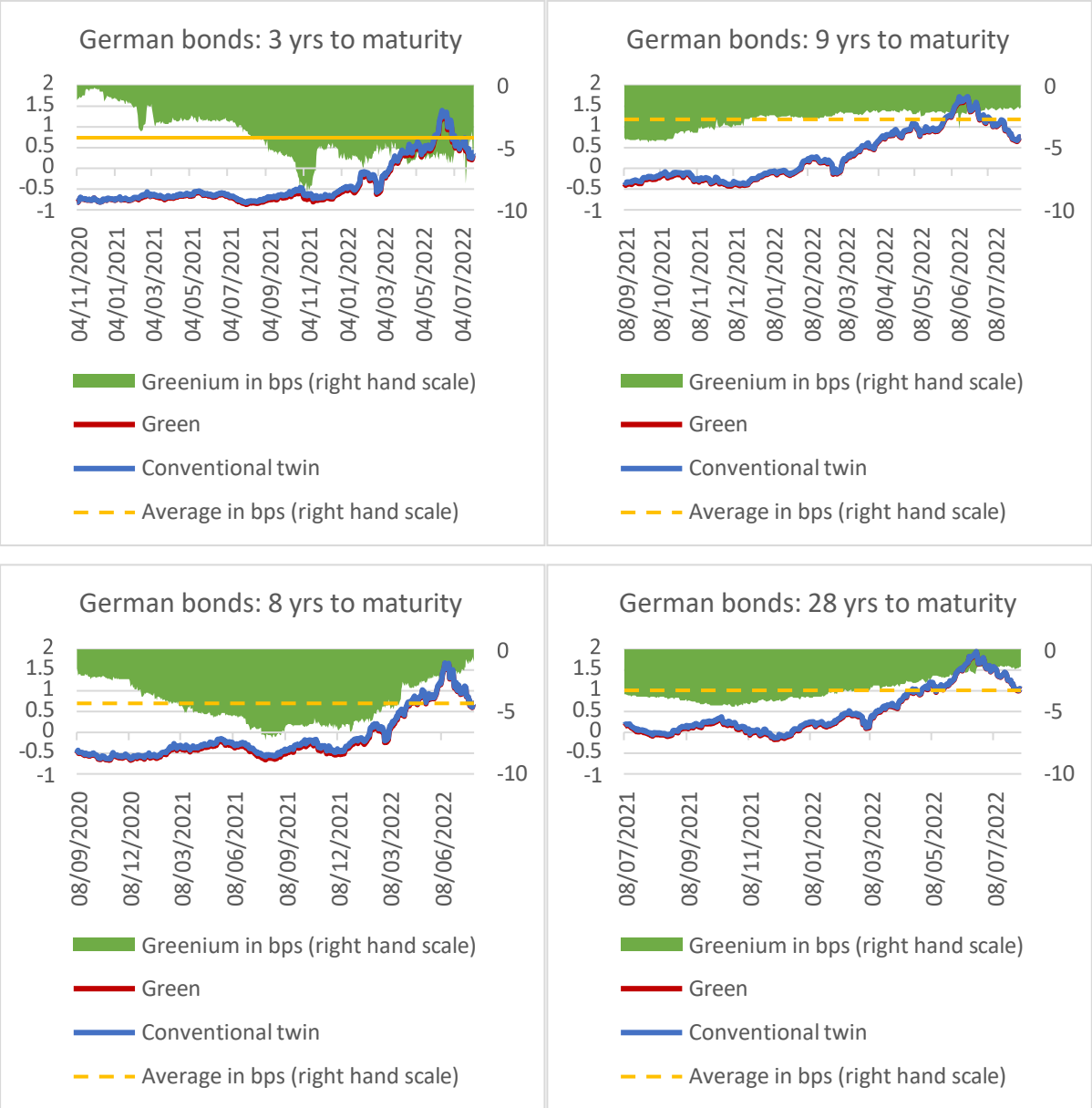
Figures 2 and 3 show the greenium[8] for those pairs. We observed statistically significant greeniums for all matched bonds. From the beginning of 2022, yields have increased for all bonds, but there is no observable trend in the level of greenium.

[6] First, the conventional bond is issued, and then issuance is reopened or tapped several times. One of those taps can be a green bond, and then the same conventional bond is emitted to the own government stock (Bundesrepublik Deutschland, 2022).

[7] Because of bigger differences in the private green bonds market, CBI (2021H1) also looked at the sector and credit rating of the bonds, but for our purposes, this simplified approach was sufficient as we look at bonds of the same issuer.

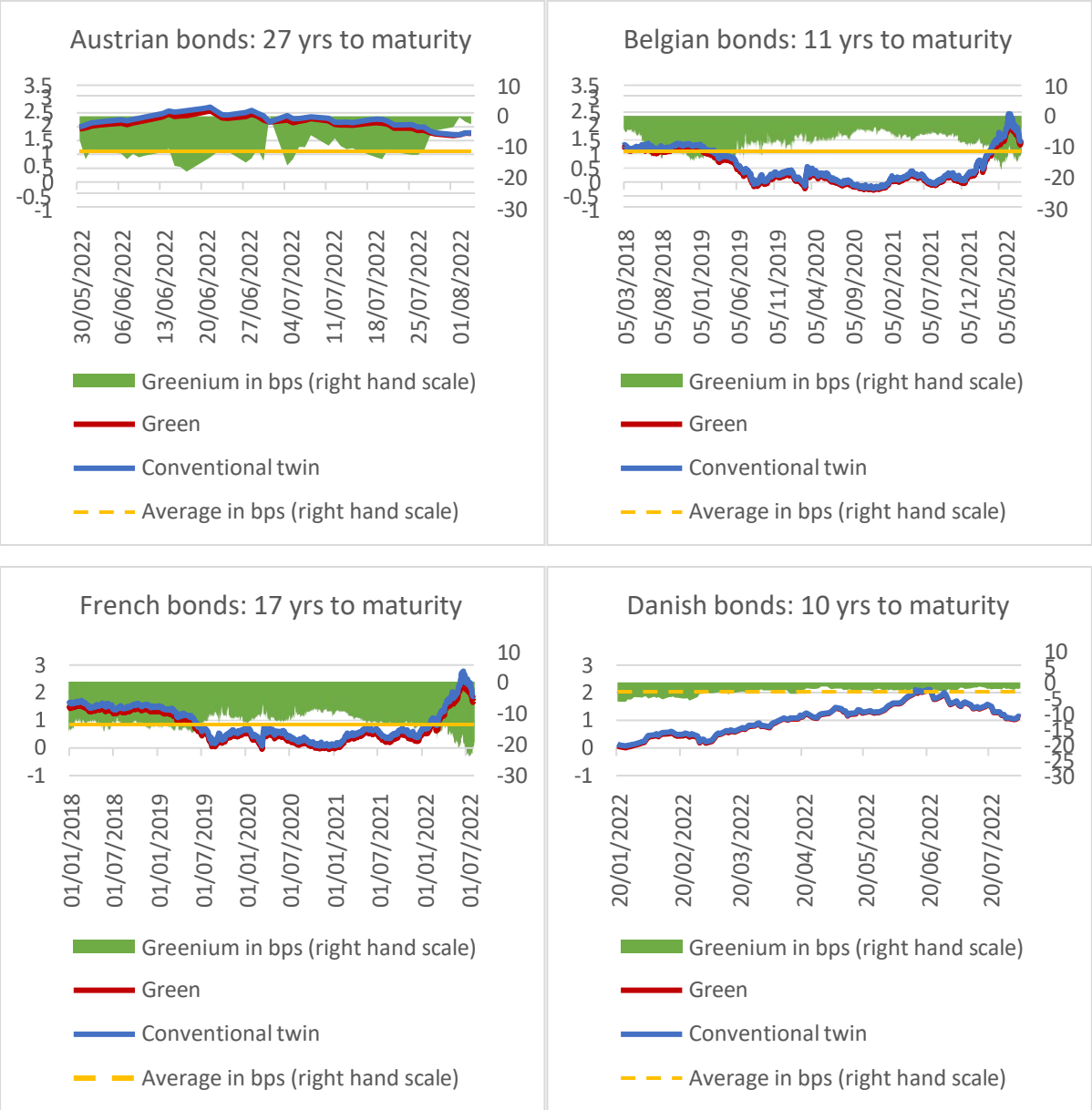
[8] The greenium is defined as green bond yield minus non-green bond yield.

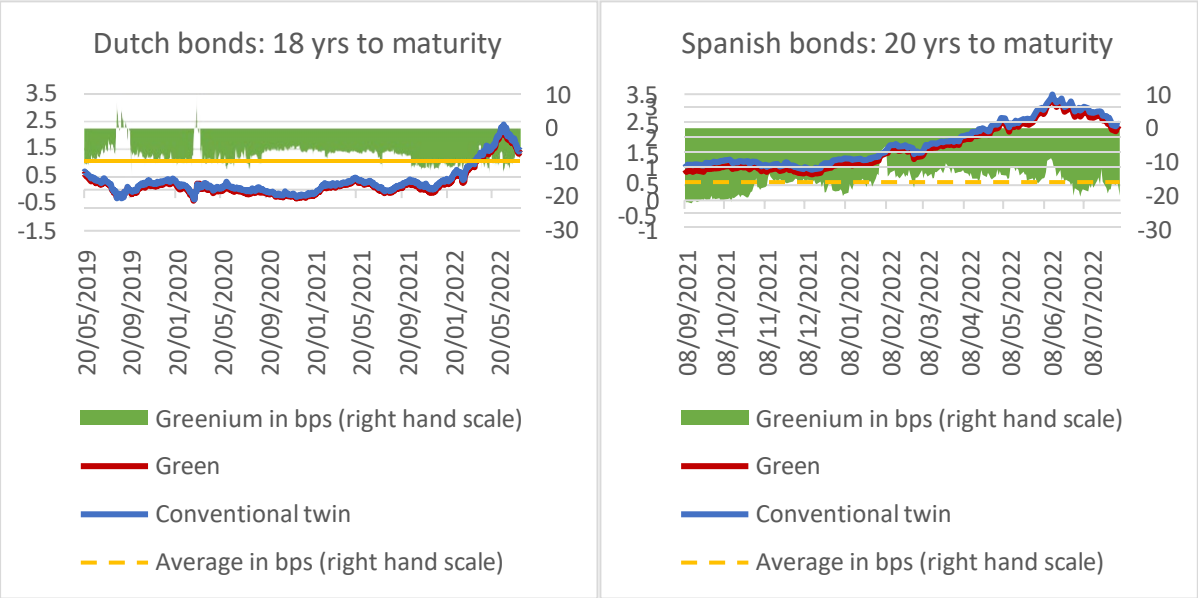
Figure 2: German bonds, mid yield to maturity



Source: Bruegel based on Bloomberg.

Figure 3: Greenium, mid yield to maturity





Source: Bruegel based on Bloomberg.

Studies of greeniums on the private market show similar differences in spreads. For instance, Baker *et al* (2018) found a 6-basis point premium when green bonds are externally verified. Gianfrate and Peri (2019) showed a statistically significant average greenium of about 21 bps for corporate issuers. Finally, the review of studies published between 2007 and 2019 shows an average greenium of 1 to 9 basis points on the secondary market (MacAskill *et al*, 2021). Regarding studies of sovereign greenium, we used only twin bonds in our sample compared to Doronzo *et al* (2021), who did not find a significant green premium. This approach allows us to investigate existing cases without creating synthetic twins.

Our analysis shows that greeniums range from around -3 bps Demark to -16bps in Spain on average. Germany, on average, has -3.6 bps greenium. We observed extreme values ranging from 10 bps (the Netherlands in March 2020) to -22 bps (Spain, Sept 2021, or France in May 2022), across countries and investigated periods. Since yields differed, we tested whether each case had a statistically significant spread difference. We performed a t-test (paired two sample for means), which confirmed that differences in greeniums are statistically significant at 5 percent for each pair.

Table 2: Average in bps through an observed period

		Average in bps
Germany	3 years to maturity	-4
	8 years to maturity	-4
	9 years to maturity	-3
	28 years to maturity	-3
Austria	27 years to maturity	-11
Belgium	11 years to maturity	-9
France	17 years to maturity	-14
Denmark	10 years to maturity	-3
the Netherlands	18 years to maturity	-8
Spain	20 years to maturity	-16

Source: Bruegel based on Bloomberg.

For green bonds without an exact match, we constructed a synthetic bond for each green bond via linear interpolation, which has the same maturity as the green bond. More precisely, we interpolated the yield curve of the non-green bonds at the green bonds' maturity to obtain the yield curve of a non-green bond with the same maturity as the green bond. With this less precise method of comparing bonds, we could not obtain statistically significant results.

5 Discussion

Our exercise indicates that negative greeniums exist for twined bonds and for exactly matched bonds. Even though the green bond market is much smaller and less liquid, investors appear to be ready to accept lower yields on green bonds as they might seek to diversify their portfolios with green bonds. For governments, the motivation for issuing green bonds is not a cheaper way to fund projects. The few basis points we can observe do not make a difference in the financing cost of the budget. More critical may be the signalling effect. Governments want to contribute to the green transition by setting an example in which they comply voluntarily with green bond standards and help define good standards of what constitutes a green bond while preventing greenwashing. A more binding framework would be a stronger signal and help avoid greenwashing (Lehmann, 2021).

6 Conclusions

While previous research combined private and public green bond data, we created a unique dataset of all EU green bonds and their twins or exact matches, where it was possible. Our analysis shows for sovereign EU countries and the EU itself a small but negative greenium for green sovereign bonds. To our knowledge, we are the first to document that systematically.

Our analysis has some limitations. The most obvious is the small number of observations, which increases the margin of error and does not allow us to check the robustness of our analysis. The study might also be impacted by the period when it was conducted, namely the uncertain situation in the financial market caused by the COVID-19 pandemic, the war in Ukraine and the expected rise in interest rates.

The green transition demands funds, which can be obtained through green finance. Green bonds may be one of the solutions to fund the transition. Recently, governments have started to issue green bonds. The wish to create a benchmark green yield curve may be a motivation for this government approach. However, it is difficult to understand why a systematic greenium in sovereign bond markets exists and would prevail, and more research on the drivers of the greenium in sovereign bond markets is warranted.

References

Bachelet, M., L. Becchetti and S. Manfredonia (2019) 'The Green Bonds Premium Puzzle: The Role of Issuer Characteristics and Third-Party Verification', *Sustainability* 11(4): 1-22

Baker, M., D. Bergstresser, G. Serafeim and J. Wurgler (2018) 'Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds', mimeo, available at http://dx.doi.org/10.2139/ssrn.3275327

Bank of France (2019) 'The green bond market is expanding rapidly but needs to be measured more accurately', *Bulletin de la Banque de France* 226/6, available at https://publications.banque-france.fr/sites/default/files/medias/documents/819345_bdf226-6_obligations_vertes_en_vfinale.pdf.

Bolton, P., L. Buchheit, M. Gulati, U. Panizza, B. Weder di Mauro and J. Zettelmeyer (2022) 'Debt and Climate', in *Geneva Report on the World Economy 2022*, forthcoming

Bundesrepublik Deutschland (2022) *The Bund's green twins: Green Federal securities*, available at https://www.deutsche-finanzagentur.de/en/institutional-investors/federal-securities/green-federal-securities/

CBI (2021H1) *Green Bond Pricing in the Primary Market: January - June 2021*, Climate Bonds Initiative, available at https://www.climatebonds.net/files/reports/cbi_pricing_h1_2021_03b.pdf

CBI (2021H2) *Green Bond Pricing in the Primary Market: July - December 2021*, Climate Bonds Initiative, available at https://www.climatebonds.net/files/reports/cbi_pricing_h2_2021_02g.pdf

CBI (2022) *Sustainable Debt Market Summary Q1 2022*, Climate Bonds Initiative, available at https://www.climatebonds.net/files/reports/cbi_susdebtsum_q12022_01f.pdf

Domínguez-Jiménez, M. and A. Lehmann (2021) 'Accounting for climate policies in Europe's sovereign debt market', *Policy Contribution* 10/2021, Bruegel, available at https://www.bruegel.org/sites/default/files/wp_attachments/PC-10-2021-030521_.pdf

Doronzo, R., V. Siracusa and S. Antonelli (2021) 'Green Bonds: The Sovereign Issuers' Perspective', *Markets, Infrastructures, Payment Systems Working Paper* No. 3, Bank of Italy

ESMA (2020) *European green bond standard*, available at https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/european-green-bond-standard_en

Fatica, S., R. Panzica and M. Rancan (2021) 'The pricing of green bonds: Are financial institutions special?' *Journal of Financial Stability* 54, June, available at https://www.sciencedirect.com/science/article/pii/S1572308921000334

Gianfrate, G. and M. Peri (2019) 'Exploring the Convenience of Issuing Green Bonds', *Journal of Cleaner Production*, available at https://ssrn.com/abstract=3329823

Hachenberg, B. and D. Schiereck (2018) 'Are green bonds priced differently from conventional bonds?' *Journal of Asset Management* 19(6): 371-383

Hyun, S., D. Park and S. Tian (2019) 'The price of going green: the role of greenness in green bond markets', *Accounting and Finance* 60(1): 73-95

Kapraun, J. and C. Scheins (2019) '(In)-Credibly Green: Which Bonds Trade at a Green Bond Premium', proceedings of Paris December 2019 Finance Meeting EUROFIDAI - ESSEC, available at https://ssrn.com/abstract=3347337

Karpf, A. and Mandel A. (2018), *A Comparative Study of the Yield Term Structure of Green and Brown Bonds in the US Municipal Bonds Market,* SSRN Electronic Journal - 2017, online: https://app.dimensions.ai/details/publication/pub.1090425174

Lehmann, A. (2021) 'The EU green bond standard: sensible implementation could define a new asset class', *Bruegel Blog*, 12 July, available at https://www.bruegel.org/2021/07/the-eu-green-bond-standard-sensible-implementation-could-define-a-new-asset-class/

Ma, C., W. Schoutens, J. Beirlant, J. De Spiegeleer, S. Höcht and R. Van Kleeck (2020) 'Are green bonds different from ordinary bonds ? A statistical and quantitative point of view', *Working Paper* N° 394, National Bank of Belgium, available at https://www.nbb.be/en/articles/are-green-bonds-different-ordinary-bonds-statistical-and-quantitative-point-view

MacAskill, S., E. Roca, B. Liu, R.A. Stewart and O. Sahin (2021) 'Is there a green premium in the green bond market? Systematic literature review revealing premium determinants', *Journal of Cleaner Production* 280(2), available at https://www.sciencedirect.com/science/article/abs/pii/S0959652620345352?via%3Dihub

Nanayakkara, M. and S. Colombage (2018) 'Do Investors in Green Bond Market Pay a Risk Premium? Global Evidence', 31st Australasian Finance and Banking Conference 2018, available at https://ssrn.com/abstract=3221874

OECD (2021) *Increasing sovereign green bond issuance, helping to promote green growth*, Organisation for Economic Co-operation and Development, available at https://www.oecd.org/coronavirus/en/data-insights/increasing-sovereign-green-bond-issuance-helping-to-promote-green-growth.

Partridge, C. and F. Medda (2019) 'The evolution of pricing performance of green municipal bonds', *Journal of Sustainable Finance & Investment* 10(1): 44-64, available at https://doi.org/10.1080/20430795.2019.1661187

Preclaw, R. and A. Bakshi (2015) 'The Cost of Being Green', *Environmental Finance*, Barclays, available at https://www.environmental-finance.com/content/research/the-cost-of-being-green.html

Tang, D. and Y. Zhang (2020) 'Do shareholders benefit from green bonds?' *Journal of Corporate Finance* 61, April, available at https://www.sciencedirect.com/science/article/abs/pii/S0929119918301664?via%3Dihub

The Economist (2021) 'A wave of green government bonds is flooding markets', available at https://www.economist.com/finance-and-economics/2021/10/09/a-wave-of-green-government-bonds-is-flooding-markets

Zerbib, O. (2018) 'Is There a Green Bond Premium? The Yield Differential Between Green and Conventional Bonds', *Journal of Banking and Finance* 98: 39-60 (published as 'The effect of pro-environmental preferences on bond prices: Evidence from green bonds'), available at https://ssrn.com/abstract=2889690

Annex A: Literature review

	If green premium exists	How they matched	Results
Bachelet *et al* (2019)	Yes. *Institutional green bonds:* negative premium. *Private green bonds:* positive premia, unless the issuer commits to certifying the bond green.	Matched by: - type of organisation, - currency, - rating, - bond structure, - coupon type (coupon rate: +/- 0.25%), - amount issued (+/- 400%), - maturity date (+/- 2yrs).	Role of verification and issuer characteristics. Institutions issue green bonds with higher liquidity and negative premia compared to private. The issuer's reputation or green third-party verifications are essential. The positive premium is very strong for the non-certified categories.
Baker *et al* (2018)	Yes, negative premium Corporate and municipal bonds.	Asset's pricing model	Both pricing and ownership effects are stronger for bonds that are externally certified as green. -6 basis point premium when green bonds are externally verified. Authors notice that sin stocks are associated with higher returns. Green bond ownership is more concentrated since a subset of investors is willing to sacrifice some return to hold green bonds.
CBI (2021H1)	Mixed results. Sovereign and non-sovereign bonds.	Matched by: - issuer, - currency, - maturity, - sector, - credit rating.	26/33 non-sovereign plus a further three sovereign bonds show greenium.
CBI (2021H2)	Mixed results for sovereign.	Matched by: - issuer, - currency, - maturity, - sector, - credit rating.	Two out of four sovereign bond pairs indicate negative green premium.
Doronzo *et al* (2021)	No significant premium	Matched by: - issuer, - maturity, -currency, - payment rank, - credit rating.	Green bonds exhibit specific additional administrative, legal and marketing burdens, which however do not offset the benefits from the signalling effect they produce.
Fatica *et al* (2021)	Negative premium for supranational institutions and corporates.	Asset's pricing model	Premium for green bonds issued by supranational institutions and corporates but no yield differences in case of issuances by financial institutions.

Gianfrate and Peri (2019)	Yes, negative premium.	The propensity score matching	Statistically significant average greenium of about 18 bps. The greenium for corporate issuers is larger, at 21 bps.
Hachenberg and Schiereck (2018)	Mixed results.	Matched by: - issuer, - currency, - ranking, - not structured bonds - depending on the green bond: fixed or floating - depending on the green bond: secured or unsecured, - issue size is at least $150 million.	The secondary market trade marginally tighter for the respective period than non-green bonds of the same issuers. Financial and corporate green bonds trade tighter than comparable non-green bonds. On the other hand, the government green bonds trade marginally wider.
Hyun *et al* (2019)	No robust evidence of a green premium.	Matched by: - issuer, - currency, - rating, - bond structure, - maturity (the closest issue date to the green bond).	Controlling for other pricing factors, having an independent reviewer and a CBI certificate significantly reduces the green bond premium by about 6 and 15 basis points (bps), respectively.
Kapraun and Scheins (2019)	Yes, negative.	Matched by: - issuer, - currency, - coupon type, - seniority (order of repayment in case of bankruptcy).	Credibility plays an important role. Premium is higher for bonds issued by governments or supranational and for bonds denominated in dollars or euros.
Karpf and Mandel (2018)	Mixed results. US municipal bonds in the secondary market.	Linear mixed-effects models with random intercepts	Issuers of green bonds have historically faced a negative premium. In recent years the premium has turned positive, suggesting that the credit quality of municipal green bonds has increased.
Ma *et al* (2021)	No statistically significant evidence of a green premium.	Matched by: - maturity, - seniority, - currency.	The lagging effect between the greenium and stress in financial markets can indicate that sustainable investments like green bonds are potentially more immune to systemic crises.
MacAskill *et al* (2021)	Yes.	Systemic literature review	There is a green premium within 56% of primary and 70% of secondary market studies, particularly for those green bonds that are government-issued, investment grade, and that follow

			defined green bond governance and reporting procedures.
Nanayakkara and Colombage (2018)	Yes, negative premium.	The option-adjusted spread (OAS) method, which measures the difference in yield between a bond with an embedded option.	Green bonds are traded at a premium of at least 63bps in the global capital market. The reputation of issuing enterprise is a key determinant of the credit spread.
Partridge and Medda (2019)	Mixed results. US municipal bonds.	Matched by: - issuer, - use of proceeds, - issue date, - maturity date, - coupon.	No evidence in the primary market, statistically significant premium in the secondary market of 5 basis points by 2018.
Preclaw and Bakshi (2015)	Yes, negative premium.	OAS	Premium at least in the secondary market.
Tang and Zhang (2020)	No significant premium.	Matched by: - issuer - the year of issuance.	Increased institutional ownership and improved stock liquidity after green bond issuance. Green bonds can help enlarge the investor base because issuing them can attract more media exposure and be used by impact investors to satisfy their investment mandates.
Zerbib (2018)	Yes, small negative premium.	Matched by: - issuer, - maturity, - currency, - rating, - bond structure, - seniority, - collateral - coupon type, - a limited difference in issue date and size.	A negative premium is more pronounced for financial and low-rated bonds.

Annex B: Comparison between the characteristics of green and conventional bonds

Name of bond (BBG ticker)	Country of issuance	Date of issuance	Maturity	Outstanding amount (€ billions)	Currency
BW790654 Corp	Austria	31/05/2022	23/05/2049	4	EUR
BW892759 Corp	Austria	31/05/2022	23/05/2049	-	EUR
AQ387666 Corp	Belgium	05/03/2018	22/04/2033	10.43	EUR
AR617235 Corp	Belgium	05/03/2018	22/04/2033	-	EUR
FRTR 0.5 06/25/2044 Govt	France	23/03/2021	25/06/2044	14.18	EUR
-	France	-	-	-	-
FRTR 1.75 06/25/2039 Govt	France	31/01/2017	25/06/2039	30.94	EUR
FRTRD 0 06/25/2039 Govt	France	24/01/2017	25/06/2039	-[9]	EUR
BS926229 Corp	Denmark	21/01/2022	15/11/2031	8.97	DKK
BN398347 Corp	Denmark	22/01/2021	15/11/2031	68.53	DKK
BM138425 Corp	Germany	06/11/2020	10/10/2025	5	EUR
BK306463 Corp	Germany	10/07/2020	10/10/2025	25	EUR
BR243376 Corp	Germany	10/09/2021	15/08/2031	8	EUR
BP980366 Corp	Germany	18/06/2021	15/08/2031	31	EUR
ZO291992 CORP	Germany	09/09/2020	15/08/2030	8	EUR
BJ948280 CORP	Germany	19/06/2020	15/08/2030	32	EUR
BP474265 Corp	Germany	18/05/2021	15/08/2050	10	EUR
ZR097974 Corp	Germany	23/08/2019	15/08/2050	34	EUR
BP158835 Corp	Hungary	28/04/2021	28/04/2051	91.20	HUF
-	Hungary	-	-	-	-
BJ814642 Corp	Hungary	05/06/2020	05/06/2035	1.50	EUR
-	Hungary	-	-	-	-
BT572641 Corp	Hungary	26/01/2022	27/05/2032	105.26	HUF
-	Hungary	-	-	-	-
BU579727 Corp	Hungary	25/02/2022	25/02/2032	7.80	JPY
-	Hungary	-	-	-	-
ZO392836 Corp	Hungary	18/09/2020	18/09/2030	4.50	JPY
-	Hungary	-	-	-	-
BU579676 Corp	Hungary	25/02/2022	22/02/2029	4.70	JPY
-	Hungary	-	-	-	-
ZO392837 Corp	Hungary	18/09/2020	17/09/2027	15.50	JPY
-	Hungary	-	-	-	-

[9] This is an Inflation Linked Coupon Strip. For coupon and principal strips, BBG does not have amounts issued and outstanding. These types of securities are stripped off government bonds in private transactions, and the data regarding the amounts is not disclosed.

BU578917 Corp	Hungary	25/02/2022	25/02/2027	46.80	JPY
-	Hungary	-	-	-	-
BS973909 Corp	Hungary	16/12/2021	16/12/2024	1.00	CNY
-	Hungary	-	-	-	-
AU920470 Corp	Ireland	17/10/2018	18/03/2031	6.85	EUR
-	Ireland	-	-	-	-
BO383338 Corp	Italy	10/03/2021	30/04/2045	13.5	EUR
-	Italy	-	-	-	-
AP496420 Corp	Latvia	17/10/2017	17/10/2024	0.02	EUR
-	Latvia	-	-	-	-
AS442589 Corp	Lithuania	03/05/2018	03/05/2028	0.07	EUR
-	Lithuania	-	-	-	-
ZS094777 Corp	Netherlands	23/05/2019	15/01/2040	10.71	EUR
EK079941 Corp	Netherlands	21/02/2014	15/01/2040	-	EUR
AX451553 Corp	Poland	07/03/2019	08/03/2049	0.5	EUR
-	Poland	-	-	-	-
AX451552 Corp	Poland	07/03/2019	07/03/2029	1.5	EUR
-	Poland	-	-	-	-
AR022483 Corp	Poland	07/02/2018	07/08/2026	1	EUR
-	Poland	-	-	-	-
SPGB 1 07/30/42 Corp	Spain	14/09/2021	30/07/2042	7.24	EUR
SPGBS 0 07/30/42 Corp	Spain	04/09/2015	30/07/2042	-	EUR
ZO243821 Corp	Sweden	09/09/2020	09/09/2030	20	SEK
-	Sweden	-	-	-	-
BR898393 Corp	EU	19/10/2021	04/02/2037	17	EUR
-	EU	-	-	-	-
BV719365 Corp	EU	12/04/2022	04/02/2043	6	EUR
-	EU	-	-	-	-

© Bruegel 2022. All rights reserved. Short sections, not to exceed two paragraphs, may be quoted in the original language without explicit permission provided that the source is acknowledged. Opinions expressed in this publication are those of the author(s) alone.

Bruegel, Rue de la Charité 33, B-1210 Brussels
(+32) 2 227 4210
info@bruegel.org
www.bruegel.org