An environmental mandate, now what?

Alternatives for Greening the Bank of England's Corporate Bond Purchases

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Executive summary

In March 2021, the UK Government explicitly included the support for the transition to a net zero economy in the mandate of the Bank of England. In response, the Bank announced it would green its Corporate Bond Purchase Scheme (CBPS) and by November 2021 it provided details about the greening framework. The Bank plans to use a climate scorecard that evaluates the bond issuers' climate performance and tilt purchases towards companies that are stronger climate performers within their sectors.

The new environmental mandate has created a unique opportunity for the Bank to play a leading role in the decarbonisation of monetary policy. However, the approach that the Bank has taken to green the CBPS lacks ambition. The Bank's greening strategy has two fundamental limitations. First, it relies on a 'carrots first, sticks later' principle that precludes the introduction of substantial penalties for poor climate performers, at least at a first stage. Second, the Bank remains committed to the principle of 'market neutrality', despite having recognised its inherent carbon bias. This restricts the Bank's ability to reduce subsidies it extends to carbon-intensive activities in the CBPS.

We explore these limitations through a quantitative analysis that replicates the tilting of CBPS holdings as proposed in the Bank's approach, and we show the following:

> The Bank's tilting framework cannot reduce the representation of carbon-intensive activities in the CBPS and can paradoxically lead to some carbon-intensive companies getting better treatment than environmentally friendly companies. This is a consequence of the Bank's continued adherence to the market neutrality principle, which leads to the tilting of CBPS holdings *within* sectors so that the scheme continues to reproduce the underlying sectoral composition of the bond market.
> The Bank's tilting approach is not going to substantively reduce the Weighted Average Carbon Intensity (WACI) of the CBPS portfolio. In our replication, the WACI would only decline by 7%. Thus, the Bank will find it challenging to achieve even its own target of 25% reduction in WACI by 2025.

To help the Bank of England genuinely lead by example on the decarbonisation of monetary policy, we propose two alternatives: *Strong Tilting* and *Strong Tilting+Exclusion*. The *Strong Tilting* option adds activities-based taxonomies into the tilting strategy and reallocates purchases across different sectors without being restricted by the market neutrality principle. In the *Strong Tilting+Exclusion* option, we additionally exclude from the Bank's holdings the bonds of fossil fuel companies and the bonds issued by non-renewable electricity utilities with a poor climate performance. Our quantitative analysis shows the following:

> Our proposals would substantially reduce the subsidies that the Bank of England extends to companies engaged in carbon-intensive activities. Under the *Strong*

Tilting option, the proportion of carbon-intensive bonds in the total CBPS holdings declines from 54% to 48%. In the *Strong Tilting+Exclusion* option, this proportion declines even more to 36%.

Under the *Strong Tilting* option, the WACI of the CBPS portfolio declines by 11%, while *Strong Tilting+Exclusion* leads to a decline of WACI by 39%, allowing the Bank to achieve its 2025 target right now instead of waiting for three more years.

Importantly, the *Strong Tilting+Exclusion* option will likely have the strongest impact on the decarbonisation of the UK economy. It would directly penalise those companies that have done nothing or too little to address the climate crisis. Excluding these companies from CBPS would not just increase their cost of borrowing through bond markets. It would entail adverse reputational effects by sending a strong signal to markets that companies which fail to contribute to the achievement of the Paris targets can suffer financially. Such reputational consequences can increase the pressure on companies to decarbonise their activities and fundamentally change their business models. In comparison, such pressures are minimal under the Bank's tilting option, whereby some carbon-intensive companies could even benefit from the incorporation of climate criteria into the Bank's monetary framework.

Our proposals remain applicable should the Bank decide to taper its corporate asset purchases in the coming months. For example, the Bank can implement tapering by excluding from the eligible universe, or reducing the holdings of, those bonds that have been issued by poor climate performers. A green tapering would give a powerful signal to financial markets.

The climate emergency cannot be addressed through economic policies that simply tinker around the edges. A sharp reduction in emissions requires bold changes in the design of economic policies and the implementation of unprecedented measures that will transform the structure of our financial systems. As a powerful policy institution with a new environmental mandate, the Bank of England should take up the challenge, lead by example, and contribute decisively to the fight against climate change.

1   Introduction

The Bank of England (BoE) has come under growing pressure to play its part in the decarbonisation of the UK economy (see, e.g., Macquarie, 2018; Gabor et al., 2019; Dafermos et al., 2020; van Lerven et al., 2021). Initially, it dismissed calls for decarbonising its monetary policy, arguing that environmental sustainability was not part of its mandate. This, however, changed in March 2021 when the UK Government explicitly included the support for the transition to net zero in the BoE mandate.[1] In

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[1] 1See here the letter from the Chancellor to the BoE Governor: https://www.

response, the Bank announced the greening of its Corporate Bond Purchase Scheme (CBPS) by the end of 2021.[2]

Then, in May 2021 the BoE set out the general principles of its approach to greening the CBPS. [3] It acknowledged that the 'market neutrality' principle – which allocates unconventional bond purchases according to the existing sectoral composition in the bond market – is inconsistent with the environmental mandate. The Bank echoed previous analyses showing that market neutrality hardwires a carbon bias into the CBPS (see Matikainen et al., 2017; Dafermos et al., 2020). This carbon bias implies that the CBPS may lower the cost of borrowing (thus extending an implicit subsidy) and encourage more debt issuance by carbon-intensive firms relative to low-carbon firms. In its current guise, the CBPS reinforces market failures and the carbon lock-in, whilst undermining the goals of the Paris Agreement.

The BoE outlined several tools to rebalance the carbon-intensive CBPS portfolio: (i) *portfolio targets* for monitoring progress towards the decarbonisation of CBPS; (ii) *tilting*, i.e. rebalancing of corporate bond purchases towards issuers that perform relatively strong from a climate perspective; (iii) *exclusion* of bond issuers whose activities are incompatible with climate neutrality; and (iv) *escalation*, a strategy of introducing progressively more stringent measures – tilting, asset exclusion and divestment – for issuers who do not improve their climate performance.

In November 2021, the BoE provided further details about the greening of its CBPS (Bank of England, 2021b). The Bank clarified that it will rely on a climate scorecard for firms to tilt purchases *within* sectors without altering the representation of sectors in its programme. This means that it will effectively retain market neutrality, despite having recognised the problems of this principle in the context of the climate crisis. The Bank also announced criteria for the exclusion of companies from the CBPS eligible list, which however affect a very small subset of carbon-intensive firms. The new framework is being deployed in the Bank's reinvestments between November 2021 and January 2022.

In this report, we assess the Bank's approach to the greening of the CBPS and propose alternatives. We argue that the Bank's greening strategy has two fundamental limitations. First, the Bank relies on a 'carrots first, sticks later' principle that precludes the introduction of any substantial penalties for poor climate performers, at least at a first stage. Second, it continues to adhere to the principle of market neutrality, which does not allow for the introduction of substantial penalties for companies that engage

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bankofengland.co.uk/-/media/boe/files/letter/2021/march/2021-mpc-remit-letter.pdf?la=en& hash=C3A91905E1A58A3A98071B2DD41E65FAFD1CF03E.

[2] See the announcement of the Bank here: https://www.bankofengland.co.uk/news/2021/ march/mpc-remit-statement-and-letter-and-fpc-remit-letter.

[3] See Bank of England (2021a). For more information about the CBPS, see Appendix A.

in carbon-intensive activities.[4]In short, the Bank's approach lacks ambition: although it is nominally greener than previous strategies, it will have relatively negligible effects on the overall composition of the CBPS portfolio from a climate perspective.

Albeit the small size of the CBPS relative to the overall corporate bond market (£20bn), the Bank's strategy of postponement and delay sets a worrying standard for financial markets. The BoE has the opportunity to create direct pressure – via substantial penalties – on polluting companies. Its decision to waste this opportunity is at odds with a precautionary or systemic risk approach to climate change which emphasises that central banks should do 'whatever it takes' to prevent worst-case yet plausible scenarios of irreversible climate-induced collapse of economic, financial and social systems.[5]

To capture empirically this lack of ambition, we replicate the key aspects of the BoE's tilting approach. We show that the BoE's reliance on a climate scorecard, which ignores the carbon footprint of the activities of bond issuers, does not reduce the representation of carbon-intensive activities in the CBPS and paradoxically leads to some carbon-intensive companies getting better treatment than environmentally friendly ones. This is a direct consequence of the BoE's continued adherence to the market neutrality principle, which tilts bond purchases according to climate scorecards *within* sectors, so that the CBPS continues to replicate the underlying sectoral +sition of the bond market. For example, the BoE would reduce the holdings of some fossil fuel bonds but would increase purchases of bonds issued by other fossil fuel companies that perform better in the same sector. Similarly, some environmentally friendly companies would see a decline in the BoE holdings because they do not perform sufficiently well according to the climate scorecard. For example, in our replication, the Bank increases the holdings of bonds issued by BP PLC, a fossil fuel company, while it reduces the holdings of bonds issued by Suez SA, an 'Environmental services and equipment' company.

Based on the BoE's preferred indicator for the climate evaluation of its portfolio – the Weighted Average Carbon Intensity (WACI) – we find that our replicated *BoE Tilting* generates only a small decline in WACI compared to what is the case before tilting (255 tCO_2e/$m vs 237 tCO_2e/$m) – a mere 7% change.

To help the BoE genuinely lead by example on the decarbonisation of monetary policy, we propose two alternatives. The first alternative, the *Strong Tilting* option, adds activities-based taxonomies into the tilting strategy and reallocates purchases across different sectors without being restricted by the market neutrality principle. In our second alternative, the *Strong Tilting+Exclusion* option, we additionally exclude the

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[4] For the problems with the use of market neutrality in the design of monetary policies, see, for example, Senni and Monnin (2020), van't Klooster and Fontan (2020), Dafermos et al. (2021b) and Robins et al. (2021).

[5] See Chenet et al. (2021) and Dafermos (2021).

bonds of fossil fuel companies and the bonds issued by non-renewable electricity utilities with a poor climate performance. Our *Strong Tilting+Exclusion* option reduces the WACI of the BoE by 39%. The Bank, therefore, reduces its WACI by more than 25% now, instead of waiting until 2025 for this to happen – as is its current plan. Moreover, under the *Strong Tilting* option, the proportion of bonds issued by carbon-intensive companies declines from 54% (pre-tilting) to 48%. This proportion declines even more, from 54% to 36%, under the *Strong Tilting+Exclusion* option. We argue that the Bank needs to use these alternative approaches if it wants to substantively deliver on its environmental mandate.

The report is structured as follows. In Section 2 we assess the Bank's strategy to green the CBPS, highlighting its lack of ambition in light of the new environmental mandate. In Section 3 we explain how we capture the climate footprint of bonds, setting the basis for the quantitative analysis of the BoE's tilting approach and our suggested alternatives. In Section 4 we present the quantitative results of our replication and compare the BoE's approach with our alternatives. In Section 5 we discuss how these alternatives can affect the low-carbon transition and explain why the exclusion of poor climate performers should be a core feature of a climate-aligned CBPS – consistent with the Bank of England's new environmental mandate. In Section 6 we summarise the results and our policy recommendations.

2   The Bank's strategy for greening the CBPS: 'carrots first, sticks later' and market neutrality

The CBPS was first launched as a £10 billion corporate asset purchase programme, part of a broader monetary stimulus package introduced in August 2016 to ease monetary conditions after the Brexit referendum. With the onset of the COVID-19 pandemic, the BoE scaled corporate bond purchases up to £20 billion in March 2020.

The Bank's purchases directly increase the demand for eligible corporate bonds (direct demand channel), pushing yields down. Purchases can also cause a decline in the yields of other bonds/financial assets through a portfolio rebalancing channel (the sellers of the bonds might use the money that they receive to buy other assets) and through a liquidity channel (Bank purchases increase liquidity in financial markets, leading to more trading of assets with a high illiquidity premium).[6] Empirical analyses have shown that the CBPS has reduced corporate bond yields overall, and the yields of eligible bonds compared to those that are not eligible (see Belsham et al., 2017; Boneva et al., 2018;

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[6] See, for example, Joyce et al. (2011), Belsham et al. (2017) and Boneva et al. (2018).

D'Amico and Kaminska, 2019). Lower yields can incentivise firms to increase bond issuance and investment.

While some might suggest that £20 billion is comparatively low when contrasted against other quantitative easing schemes, the BoE's corporate bond purchases have significant wider 'signalling effects' on the financial markets that should not be downplayed. Given that the BoE is both a regulator and investor, the signalling channel is particularly important from an environmental perspective as it sends a powerful message to markets about the Bank's views on specific sectors and/or issuers.

The BoE has designed its corporate QE programme according to a 'market neutrality' principle. It first stipulates a list of eligible bonds and then purchases a portion of these bonds in line with the sectoral make-up of the eligible bond market. The market neutrality principle seeks to ensure that purchases replicate the existing sectoral composition of the market so as to minimise any distortion of the CBPS on relative borrowing across sectors and activities. Problematically, while the CBPS may be market neutral, it is not 'climate neutral'. Replicating the sectoral composition of the bond market also means replicating market failures and the mispricing of assets in the age of the climate crisis. Consequently, the CBPS ends up heavily biasing the allocation of capital towards carbon-intensive sectors: it is well-documented that, based on their contribution to gross value added (GVA) and employment, carbon-intensive sectors are over-represented in the BoE's list of eligible bonds.[7] This carbon bias puts the CBPS at odds with the government's environmental objectives.

Prior to 2021, the BoE argued that it did not have the mandate to adequately address the carbon bias its own policy was reinforcing. In March 2021, however, the remit of the BoE was updated to explicitly reflect the government's target of achieving the transition to an environmentally sustainable and resilient net zero economy.[8] As the BoE puts it, the change to the remit 'requires the Bank to review the makeup of the CBPS' (Bank of England, 2021a, p. 1).

Indeed, with the BoE's new environmental mandate comes new opportunities. The BoE can now incorporate climate criteria directly into its purchases without having to stick to the climate-harming market neutrality principle. Rather than undermining democratically defined climate goals, the BoE has the flexibility to green the CBPS such that it maximises its contribution to the government's decarbonisation targets.

The toolkit for greening the CBPS includes four instruments (Bank of England, 2021a, 2021b):

  1. climate targets for the CBPS portfolio;

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[7] See Matikainen et al. (2017) and Dafermos et al. (2020).

[8] See here: https://www.bankofengland.co.uk/news/2021/march/mpc-remit-statement-andletter-and-fpc-remit-letter.

2. eligibility according to climate criteria;
3. tilting holdings towards stronger climate performers; and
4. escalation through progressively tighter repercussions towards active divestment (i.e. the selling of corporate bonds of issuers that, over time, fail to meet standards of climate performance).

To ensure an 'orderly transition' the BoE intends to use this toolkit based on a 'carrots first, sticks later' principle, which precludes the introduction of any substantial penalties for poor climate performers, at least at a first stage (see Bank of England, 2021a, 2021b). It also intends to guide tilting through the market neutrality principle despite its incompatibility with climate neutrality. We discuss the merits and limitations of the instruments in turn.

The Bank's intermediate portfolio-level climate target: 25% reduction in the CBPS WACI by 2025

The BoE plans to lower the carbon intensity of the CBPS portfolio by 25% until 2025, to then bring it to net zero by 2050. The Bank will use a backward-looking metric to assess progress against the interim climate target: the Weighted Average Carbon Intensity (WACI). The WACI has become a standard metric for measuring the climate performance of portfolios. While its backward-looking focus does not capture companies' transition plans, the Bank has decided against forward-looking portfolio metrics, since it believes they are not robust enough to credibly anchor companies' transition plans for the 2025 horizon. The Bank will calculate the WACI of the CBPS portfolio using only Scope 1 and Scope 2 emissions, i.e. emissions generated directly by firms or during the production of the energy that they use. It omits Scope 3 emissions (i.e. indirect emissions linked with a company's value chain), as it believes that data gaps do not permit an accurate measurement of Scope 3 emissions at this stage.

While such portfolio-level targets are a welcome first step towards correcting the CBPS's carbon bias, this by itself is insufficient. Without explicitly taking aim at sectors that engage in carbon-intensive activities, like fossil fuel and non-renewable utilities, through say sectoral targets, portfolio-level targets are a black box. The missed opportunity to reduce subsidies to climate laggards will be further reinforced by the Bank's decision to preserve the principle of market neutrality.

Green eligibility

Before its environmental mandate, the BoE did not consider the climate footprint of bond issuers as a relevant criterion for determining the universe of bonds eligible for purchase. It rather focused on standard criteria like the investment grade and the size of issuance (see Appendix A). It now plans to use a 'phased' approach that would eventually only deem eligible those bonds issued by companies with climate investment

plans credibly aligned with the 2050 net zero transition and verified by an appropriate third party.

The November 2021 announcement specified two green eligibility requirements (see Bank of England, 2021b): climate disclosures/decarbonisation targets and compatibility of companies' activities with net zero. The BoE will impose mandatory climate-related financial disclosures after April 2022 for all firms with over 500 employees and a turnover of over £500 million.[9] It will accept a broad range of disclosure formats that are in line with the TCFD (Task Force on Climate-related Financial Disclosures) recommendations. These include: CDP
(formerly the Carbon Disclosure Project), the Sustainable Accounting Standards Board and International Integrated Reporting Framework (now collectively known as the Value Reporting Foundation, VRF), the Carbon Disclosure Standards Board and the Global Reporting Initiative. Additionally, starting with the November 2021 round, it will make bonds ineligible for issuers that (i) belong to high-emitting sectors (energy, electricity, gas and water) and have not published an emissions reduction target, (ii) generate any revenue using mining thermal coal or (iii) generate any revenue using thermal coal unless they meet a set of specific criteria.[10]

The Bank thus effectively introduces immediate restrictions only on specific coal mining activities (in line with the government's plan to eliminate coal-fired power generation by 2025), albeit recognising that this would have a very limited impact on its portfolio since coal usage is very low in the UK (Bank of England, 2021b, p. 45). It postpones the exclusion of bonds linked to other fossil fuels. *This soft approach to the elimination of high-carbon bonds from the Bank's list of eligible assets is inconsistent with the climate emergency that we are facing.* Given the potential catastrophic and irreversible losses from climate change, alongside the fundamental uncertainty and systemic nature of climate risks, a precautionary approach is warranted so that the burden of proof is shifted: the Bank should exclude fossil fuel bonds unless scientific evidence categorically suggests they do not represent a systemic risk to the climate and financial systems.

Tilting

The BoE will use a scorecard to evaluate issuers' climate performance and then tilt purchases towards strong climate performers.[11] The scorecard relies on four metrics:

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[9] This is in line with the UK Government's recent decision about mandatory climate disclosures. See Department for Business, Energy & Industrial Strategy (2021).

[10] These crteria include: no investment in new unabated thermal coal plants; commitments for the elimination of existing thermal coal activity; reduction of emissions over time in line with sectoral net zero pathways; a minimum presence of renewable energy in the energy mix.

[11] For the use of tilting in the greening of monetary policy, see Schoenmaker (2021).

1. *The current carbon intensity of companies:* This is a backward-looking metric that compares the carbon intensity of bond issuers (expressed in Scope 1 and Scope 2 carbon dioxide emissions per million pounds of revenue) with the WACI of the CBPS.

2. *Past change in absolute emissions*: This is the second backward-looking metric that the Bank employs. It compares companies' rate of reduction in absolute emissions over the last three years with the reduction in emissions that is necessary in 1.5°C transition pathways. The Bank assigns the same weight to metric (1) and metric (2).

3. *Climate disclosures:* The Bank gives credit to companies that have made climate-related financial disclosures. The weight given to the metric is higher in sectors with higher levels of disclosure. The bank deems climate disclosures as a forward-looking metric.

4. *Emissions reduction target:* In this second forward-looking metric, the Bank gives credit to firms that have a target for the reduction in emissions in the future. The credit is higher if there is a third-party validation of the target. As in metric (3), the weight depends positively on the proportion of companies that have set a target.

Note that while the Bank decided against the use of forward-looking metrics for its 2025 portfolio-level decarbonisation target, it uses forward-looking metrics for tilting its purchases. This introduces an inconsistency: the portfolio target for 2025 is directly linked only with the backward-looking metric (1), but tilting will rely on a broader set of metrics that capture forward-looking perspectives as well. This inconsistency might affect the ability of the Bank to deliver on its 2025 ambitions.

The BoE allocates firms to four buckets on the basis of the climate scorecard (very strong, strong, poor and very poor performers). Importantly, the Bank envisages tilting purchases *within* sectors, planning to purchase relatively more of the debt issued by issuers that perform better according to its climate scorecard, ***but without altering the sector allocation of its purchases set by the principle of market neutrality***. Its purchases will simply reorient from poor performers (defined by the climate scorecard) to stronger performers within sectors. While this policy choice may reflect its concern to deflect criticism that it engages in credit allocation,[12] we show in the next sections that it can lead to plausible scenarios that generate perverse outcomes where carbon-intensive companies get better treatment than green companies, preserving the carbon bias.

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[12] See Bezemer et al. (2021). [13]See also Youel (2021).

Escalation

The BoE escalation approach explicitly favours light positive tilts over steep negative tilts, exclusions and divestment during the first stage of its greening process. Stricter repercussions might be considered only at a later stage. The Bank argues that this gradual 'carrots first, sticks later' approach is better aligned with an orderly transition because 'Big Bang' divestment or exclusions would reduce the BoE's influence over polluters. It also argues that increasing the cost of borrowing for poor climate performers might be counter-productive because these companies need to get better access to finance to be able to undertake low-carbon investment and reduce their emissions (see Bank of England, 2021a, 2021b).

However, these arguments are misplaced for at least two reasons. First, a small reduction in the cost of borrowing of carbon-intensive companies might prove insufficient to make these companies change: it might still be more profitable for them to continue using their carbon-intensive assets and fossil fuel resources.[13] Penalties can provide a much stronger signal to the financial markets, creating more pressure on firms to decarbonise. Second, in designing its escalation approach, the Bank implicitly uses the November 2021 announcement as the starting point for evaluating decarbonisation efforts. However, carbon-intensive firms have known for years (even decades) that their activities are responsible for the climate crisis. It is unclear why the Bank should give them more time, especially given that we cannot afford new investment in fossil fuel supply if we are to limit the rise in global temperatures to 1.5 °C (see e.g. IEA, 2021; SEI et al., 2021).

In the following sections, we outline tilting alternatives that are not restricted by the market neutrality and the 'carrots first, sticks later' principles. This allows us to map out more ambitious options for decarbonisation.

3   Identifying the climate footprint of bonds

A first crucial step in designing options for greening the CBPS is to identify the climate footprint of bonds. To replicate the BoE approach (see Bank of England, 2021b), we use the following backward-looking and forward-looking metrics[14] at a company level:[13]

1. the carbon intensity of the bond issuer compared to the Weighted Average Carbon Intensity (WACI) of the Bank of England portfolio;
2. the decarbonisation that the bond issuer has achieved over the last three years compared to the reduction of emissions that is necessary according to 1.5°C transition pathways;

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[13] We do not have access to data that allow us to use a metric that captures climate-related financial disclosures.

3. whether the bond issuer has an emissions reduction target or not.[14]

We allocate firms to four different climate buckets (A: very strong climate performers; B: strong climate performers; C: poor climate performers; D: very poor climate performers) for each one of these metrics. Then, we weight the buckets together to allocate firms to an overall climate category.[15]

[14]Backward-looking and forward-looking metrics about the climate footprint of companies have both advantages and disadvantages (see also TCFD, 2021a; Bank of England, 2021a). The key advantage of backward-looking metrics is that they capture the actual climate performance of firms and their interpretation is straightforward. However, they do not consider the plans that firms might have about the reduction of their climate footprint in the coming years. Forward-looking metrics consider the future plans of firms, but they might over-rely on the promises of companies about their decarbonisation, which might not be credible. In addition, some forward-looking metrics (like the Implied Temperature Rise) require several assumptions about the allocation of carbon budgets and have to rely on climate scenarios (see e.g. Raynaud et al., 2020; TCFD, 2021a). Some of these assumptions might be arbitrary, the results might be quite sensitive to changes in these assumptions, and the reliance on scenarios might make the analysis quite complicated, making it difficult for these metrics to be used as a basis for policy decision making. The BoE and our quantitative analysis rely on relatively simple forward-looking metrics that confine their attention to the decarbonisation plans of firms, avoiding some of the limitations of forward-looking approaches.

In the *Strong Tilting* and *Strong Tilting+Exclusion* options, we use a slightly different way to determine the climate buckets of the bond issuers. Based on Dafermos et al. (2021a), we construct a Company Climate Index (*CCI*) that is a weighted average of the company-level climate metrics. The metrics are similar as in the BoE climate scorecard. However, there are two differences. First, in calculating (1) we compare the carbon intensity of bond issuers with the carbon intensity of their peers. This is more reasonable given (i) the large diversity in the mean value of carbon intensity across different sectors and (ii) the fact that Scope 3 emissions have not been included in our analysis, making the comparison of carbon intensity across sectors less meaningful.[16] Second, in calculating

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[14] We do not have access to data that allow us to distinguish between validated and non-validated targets.

[15] The information provided by the Bank of England (2021b) is not detailed enough to allow us to perfectly replicate their climate scorecard. Moreover, the database that we use (Refinitiv Eikon) is not the same as the databases that the BoE uses to apply its climate scorecard. Despite this, our replicated classification of firms into climate buckets does not differ very significantly from the BoE categorisation, which is available here: https://www.bankofengland.co.uk/-/media/boe/files/markets/greening-cbps/percentage-of-firms-on-the-cbps-eligible-list-acrossscorecard-categories.pdf?la=en&hash=AE3A75897EFF58A73FD602146CD2792560CD09C5. In our replication, the proportion of eligible issuers in each climate bucket are 18% (A), 22% (B), 37% (C) and 23% (D), while in the BoE climate scorecard these proportions are 9% (A), 42% (B), 34% (C) and 15% (D).

[16] The volume of Scope 3 emissions differs substantially across sectors (see TCFD, 2021b).

(3) the emissions reduction target is evaluated based on how close the target is to the decarbonisation rate that is needed according to 1.5^{o}C transition pathways (see Appendix B for further details).

The *CCI* takes values between 0 and 2 – the higher the value of the *CCI*, the worse the climate performance of the company. We classify companies into four climate buckets as follows:

Bucket A (very strong climate performers): 0≤ *CCI*<0.5 Bucket B
(strong climate performers): 0.5≤ *CCI*<1
Bucket C (poor climate performers): 1≤ *CCI*<1.5
Bucket D (very poor climate performers): 1.5≤ *CCI*≤2

Table 1 summarises the differences between the replicated BoE climate scorecard and our climate scorecard. More details about the formulas and the data that we use in these scorecards are provided in Appendix B.

Table 1: Replicated Bank of England climate scorecard vs our climate scorecard: key differences

	Bank of England climate scorecard	**Our climate scorecard**
Carbon intensity	Relative to the WACI of the Bank of England portfolio	Relative to the carbon intensity of the peers
Emissions reduction target	Binary variable	Relative to 1.5^{o}C transition pathways
Allocation to climate buckets	Based on the individual climate metrics	Based on the Company Climate Index (*CCI*)

In the *Strong Tilting* and *Strong Tilting+Exclusion* options, we do not, however, only rely on the company-level climate buckets. We also take into account the main activity that the companies engage in. We do so because two companies that are in the same climate bucket might have a different climate footprint depending on what their main activities are. For example, a fossil fuel company that has a better climate performance compared to other fossil fuel companies has a much higher climate footprint relative to a renewable energy company that might happen to be in the same climate bucket. We, therefore, consider whether a bond has been issued by a company whose primary activity is carbon-intensive or a company whose primary activity is (potentially) green. On top of this, we take into account whether a bond has a 'green bond' label to reflect the fact that some bonds can directly finance projects that support the transition to a

low-carbon economy. For more details about our activities-based categorisation of bonds, see Appendix C.

According to our approach, carbon-intensive companies that wish to reduce the climate footprint of their bonds – and, therefore, get a better treatment in the CBPS – can do so via three interconnected ways. First, they can take action to improve their *CCI*, for example, by reducing their emissions. Second, they can change their business model in a fundamental way. For instance, non-renewable electricity utilities can be transformed into renewable ones through ambitious low-carbon investments that would make renewables-related activities the main source of their revenues. Both actions could improve the climate footprint of their standard bonds. A third way would be for them to issue green bonds to finance specific decarbonisation projects.

4 How to green the CBPS: the Bank of England's approach vs alternatives

We analyse the Bank of England's approach to the greening to the CBPS and we compare it with two alternatives:[17]

1. **BoE Tilting**: To replicate the Bank of England's approach we use the BoE climate scorecard described in the previous section to allocate firms to four different buckets. We then simulate the BoE's tilted purchases towards stronger climate performers. The rebalancing of the portfolio takes place within sectors to keep market neutrality. The purchases of bonds issued by companies with a stronger climate performance in the scorecard increase, while the purchases of bonds issued by companies with a poorer climate performance in the scorecard decrease, irrespective of the main activity of the companies.

2. **Strong Tilting**: The BoE rebalances its holdings based both on the *CCI* and the climate impact of the main activities of the bond issuers. Under this option, all the holdings of bonds issued by companies that engage in carbon-intensive activities decline (with the exception of green bonds), but the decline is lower for those companies that perform better based on the *CCI*. Similarly, the BoE increases the holdings of bonds issued by companies engaging in green activities, but the increase is less for those companies that have a relatively poor performance based on the *CCI*. Compared to the BoE tilting, this option does not, therefore, retain market neutrality. The tilting in the holdings that refer to the companies that are neither green nor carbon-intensive follows a similar rationale as in the *BoE Tilting* option.

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[17] The formulas that we use are reported in Appendix D.

3. **Strong Tilting+Exclusion**: This is the same as the *Strong Tilting* option with the additional feature that the bonds of fossil fuel companies and the bonds issued by non-renewable electricity utilities with a poor climate performance are excluded, while new climate-friendly bonds and other non-carbon-intensive bonds (which are included in the list of eligible bonds) are purchased by the BoE.

BoE Tilting

Figure 1, first column, shows the decomposition of the Bank's pre-tilting holdings by climate bucket. According to our replication, poor and very poor climate performers account for about 61% of the total BoE holdings. The *BoE Tilting* approach reduces *marginally* the representation of bonds that are issued by poor and very poor climate performers (to about 56%) and increases the representation of bonds issued by strong and very strong climate performers (see the second column in Figure 1).

Figure 2 shows the sectoral decomposition of the pre-tilting and *BoE Tilting* holdings, using the nine sector-classification that the Bank relies on to apply the market neutrality principle. Our replication follows the market neutrality principle since holdings per sector in the *BoE Tilting* option remain the same as before tilting. Purchases are reallocated towards stronger climate performers within sectors. However, the poor and very poor climate performers can only be penalised in sectors in which they co-exist with some strong or very strong performers. Similarly, the holdings of strong and very strong climate performers can only increase in sectors in which they co-exist with poor or very poor performers. In our replication the latter is not the case in the 'Communications' sector (see Figure 2): the Bank cannot increase its support to strong and very strong climate performers since this would violate the market neutrality principle.[18]

Market neutrality also implies that the *BoE Tilting* approach ignores companies' activities. Tilting relies only on the cl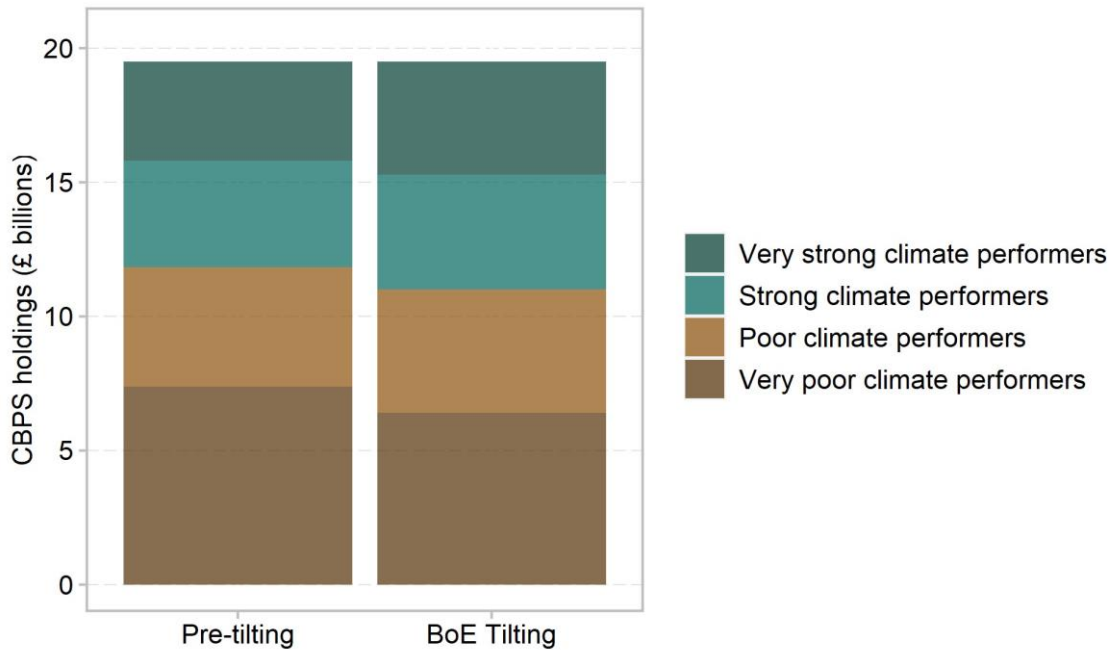imate buckets of companies which do not **Figure 1:** Decomposition of CBPS holdings by climate bucket, pre-tilting and BoE Tilting

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[18] A different design of our replication could reallocate purchases from strong to very strong climate performers so that tilting would still take place in the 'Communications' sector. However, this would be unfair for the strong climate performers in this sector and could undermine the net zero transition.

take into account whether companies' main activities are carbon-intensive or climate friendly. As a result, some carbon-intensive companies, which happen to perform better than their sectoral peers, might be treated more favourably than companies that engage in climate friendly activities in other sectors. For example, in our replication, BP PLC – a fossil fuel company – is allocated to climate bucket B (strong climate performer), while Suez SA – an 'Environmental services and equipment' company[19] – is allocated to climate bucket D (very poor climate performer). Under the *BoE Tilting* approach, the Bank of England would increase the purchases of BP PLC bonds and reduce the purchases of Suez SA bonds.

Strong Tilting

The *Strong Tilting* option penalises carbon-intensive companies: the BoE would purchase a lower proportion of their bonds (albeit the decline in purchases would be lower for companies that have a relatively low *CCI*). At the same time, the BoE would purchase a higher amount of bonds issued by companies that engage in **Figure 2:** Decomposition of CBPS holdings by climate bucket and Bank of England sectors, pre-tilting and BoE Tilting

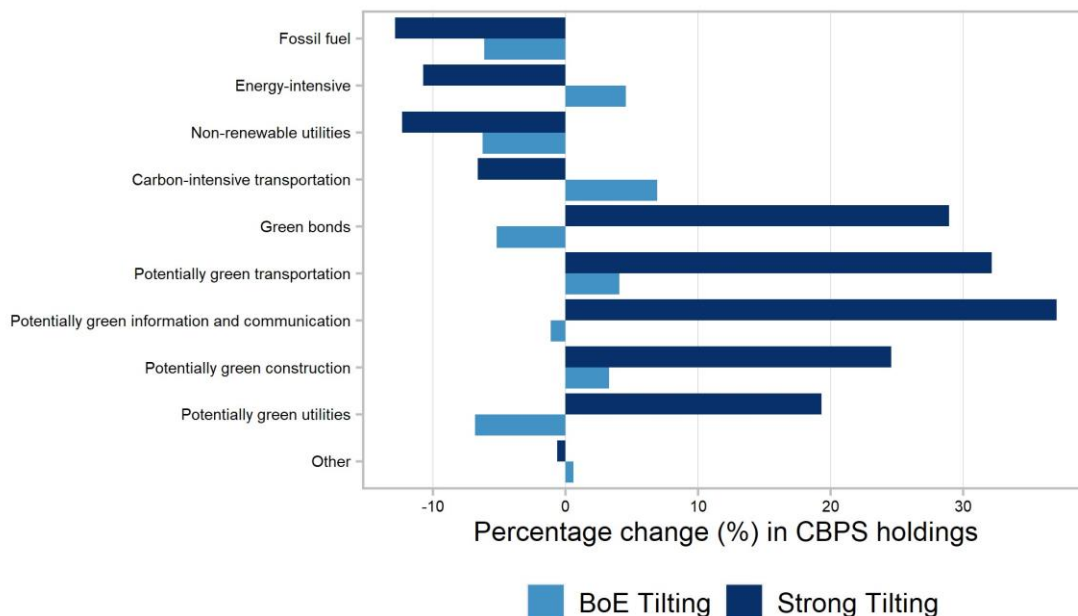---

[19] Based on its TRBC industry.
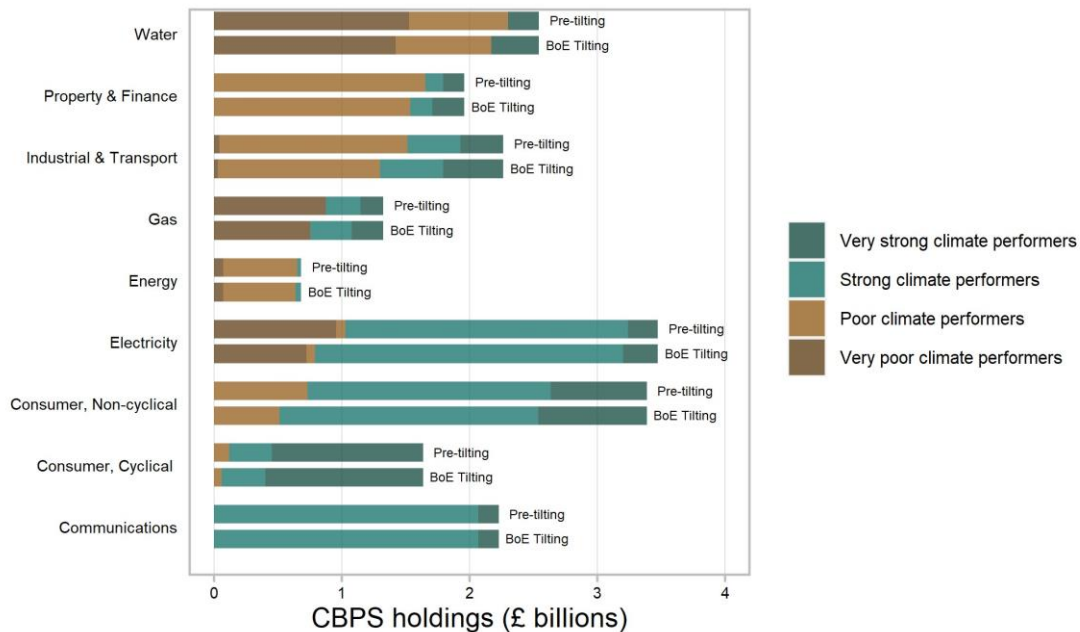
Source: BoE (bond ISIN codes, 5 November 2021), Refinitiv Eikon (bond outstanding amount, November 2021; financial and environmental variables) and authors' calculations

potentially green activities or issue green bonds (but the increase in purchases would be lower for companies that have a relatively high *CCI*).

In Figure 3 and Figure 4 we compare the *BoE Tilting* with our *Strong Tilting* option. Under *Strong Tilting*, the purchases of bonds issued by companies that engage in carbon-intensive activities decline, and vice versa for the purchases of debt issued by environmentally friendly companies. Contrast this with the *BoE Tilting* approach whereby it is possible for the purchases of bonds of carbon-intensive companies to increase and the purchases of the bonds of environmentally friendly companies to decline. For example, as shown in Figure 3, in the *BoE Tilting* option, the holdings of carbon-intensive transportation bonds increase on average by 6.9% and the holdings of energy-intensive bonds increase by 4.6%, in contrast to what happens in the *Strong Tilting* option, where the holdings of these bonds decline by 6.6% and 10.7%, respectively. Additionally, the holdings of bonds issued by potentially green information companies and potentially green utilities decline by 1.1% and 6.8%, respectively, in the *BoE Tilting* option, while they increase by 37.0% and 19.3%, respectively, in the *Strong Tilting* option.

Figure 4 zooms in on the carbon-intensive activities.   Under the *BoE Tilting* **Figure 3:** Average percentage change (%) in the CBPS holdings per activity, BoE Tilting and Strong Tilting

16

Source: BoE (bond ISIN codes, 5 November 2021), Refinitiv Eikon (bond outstanding amount, November 2021; NACE 4-digit codes; TRBC codes; financial and environmental variables) and authors' calculations

approach, the BoE purchases a higher amount of carbon-intensive bonds issued by companies that perform relatively better from a climate perspective. For some bonds, the percentage increase in the CBPS holdings is higher than 20%. On the contrary, the *Strong Tilting* approach *penalises* all fossil fuel bonds (i.e. the percentage change in purchases is negative), and other carbon-intensive bonds. The only case in which the purchases of the bonds of carbon-intensive companies increase under *Strong Tilting* is when these bonds are green: the increase in the purchases of specific bonds of non-renewable utilities, shown in Figure 4b, is due to the fact that these bonds are green.

Strong Tilting+Exclusion

Figure 5 illustrates the key advantages of the *Strong Tilting+Exclusion* option over the other options. The figure shows how the composition and the value of corporate bond purchases changes under the three options. By design, all three preserve the existing value of CBPS holdings (close to £19.4 billion as of early December).
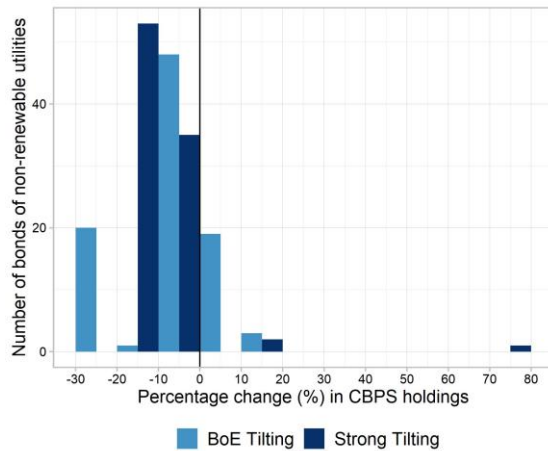
The Weighted Average Carbon Intensity (WACI) in the *BoE Tilting* (237 **Figure 4:** Number of bonds per band of percentage change (%) in CBPS holdings, fossil fuel, non-renewable utility, energy-intensive and carbon-intensive transportation companies, BoE Tilting and Strong Tilting
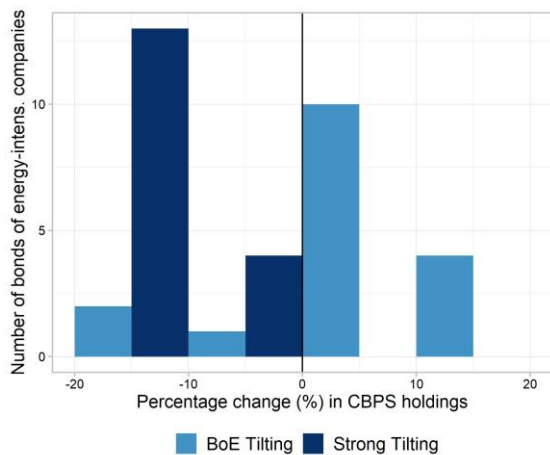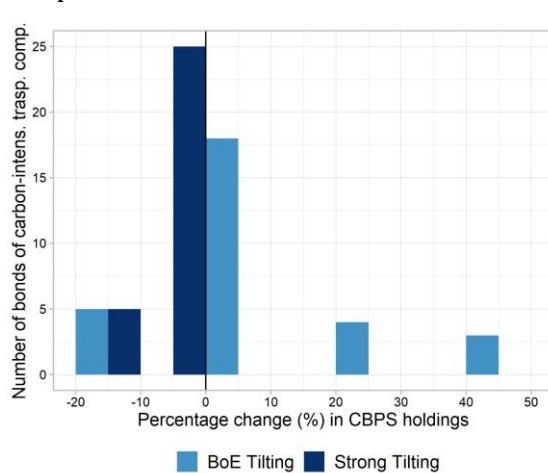
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(a) Fossil fuel companies
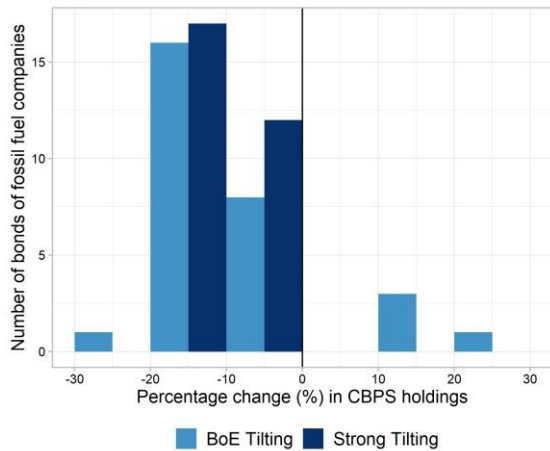
(b) Non-renewable utilities

(c) Energy-intensive companies

(d) Carbon-intensive transportation companies

Note: Each bar shows the number of bonds that see a specific percentage change in the CBPS holdings under the BoE Tilting and Strong Tilting options. For example, Figure 4a, which refers to fossil fuel activities, shows that the BoE Tilting reduces the holdings of 8 bonds by 0-10%, the holdings of 16 bonds by 10-20% and the holdings of 1 bond by 20-30%, while it increases the holdings of 3 bonds by 10-20% and the holding of 1 bond by 20-30%. The same figure shows that Strong Tilting reduces the holdings of 12 bonds by 0-10% and the holdings of 17 bonds by 10-20%.

Source: BoE (bond ISIN codes, 5 November 2021), Refinitiv Eikon (bond outstanding amount, November 2021; NACE 4-digit codes; TRBC codes; financial and environmental variables) and authors' calculations

tCO$_2$e/\$m) is lower than the WACI before tilting (255 tCO$_2$e/\$m).[20] However, the WACI declines much more under the *Strong Tilting* and *Strong Tilting+Exclusion* options. *Strong Tilting+Exclusion* would reduce the WACI of the BoE by more than 25% now

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[20] The WACI is calculated by taking the average carbon intensity that corresponds to each bond

instead of 2025, the intermediary target of the BoE (the exact percentage reduction in WACI is 39%). Moreover, under the *Strong Tilting* option, the proportion of bonds issued by carbon-intensive companies declines from 54% (*Pre-tilting*) to 48%, but this proportion declines even more, from 54% to 36%, under the *Strong Tilting+Exclusion* option.

Figure 5: Decomposition of CPBS holdings by activity (in £ billions), and weighted average carbon intensity (WACI) (in tCO_2e/$m), pre-tilting and green options

Note: The figures above each bar show the WACI.

Source: BoE (bond ISIN codes, 5 November 2021), Refinitiv Eikon (bond outstanding amount, November 2021; NACE 4-digit codes; TRBC codes; financial and environmental variables) and authors' calculations
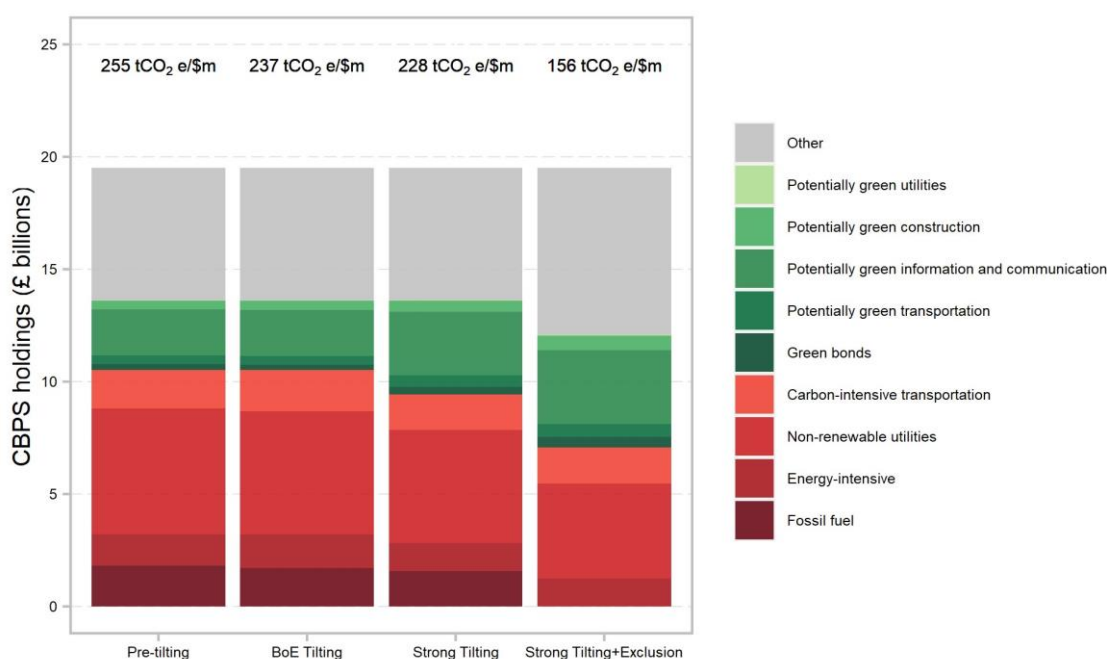
The proportion of bonds issued by carbon-intensive companies in the *BoE Tilting* remains almost the same. This is so because the *BoE Tilting* option reallocates purchases within sectors to respect market neutrality, so there is only a small change in the allocation of holdings between carbon-intensive, green and other sectors. The WACI, however, declines, since the holdings of the bonds of carbon-intensive companies with a strong climate scorecard performance

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weighted by the proportion of the tilted holdings of the bond in the total tilted bond holdings.

increase, while the holdings of other carbon-intensive sectors with a relatively poor climate performance decline.

5 How can our proposals affect climate neutrality?

Greening the CBPS can affect decarbonisation efforts through two channels. The *direct demand channel*, which also applies to the standard corporate QE programmes, directly benefits companies that are eligible in the CBPS programme through a reduction in yields on their bonds. These companies could increase bond issuance to finance investment. By increasing the purchases of climate-friendly bonds and reducing holdings of carbon-intensive bonds, the BoE can create more favourable conditions for the financing of green investments and increase the cost of borrowing for carbon-intensive companies.

We describe the second channel as the *climate signalling channel*. By identifying which companies perform better/worse than others from a climate perspective, the BoE can give strong signals about how these companies will be perceived by central banks and financial markets as the fight against climate change intensifies. Companies that the Bank identifies as better climate performers can be treated in more favourable terms by financial markets as well as their stakeholders compared to companies that will, for example, be excluded from the CBPS because of their poor climate performance. This can affect companies' access to finance and their overall economic performance. The existence of signalling effects is well recognised for central banks' monetary policies.

The *Strong Tilting+Exclusion* option is likely to have the strongest impact on decarbonisation through these channels. It would directly penalise those companies that have done nothing or too little to address the climate crisis. Excluding these companies from CBPS would not only increase their cost of borrowing on the bond market. It would also harm their reputation, giving a very strong signal to markets that companies that fail to contribute to the achievement of the targets of the Paris Agreement can suffer financially. This has the potential to significantly increase the pressure on these companies to decarbonise their activities and change fundamentally their business plans. Such pressure would be lower under the *Strong Tilting* option whereby carbon-intensive companies would be penalised but not be excluded from the BoE purchases. And it would be very low under the *BoE Tilting* option, whereby carbon-intensive companies could even benefit from the incorporation of climate criteria into the QE programme.

Crucially, our alternatives encourage carbon-intensive companies to avoid an increase in their cost of borrowing in the short run by issuing green bonds and designing credible

decarbonisation plans. In the medium run, they can reduce any CBPS-induced increase in their cost of borrowing if they manage to reduce emissions and change their business model.

6   Conclusion

The change in the mandate of the Bank of England gives a significant opportunity to the Bank to play a leading role in the decarbonisation of monetary policy, in line with the climate emergency that we are facing. However, this opportunity might be squandered if the Bank proceeds with its light 'carrots first, sticks later' approach and continues to adhere to the principle of market neutrality. On the contrary, what the Bank needs to do is to adopt, without delay, a strict attitude against polluting companies that have a historical responsibility for the climate crisis, are incompatible with the net zero transition and lack Paris-aligned decarbonisation plans.

Our quantitative analysis showed that the combination of a strong tilting approach with the exclusion of highly polluting companies would quickly reduce the WACI of the CBPS and has the potential to maximise the contribution of the Bank to the fight against climate change in line with its new secondary mandate. At the same time, it would not reduce the overall holdings of the Bank and would, therefore, not undermine its primary price stability mandate.

The benefits of our recommendations would not only materialise through the *direct demand channel*, which is likely to be relatively weak given the small size of the CBPS. The implementation of our proposals would most crucially affect decarbonisation via the *climate signalling channel*: the Bank would send a clear message to financial markets that it would stop purchasing the bonds of companies that have done nothing or too little to achieve the democratically defined goals of the Paris Agreement. Leading by example through such a decision the Bank would not only inspire the wider investment and central banking community, but would also help create a much-needed pressure on polluting companies to take decisive climate action as soon as possible. In contrast, the current approach of the BoE, which adheres to the market neutrality principle, does not necessarily penalise carbon-intensive companies and postpones any significant exclusions for later, is unlikely to have a significant contribution to decarbonisation. Indeed, the signal of 'postponement' and 'delay' of decarbonisation to financial markets sets a deeply worrying standard unbefitting one of the world's most powerful financial institution.

More broadly, the way that the Bank assesses the climate performance of bond issuers does not only affect the design of the CBPS (and the wider structure of UK financial markets). It is likely to be used as a benchmark by other central banks around the globe

for the greening of their own monetary and financial policy tools. It is therefore important for the BoE to get it right.

Our proposals would still be applicable in the case that the BoE decides to taper its corporate asset purchases in the coming months. For example, the BoE can implement tapering by excluding from the eligible universe, or reducing the holdings of, those bonds that have been issued by poor climate performers. This would give a powerful signal to the financial markets.

In this report, we have overall shown how the Bank of England can adopt an ambitious approach to the greening of its CBPS. Our proposals reflect the fact that, in the age of the climate emergency, it is important that firms take higher climate responsibilities: the burden of proof that they take climate consistent actions should lie primarily on them and less on policy institutions that evaluate them.

The climate emergency will not be addressed through marginal changes in economic policy making that simply tinker around the edges. A sharp reduction in emissions requires fundamentally bold changes in macrofinancial policies. As a powerful policy institution with a new environmental mandate, the Bank of England should take up the challenge, lead by example, and contribute decisively to the fight against climate change.

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Appendix A: The BoE's eligibility list and the CBPS holdings

The Bank implements the Corporate Bond Purchase Scheme (CBPS) via a two-step process. First, it specifies a list of eligible bonds based on criteria related primarily to the maturity of bonds, their investment grade, the amount in issue and the contribution of bond issuers to the UK economy (the exact criteria are reported below). Second, a proportion of these eligible bonds are purchased, applying the market neutrality principle. In practice, this means that the Bank estimates the contribution of different sectors to the universe of eligible bonds and buys bonds such that the share of each sector in purchases is close to its share in the eligible bond universe.

The main bond eligibility criteria set by the BoE for the CBPS are as follows:

1. the bond should have been issued in sterling by companies that are not subject to financial sector regulation;
2. the residual maturity of the bond is at least three months and the bond was issued at least one month before the BoE list of eligible bonds was published;
3. the bond should be rated investment grade; and
4. the amount in issue should be at least £100 million.[21]

The BoE provides the list of bonds that are eligible according to its criteria. We use the list that was published on 5 November 2021. The BoE also provides a list that includes the names of the issuers whose bonds are held in the CBPS portfolio (as at 3 November 2021), without, however, reporting which bonds of these issuers are held and the corresponding amount.[22] Thus, to replicate the CBPS portfolio, we assume that (i) all the eligible bonds of the issuers included in the CBPS holdings are held by the BoE and (ii) the proportion of the outstanding amount of each bond that has been purchased is the same for all bonds. To estimate this proportion we divide the total holdings of the BoE as at 1 December 2021 (approximately equal to £19.5bn) by the total amount of all the eligible bonds included in the CBPS. This gives a proportion approximately equal to 0.145. We call this proportion the 'holding factor'.

The BoE list of eligible bonds comprises 430 bonds whose outstanding amount is £165bn. As explained in Appendix C, our analysis requires the identification of the 4-digit NACE

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[21] There are some additional criteria according to which the bonds (i) should be cleared and settled through Euroclear and/or Clearstream, (ii) need to be admitted to official listing on an EU stock exchange and (iii) need to be conventional senior unsecured or secured, unsubordinated debt. For more details, see https://www.bankofengland.co.uk/markets/market-notices/2020/ asset-purchase-facility-additional-corporate-bond-purchases; see also https://www.bankofengland. co.uk/markets/market-notices/2020/apf-pricing-of-cbps-eligible-securities-june-2020.

[22] Both lists are available here: https://www.bankofengland.co.uk/markets/bank-of-englandmarket-operations-guide/information-for-participants.

code and the Refinitiv Business Classification (TRBC) code of the bond issuer. Therefore, we exclude those bonds for which the NACE or TRBC codes are not available in Refinitiv Eikon. The ultimate number of eligible bonds that we use in our analysis is 408 (with an outstanding amount of £159bn). Moreover, we have managed to match 100 out of the 111 issuers in the CBPS holdings with issuers in the BoE list of eligible bonds. Hence, our analysis of CBPS holdings is confined to these 100 issuers that have issued 328 eligible bonds (with an outstanding amount of £134bn).

Appendix B: Climate scorecards

The replicated Bank of England climate scorecard

To replicate the Bank of England's (2021b) climate scorecard, we calculate the following metrics for each company:[23]

(1)   *Relative Carbon Intensity based on the CBPS WACI* (RCI_{WACI}): This relies on the carbon intensity of each company compared to the WACI of the Bank of England's CBPS portfolio. We use the company-level carbon intensity provided by Refinitiv Eikon, which is equal to the sum of Scope 1 and Scope 2 CO_2 equivalent GHG emissions (in tonnes) over the company revenues (in $ millions) – we use the data for the last available fiscal year. The carbon intensity of each company j (CI_j) is compared with the $WACI$ of the pre-tilting holdings of the Bank of England. The formula that we use is as follows:[24]

$$RCI_{WACI,j} = min\left[\frac{CI_j}{WACI}, 2\right] \tag{1}$$

(2)   *Relative Backward-looking Decarbonisation Rate (RBDR)*: This is defined based on the average annual percentage decline in emissions over the last three years, which we call the Backward-looking Decarbonisation Rate (BDR). We use Scope 1 and Scope 2 emissions from Refinitiv Eikon and give a higher weight to more recent data. To calculate the Relative Backward-looking Decarbonisation Rate for company j we compare the BDR with $DR_{ALIGNED}$, which is the annual decarbonisation rate that is aligned with a 1.5^{o}C transition pathway according to Teske et al. (2020) – we use sector-specific pathways when available. This is the formula that we use:

$$RBDR_j = min\left(0, \text{ if } BDR_j \geq 2DR_{ALIGNED}, \frac{2DR_{ALIGNED} - BDR_j}{DR_{ALIGNED}}, 2\right), \text{ otherwise.} \tag{2}$$

The formula suggests that $RBDR = 0$ when a company has achieved a decarbonisation rate that is at least twice higher than the climate-aligned rate (i.e. $BDR \geq 2DR_{ALIGNED}$), $RBDR = 1$ when the past decarbonisation rate is equal to the climate-aligned rate (i.e. $BDR = DR_{ALIGNED}$) and $RBDR = 2$ when $BDR \leq 0$. Note that when Refinitiv Eikon reports no data about the past reduction of emissions for a company, we set $RBDR = 2$.

(3)   Emissions Reduction Target (ERT): This takes a value of 0 when a company has reported an emissions reduction target and 2 otherwise.

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[23] For the companies that engage in financial and insurance activities (NACE codes K.64, K.65 and K.66), we use the company-level data that correpond to their ultimate parents.

[24] If Refinitiv Eikon does not provide data for the carbon intensity of a company, we use as a proxy the median intensity of the companies that belong to the same TRBC business sector.

We allocate firms to four different buckets (A,B,C,D) for each one of these metrics. In particular:

> Bucket A (very strong climate performers): $0 \leq RCI_{WACI}, RBDR, ERT < 0.5$
>
> Bucket B (strong climate performers): $0.5 \leq RCI_{WACI}, RBDR, ERT < 1$
>
> Bucket C (poor climate performers): $1 \leq RCI_{WACI}, RBDR, ERT < 1.5$
>
> Bucket D (very poor climate performers): $1.5 \leq RCI_{WACI}, RBDR, ERT \leq 2$

Then, we weight the buckets together to allocate firms to an overall climate category. Following the Bank of England (2021b), we use sector-specific weights.[25] The weights w_{1s} and w_{2s}, which correspond to RCI_{WACI} and $RBDR$, respectively, are the same, while w_{3s}, which corresponds to ERT, is higher the higher is the proportion of companies in sector s that report emission reduction targets. In particular:

$$w_{1s} = w_{2s} = (1 - w_{3s})/2$$

$$w_{3s} = (1/3)prop_s$$

where $prop_s$ is the proportion of eligible companies in sector s that have reported decarbonisation targets.

Our climate scorecard

Our climate scorecard relies on the Climate Company Index (CCI). For each company j the CCI is given by:

$$CCI_j = w_{1s}RCI_{PEERS,j} + w_{2s}RBDR_j + w_{3s}RFDR_j \qquad (3)$$

where RCI_{PEERS} is the *Relative Carbon Intensity* that is defined based on the carbon inensity of a company's peers, $RBDR$ is the *Relative Backward-looking Decarbonisation Rate*, $RFDR$ is the *Relative Forward-looking Decarbonisation Rate*, and w_{1s}, w_{2s} and w_{3s} are sector-specific weights. The sector-specific weights and $RBDR$ are defined as in the Bank of England climate scorecard. The rest components of the CCI are defined below.

RCI_{PEERS}: The carbon intensity of each company (CI_j) is compared with the carbon intensity of its peers in the Refinitiv Eikon database (peers are defined as those companies that belong to the same TRBC business sector). The formula that we use is as follows:

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[25] We rely on the nine-sector classification of the Bank of England.

$$RCI_{PEERS,j} = min\left[\frac{CI_j}{CI_{PEERS,j}}, 2\right] \tag{4}$$

RFDR: The Forward-looking Decarbonisation Rate (*FDR*) is defined as the annual targeted percentage reduction in Scope 1 and Scope 2 emissions of the bond issuer in the coming years (based on data from Refinitiv Eikon). To calculate the Relative Forward-looking Decarbonisation Rate for company *j* we compare the *FDR* with $DR_{ALIGNED}$, which is the annual decarbonisation rate that is aligned with 1.5^{o}C transition pathways. In particular:

$$RFDR_j = \begin{cases} 0 & \text{, if } FDR_j \geq 2DR_{ALIGNED}, \\ min\left[\frac{2DR_{ALIGNED} - FDR_j}{DR_{ALIGNED}}, 2\right] & \text{, otherwise.} \end{cases} \tag{5}$$

According to this formula, *RFDR* = 0 when a company has a target for its decarbonisation rate that is at least twice ambitious as the climate-aligned target (i.e. $FDR \geq 2DR_{ALIGNED}$), *RFDR* = 1 when the target decarbonisation rate is equal to the climate-aligned rate (i.e. $FDR = DR_{ALIGNED}$) and *RFDR* = 2 when the target is to keep the emissions at the same level as they are right now (i.e. *FDR* = 0). Note that when the company has no target according to Refinitiv Eikon, we set *RFDR* = 2.

The *CCI* has been constructed such that it takes values between 0 and 2: 0 corresponds to the strongest climate performance (i.e. the climate damage caused by the company is at its minimum level), and 2 corresponds to the poorest climate performance (i.e. the climate damage caused by the company is at its maximum level).

We classify companies into 4 different climate buckets (A, B, C, D) based on their *CCI* as follows:

Bucket A (very strong climate performers): $0 \leq CCI < 0.5$
Bucket B (strong climate performers): $0.5 \leq CCI < 1$
Bucket C (poor climate performers): $1 \leq CCI < 1.5$
Bucket D (very poor climate performers): $1.5 \leq CCI \leq 2$

Appendix C: Activities-based categorisation of bonds

Bonds are classified into three categories based on the main activity of their issuers [26] and whether they have a green label or not:

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[26] For the companies that engage in financial and insurance activities (NACE codes K.64, K.65 and K.66), our categorisation is based on the main activities of their ultimate parents.

1. *CIA bonds*: these are bonds issued by companies that engage in carbon-intensive activities (CIA).
2. *GREEN bonds*: these are bonds that have a green bond flag in Refinitiv Eikon[27] or the main activity of their issuers is 'potentially green'.
3. *OTHER bonds*: these are bonds that do not belong to any of the above categories, i.e. they do not have a green flag in Refinitiv Eikon and the activity of their issuers is not classified as carbon-intensive or potentially green.

We explain below how we identify carbon-intensive and potentially green activities using the NACE classification and the Refinitiv Business Classification (TRBC).

Carbon-intensive activities

We identify carbon-intensive activities drawing on Battiston and Monasterolo (2019). Our starting point is the NACE-based Climate Policy Relevant Sectors (CPRS) classification, first presented in Battiston et al. (2017).[28] This classification specifies sectors that can be affected by climate policies and are subject to climate transition risks. However, not all of these sectors are necessarily carbon-intensive. Battiston and Monasterolo (2019) have identified carbon-intensive sectors, which are a subset of CPRS. We have, therefore, specified NACE 4-digit codes that correspond to carbon-intensive activities following the rationale of their classification.

The principal activity of a company is classified as carbon-intensive if (i) it belongs to our NACE list of carbon-intensive activities and (ii) its TRBC activity code does not correspond to a potentially green activity (see below). For example, if the NACE code of the principal activity of a company is 35.11 ('Production of electricity'), but its TRBC activity code corresponds to 'Renewable energy services', this company is not deemed to engage in carbon-intensive activities. Following this approach, we specify four types of carbon-intensive activities: (i) fossil fuel activities; (ii) energy-intensive activities; (iii) activities of non-renewable utilities and (iv) carbon-intensive transportation activities.

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[27] Refinitiv Eikon defines green bonds as fixed income products that offer investors the opportunity to participate in the financing of large sustainable energy green projects that help mitigate climate change and help countries adapt to the effects of climate change. The issuance of green bonds does not necessarily translate into an improvement in the carbon intensity of their issuers (see Ehlers et al., 2020). We explicitly consider that in the design of our alternatives since the tilting factors for green bonds under the *Strong Tilting* and the *Strong Tilting+Exclusion* options are lower for green bond issuers that perform worse based on their *CCI* (see Appendix D).

[28] For an updated version of the CPRS classification, see: https://www.finexus.uzh.ch/en/projects/CPRS.html.

Potentially green activities

To identify potentially green activities we rely on the EU Taxonomy of sustainable activities (see European Commission, 2020). The EU Taxonomy identifies TRBC codes that capture activities that can contribute to climate mitigation because they (i) are already low-carbon, (ii) are not low-carbon but can contribute to the transition to a low-carbon economy by reducing emissions (transition activities), or (iii) enable other activities to achieve emissions reductions (enabling activities).[29]

A limitation of the EU classification is that it includes many carbon-intensive activities in the list of sustainable activities. These are primarily the transition activities undertaken by high-carbon companies. Although we acknowledge the need for promoting activities that reduce emissions in carbon-intensive sectors, we find it misleading to call these activities 'green'. It would be more accurate to call these activities 'dirty', whose degree of dirtiness can decline. Thus, in our list of 'potentially green' activities we include all TRBC EU Taxonomy-eligible activities apart from (a) those with a NACE code that corresponds to a carbon-intensive activity according to our carbon-intensive activities classification (see above) and (b) those that are considered to be a transition activity according to the EU Taxonomy – we keep, however, as potentially green activities those activities whose TRBC code specifies an activity that clearly contributes to the low-carbon transition.[30]

Following this approach, we specify the following potentially green activities: (i) potentially green forestry; (ii) potentially green manufacturing, (iii) potentially green utilities; (iv) potentially green transportation; (v) potentially green information and communication and (vi) potentially green construction. The reason why we call these activities 'potentially green' is because we do not have sufficient micro data to check if they are actually green. According to the EU Taxonomy, activities are Taxonomy-aligned if they are both Taxonomy-eligible and meet the following conditions: (1) they do no significant harm to any other environmental objective, (2) they comply with minimum social safeguards, and (3) they meet technical screening criteria, related, for example, with energy and carbon intensity (see also Alessi et al., 2021). These conditions are not taken into account in our analysis.

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[29] These TRBC codes are available here: https://ec.europa.eu/info/files/sustainable-finance-tegtaxonomy-tools en.

[30] Examples of TRBC activities that clearly contribute to the low-carbon transition are 'Renewable energy equipment & services', 'Thermal solar systems & equipment' and 'Renewable Independent Power Producers (IPPs)'.

Appendix D: Climate tilting factors under different tilting options

Our climate tilting factors capture the percentage change in the BoE holdings of bonds after tilting, compared to the pre-tilting holdings.[31] Hence, the post-tilting holdings of bond i are given by:

$$HOLD_{i,POST} = (1 + tilt_i)HOLD_{i,PRE} \qquad\qquad (6)$$

where $HOLD_{i,POST}$ denotes the post-tilting holdings, $tilt_i$ is the climate tilting factor for bond i and $HOLD_{i,PRE}$ denotes the pre-tilting holdings. When $tilt_i > 0$, tilting leads to an increase in bond holdings; when $tilt_i < 0$, the holdings decline after tilting.

We use three different versions of climate tilting factors, which correspond to the *BoE Tilting*, *Strong Tilting* and *Strong Tilting+Exclusion* options, respectively. We analyse them in turn.

BoE Tilting

We increase the holdings of bonds issued by companies that have been allocated to climate buckets A and B, according to our replicated Bank of England scorecard (see Appendix B), and reduce the holdings of bonds issued by companies that are in climate buckets C and D. To respect market neutrality, the re-allocation of holdings takes place within each sector s – we use the nine-sector classification of the Bank of England (see Figure 2). In order for the value of holdings to remain the same after tilting, the following condition needs to hold for each sector s:

$$tilt_{A,s}HOLD_{A,s,PRE} + tilt_{B,s}HOLD_{B,s,PRE} + tilt_{C,s}HOLD_{C,s,PRE}$$
$$(7) + tilt_{D,s}HOLD_{D,s,PRE} = 0$$

where $tilt_{A,s}$, $tilt_{B,s}$, $tilt_{C,s}$ and $tilt_{D,s}$ are the climate tilting factors and $HOLD_{A,s,PRE}$, $HOLD_{B,s,PRE}$, $HOLD_{C,s,PRE}$ and $HOLD_{D,s,PRE}$ are the pre-tilting holdings in buckets A, B, C and D, respectively, for each sector s. $tilt_{A,s}, tilt_{B,s} > 0$ and $tilt_{C,s}, tilt_{D,s} < 0$. The subscript 'PRE' stands for 'pre-tilting'. We first select the climate tilting factor for bonds that belong to bucket A:

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[31] See also Schoenmaker (2021).

$$tilt_{A,s} = \frac{tilt_{A,s,max}}{1 + \frac{HOLD_{A,s,PRE}+HOLD_{B,s,PRE}}{HOLD_{C,s,PRE}+HOLD_{D,s,PRE}}}$$

(8)

where $tilt_{A,s,max}$ is the maximum value that $tilt_{A,s}$ can take; $tilt_{A,s}$ converges towards $tilt_{A,s,max}$ when the pre-tilting holdings of bonds belonging to buckets A and B are very close to 0.

We set the climate tilting factor for bucket B equal to 50% of the value of $tilt_{A,s}$:

$$tilt_{B,s} = 0.5 tilt_{A,s}$$

(9)

Similarly, the climate tilting factor for bucket C is 50% lower (in absolute terms) than $tilt_{D,s}$:

$$tilt_{C,s} = 0.5 tilt_{D,s}$$

(10)

To specify $tilt_{D,s}$, we substitute Eq. (9) and Eq. (10) into Eq. (7) and solve for $tilt_{D,s}$:

$$tilt_{D,s} = -\frac{(HOLD_{A,s} + 0.5 HOLD_{B,s})tilt_{A,s}}{0.5 HOLD_{C,s} + HOLD_{D,s}}$$

(11)

Note that $tilt_{D,s}$ should not be allowed to take values lower than -1, since this would imply a higher than 100% decline in holdings (which is not possible). In our replication exercise we set $tilt_{A,s,max} = 0.6$ in Eq. (8). This is the highest value that we can have for $tilt_{A,s,max}$ without getting $tilt_{D,s} < -1$ in some sectors. The qualitative implications of our analysis do not change if lower values are used.

Strong Tilting

Under the *Strong Tilting* option, the climate footprint of bonds is identified based both on our *CCI* and the type of activities that the companies engage in. Hence, bonds are classified following two steps. In the first step, they are classified into 4 different buckets (A, B, C, D) based on how their issuers perform according to their *CCI* (see Appendix B). In the second step, we classify bonds based on the main activities of their issuers and whether the bonds have a 'green' label or not. Based on the categorisation described in Appendix C, we have the following categories: CIA, GREEN and OTHER bonds.

Table A.1 shows all the combinations of buckets and activities-based categories that we use under the *Strong Tilting* option. Positive signs indicate combinations that exhibit positive tilting factors (i.e. their CBPS holdings increase), while negative signs indicate negative tilting factors (i.e. reduction in CBPS holdings). *Strong Tilting* has been designed such that (i) the increase in the holdings of GREEN bonds is accompanied by an equivalent reduction in the holdings of CIA bonds and (ii) the increase in A and B OTHER bonds is accompanied by an equivalent decline in the holdings of C and D OTHER bonds.

Let us first focus on the tilting related to GREEN and CIA bonds. We need the sum of GREEN and CIA bond holdings to remain the same after tilting. Hence, **Table A.1:** Sign of tilting factors under different combinations of climate buckets and activities-based categories, *Strong Tilting* and *Strong Tilting+Exclusion* options

	CIA	GREEN	OTHER
Bucket A (very strong climate performers)	-	+	+
Bucket B (strong climate performers)	-	+	+
Bucket C (poor climate performers)	-	+	-
Bucket D (very poor climate performers)	-	+	-

we have:

$$tilt_{A,GREEN}HOLD_{A,GREEN,PRE} + tilt_{B,GREEN}HOLD_{B,GREEN,PRE}$$

$$+tilt_{C,GREEN}HOLD_{C,GREEN,PRE} + tilt_{D,GREEN}HOLD_{D,GREEN,PRE}$$

$$+tilt_{A,CIA}HOLD_{A,CIA,PRE} + tilt_{B,CIA}HOLD_{B,CIA,PRE}$$

$$+tilt_{C,CIA}HOLD_{C,CIA,PRE} + tilt_{D,CIA}HOLD_{D,CIA,PRE} = 0 \tag{12}$$

where $tilt_{A,GREEN}, tilt_{B,GREEN}, tilt_{C,GREEN}, tilt_{D,GREEN} > 0$ and $tilt_{A,CIA}, tilt_{B,CIA}, tilt_{C,CIA}, tilt_{D,CIA} < 0$.

We first specify the climate tilting factor for GREEN A bonds as follows:

$$tilt_{A,GREEN} = \frac{tilt_{A,GREEN,max}}{1 + \frac{HOLD_{A,GREEN,PRE}+HOLD_{B,GREEN,PRE}+HOLD_{C,GREEN,PRE}+HOLD_{D,GREEN,PRE}}{HOLD_{A,CIA,PRE}+HOLD_{B,CIA,PRE}+HOLD_{C,CIA,PRE}+HOLD_{D,CIA,PRE}}} \tag{13}$$

where $tilt_{A,GREEN,max}$ is the maximum value that $tilt_{A,GREEN}$ can take; $tilt_{A,GREEN}$ convergences towards $tilt_{A,GREEN,max}$ when the pre-tilting GREEN holdings are very close to 0.

The climate tilting factors for the rest of GREEN bonds need to be lower since the climate performance of buckets B, C and D is less strong. Hence:

$$tilt_{B,GREEN} = 0.75 tilt_{A,GREEN} \tag{14}$$

$$tilt_{C,GREEN} = 0.5 tilt_{A,GREEN} \tag{15}$$

$$tilt_{D,GREEN} = 0.25 tilt_{A,GREEN} \tag{16}$$

The climate tilting factors for the CIA bonds of buckets A, B and C need to be lower (in absolute terms) in comparison with the tilting factor of bucket D. Hence:

$$tilt_{A,CIA} = 0.25 tilt_{D,CIA} \tag{17}$$

$$tilt_{B,CIA} = 0.5 tilt_{D,CIA} \tag{18}$$

$$tilt_{C,CIA} = 0.75 tilt_{D,CIA} \tag{19}$$

To specify $tilt_{D,CIA}$, we substitute Eq. (14), Eq. (15), Eq. (16), Eq. (17), Eq. (18) and Eq. (19) into Eq. (12) and solve for $tilt_{D,CIA}$:

$$tilt_{D,CIA} = -\frac{(HOLD_{A,GREEN,PRE} + 0.75 HOLD_{B,GREEN,PRE} + 0.5 HOLD_{C,GREEN,PRE} + 0.25 HOLD_{D,GREEN,PRE})tilt_{A,GREEN}}{0.25 HOLD_{A,CIA,PRE} + 0.5 HOLD_{B,CIA,PRE} + 0.75 HOLD_{C,CIA,PRE} + HOLD_{D,CIA,PRE}}$$

(20)

Given that the value of GREEN bonds in the CBPS holdings is much lower than the value of CIA bonds, $tilt_{A,GREEN,max}$ needs to be relatively high to ensure that $tilt_{D,CIA}$ is high enough to reflect our preference for a 'strong' reallocation of bonds from carbon-intensive activities towards climate-friendly ones. In our quantitative analysis we set $tilt_{A,GREEN,max} = 1$.

Let us now turn to the tilting of OTHER bonds. Since the holdings of OTHER bonds should remain the same, we have:

$$tilt_{A,OTHER}HOLD_{A,OTHER,PRE} + tilt_{B,OTHER}HOLD_{B,OTHER,PRE}$$
$$+ tilt_{C,OTHER}HOLD_{C,OTHER,PRE} + tilt_{D,OTHER}HOLD_{D,OTHER,PRE} = 0$$

(21)

We first select the climate tilting factor for bonds A:

$$tilt_{A,OTHER} = \frac{tilt_{A,OTHER,max}}{1 + \frac{HOLD_{A,OTHER,PRE} + HOLD_{B,OTHER,PRE}}{HOLD_{C,OTHER,PRE} + HOLD_{D,OTHER,PRE}}}$$

(22)

where $tilt_{A,OTHER,max}$ is the maximum value that $tilt_{A,OTHER}$ can take. $tilt_{A,OTHER}$ convergences towards $tilt_{A,OTHER,max}$ when the pre-tilting OTHER holdings of buckets A and B are very close to 0. In our quantitative analysis we set $tilt_{A,OTHER,max} = 0.6$, which is the same value as the value that we use for $tilt_{A,s,max}$ in Eq. (8) in the *BoE Tilting* option.

The climate tilting factor for bucket B is 50% lower than $tilt_{A,OTHER}$:

$$tilt_{B,OTHER} = 0.5 tilt_{A,OTHER}$$

(23)

Similarly, the climate tilting factor for bucket C is 50% lower (in absolute terms) than $tilt_{D,OTHER}$:

$$tilt_{C,OTHER} = 0.5 tilt_{D,OTHER}$$

(24)

To identify $tilt_{D,OTHER}$, we substitute Eq. (23) and Eq. (24) into Eq. (21) and solve for $tilt_{D,OTHER}$:

$$tilt_{D,OTHER} = -\frac{(HOLD_{A,OTHER} + 0.5 HOLD_{B,OTHER})tilt_{A,OTHER}}{0.5 HOLD_{C,OTHER} + HOLD_{D,OTHER}}$$

(25)

Strong Tilting+Exclusion

In the *Strong Tilting+Exclusion* option we follow a similar procedure as in the *Strong Tilting* option: we rely on the combination of our *CCI*-based climate scorecard and the activities-based categorisation of bonds. The key difference between the two options is that in the *Strong Tilting+Exclusion* option we exclude some carbon-intensive bonds that the BoE has bought and we replace them with GREEN and OTHER bonds that are eligible but have not been included in the Bank's purchases. In particular, the bonds that we exclude are all fossil fuel bonds as well as the C and D bonds issued by non-renewable electricity utilities. The signs of the climate tilting factors are the same as in the *Strong Tilting* option (see Table A.1).

To apply the *Strong Tilting+Exclusion* option we first need to identify what we call 'pseudo pre-tilting holdings'. These are the holdings of the Bank after the exclusion of the carbon-intensive bonds and the inclusion of the additional GREEN and OTHER bonds. To estimate these pseudo pre-tilting holdings we apply the 'holding factor' described in Appendix A to the GREEN and OTHER bonds that have been added to the Bank's purchases.

The value of pseudo pre-tilting holdings is not expected to be the same as the value of the pre-tilting holdings – unless the value of bonds that are excluded is exactly the same as the value of the bonds that are added, which can happen only by chance. In order to make sure that the post-tilting holdings will be the same as the pre-tilting ones we adjust the GREEN post-tilting holdings. In particular, the following condition needs to hold:

$$tilt_{A,GREEN,ex}HOLD_{A,GREEN,PS-PRE} + tilt_{B,GREEN,ex}HOLD_{B,GREEN,PS-PRE}$$

$$+tilt_{C,GREEN,ex}HOLD_{C,GREEN,PS-PRE} + tilt_{D,GREEN,ex}HOLD_{D,GREEN,PS-PRE}$$

$$+tilt_{A,CIA}HOLD_{A,CIA,PS-PRE} + tilt_{B,CIA}HOLD_{B,CIA,PS-PRE}$$

$$+tilt_{C,CIA}HOLD_{C,CIA,PS-PRE} + tilt_{D,CIA}HOLD_{D,CIA,PS-PRE}$$

$$= HOLD_{EXCL} - HOLD_{INCL}$$

$$(26)$$

where $tilt_{A,GREEN,EX}, tilt_{B,GREEN,EX}, tilt_{C,GREEN,EX}, tilt_{D,GREEN,EX} > 0$ and $tilt_{A,CIA}, tilt_{B,CIA}, tilt_{C,CIA}, tilt_{D,CIA} < 0$. $HOLD_{EXCL}$ are the holdings of bonds that have been excluded and $HOLD_{INCL}$ are the holdings of bonds that have been included. The subscript 'PS-PRE' denotes 'pseudo pre-tilting' and the subscript 'EX' denotes the 'Pre-tilting+Exclusion' option.

We assume that the climate tilting factors for CIA bonds are the same as in the *Strong Tilting* option. However, the climate tilting factors for GREEN bonds are adjusted to make

sure that condition (26) holds. As in the *Strong Tilting* option, the climate tilting factors for B, C and D are lower than the climate tilting factor of A GREEN bonds. More precisely:

$$tilt_{B,GREEN,EX} = 0.75 tilt_{A,GREEN,EX} \tag{27}$$

$$tilt_{C,GREEN,EX} = 0.5 tilt_{A,GREEN,EX} \tag{28}$$

$$tilt_{D,GREEN,EX} = 0.25 tilt_{A,GREEN,EX} \tag{29}$$

$tilt_{A,GREEN,EX}$ is the climate tilting factor that we use as residual to ensure that Eq. (26) holds. We substitute Eq. (27), Eq. (28), Eq. (29), Eq. (17), Eq. (18) and Eq. (19) into Eq. (26) and solve for $tilt_{A,GREEN,EX}$:

$$tilt_{A,GREEN,EX} = -\frac{(0.25 HOLD_{A,CIA,PS-PRE} + 0.5 HOLD_{B,CIA,PS-PRE} + 0.75 HOLD_{C,CIA,PS-PRE} + HOLD_{D,CIA,PS-PRE}) tilt_{D,CIA} + HOLD_{EXCL} - HOLD_{INCL}}{HOLD_{A,GREEN,PS-PRE} + 0.75 HOLD_{B,GREEN,PS-PRE} + 0.5 HOLD_{C,GREEN,PS-PRE} + 0.25 HOLD_{D,GREEN,PRE}} \tag{30}$$

Let us now turn to the tilting of OTHER bonds. Since the holdings of OTHER bonds should remain the same, we have:

$$tilt_{A,OTHER,EX} HOLD_{A,OTHER,PS-PRE} + tilt_{B,OTHER,EX} HOLD_{B,OTHER,PS-PRE}$$

$$+ tilt_{C,OTHER,EX} HOLD_{C,OTHER,PS-PRE} + tilt_{D,OTHER,EX} HOLD_{D,OTHER,PS-PRE} = 0 \tag{31}$$

We specify the climate tilting factor for bonds A as follows:

$$tilt_{A,OTHER,EX} = \frac{tilt_{A,OTHER,max}}{1 + \frac{HOLD_{A,OTHER,PS-PRE} + HOLD_{B,OTHER,PS-PRE}}{HOLD_{C,OTHER,PS-PRE} + HOLD_{D,OTHER,PS-PRE}}} \tag{32}$$

The climate tilting factor for bucket B is 50% lower than $tilt_{A,OTHER,EX}$:

$$tilt_{B,OTHER,EX} = 0.5 tilt_{A,OTHER,EX} \tag{33}$$

Similarly, the climate tilting factor for bucket C is 50% lower (in absolute terms) than $tilt_{D,OTHER,EX}$:

$$tilt_{C,OTHER,EX} = 0.5 tilt_{D,OTHER,EX} \tag{34}$$

To identify $tilt_{D,OTHER,EX}$, we substitute Eq. (33) and Eq. (34) into Eq. (31) and solve for $tilt_{D,OTHER,EX}$:

$$tilt_{D,OTHER,EX} = -\frac{(HOLD_{A,OTHER,PS-PRE} + 0.5 HOLD_{B,OTHER,PS-PRE}) tilt_{A,OTHER,EX}}{0.5 HOLD_{C,OTHER,PS-PRE} + HOLD_{D,OTHER,PS-PRE}} \tag{35}$$