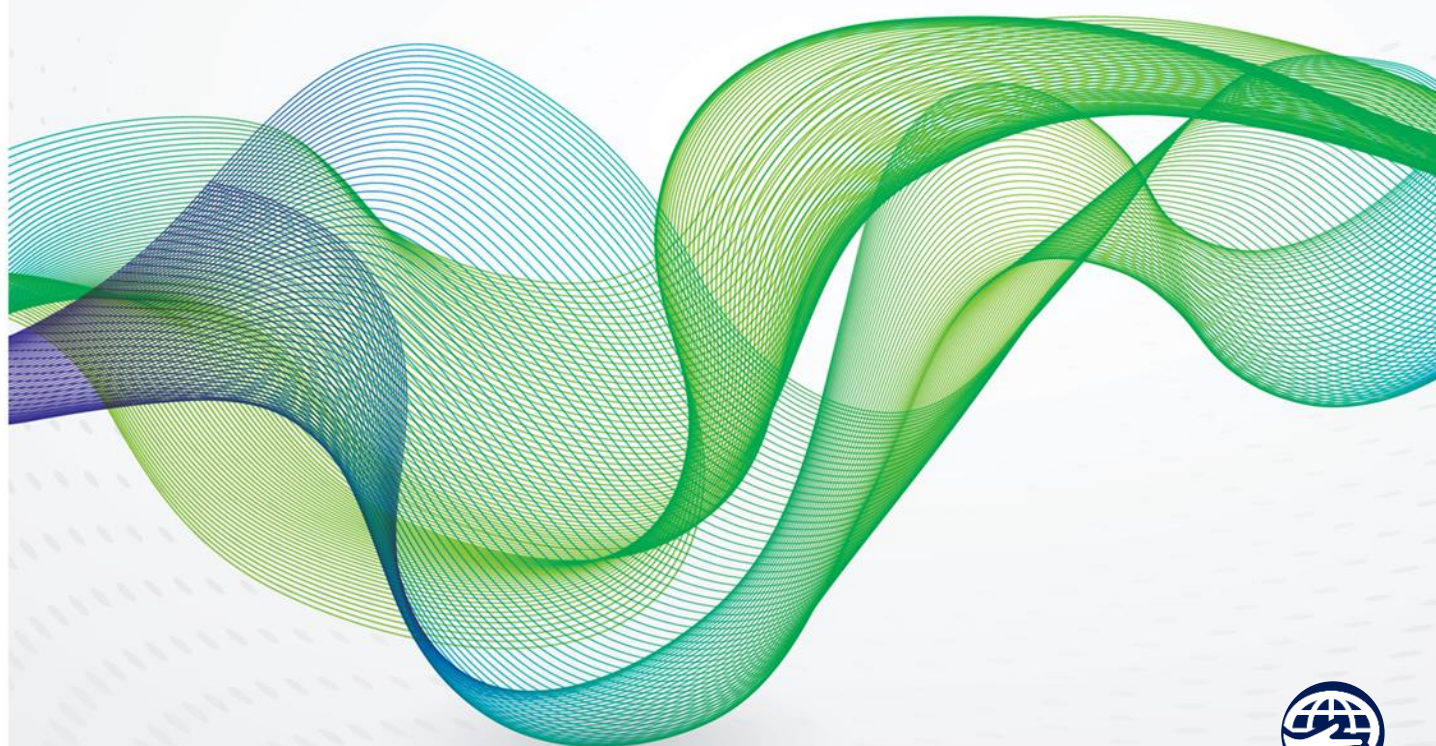




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Central Banks' 'Green Shift' and the Energy Transition



ENERGY TRANSITION

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Abstract

Central banks worldwide are stepping up actions in relation to climate change and taking on an increasingly important role in supporting the energy transition. Given the prominent role that central banks play in the financial markets and in influencing financing conditions, they can act as a powerful catalyst in addressing climate change. But their involvement and the potential consequences need to be evaluated in light of the trade-offs that central banks face. In this paper, we first focus on the European Central Bank and the Bank of England, as they are among the first and more active institutions that have been implementing 'green' policies. We then turn to central banks in developing countries, which have also been active in supporting the development of local green finance markets. However, governance and country-specific risks can impair central banks' efforts, especially in developing countries where these risks remain high.



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Introduction

Central banks and supervisory institutions have recently been taking action to address climate change. The Network for Greening the Financial System (NGFS),¹ an international institution aiming to accelerate the scaling up of green finance, is a clear example as well as a significant step towards increasing involvement and awareness of climate risks faced by the financial system and the global economy. The network was created in 2017 by eight founding central banks and now comprises 45 members.

In Europe, the Bank of England (BoE)² and the European Central Bank (ECB) are among the first institutions taking steps in this direction. Both have recently developed roadmaps to incorporate climate change considerations into their monetary policy and supervisory frameworks, while remaining within the scope of their mandates.³ Developing and emerging countries are also increasingly being exposed to climate risks and are particularly vulnerable to physical and financial risks. As a result, their central banks have also taken some significant steps in addressing the challenges of climate change, for example by putting in place some green credit allocation and green prudential policies (Dikau and Ryan-Collins, 2017).

Understanding central banks' actions and guidance in tackling climate change is relevant for bond markets in general and in particular for green bonds, whose proceeds finance climate-friendly projects (Flammer, 2021). Developed countries' central banks such as the ECB, the BoE and the US Fed, became large anchor investors in debt capital markets in the aftermath of the 2008 Great Financial Crisis conducting some extensive asset purchases as part of their unconventional monetary policy measures. In the case of the ECB, Todorov (2020) shows that the announcement and implementation in 2016 of the large-scale corporate bond purchase programme, called the corporate sector purchase programme (CSPP),⁴ led to a strong repricing in the EU corporate bond market, as well as an increase in issuance volume and a tilt towards CSPP-eligible debt. The positive effects are not limited to the increase in bond issuance but are also related to the lower cost of debt financing for issuing firms in line with the proper unfolding of the portfolio rebalancing channel (Zaghini, 2019).⁵

By the same token, the recent ECB announcement of the potential inclusion of preferential treatment of green bonds and green financing instruments within its monetary scope is expected to have a significant impact on the issuance and pricing of this segment of corporate bonds.⁶ Eliet-Doillet and Maino (2022) provide some initial insights into the effects on the European green bond market. In particular, they find that:

¹ The NGFS group describes its official mission as: 'The Network's purpose is to help strengthening the global response required to meet the goals of the Paris agreement and to enhance the role of the financial system to manage risks and to mobilize capital for green and low-carbon investments in the broader context of environmentally sustainable development. To this end, the Network defines and promotes best practices to be implemented within and outside of the Membership of the NGFS and conducts or commissions analytical work on green finance.' <https://www.ngfs.net/en>

² In its pioneering stance on incorporating climate risk assessment within the scope of the BoE supervisory function, Governor Mark Carney highlighted the challenges arising from this new form of non-financial risk, referring to the 'tragedy of the horizon', which describes the long-term risks represented by climate change and the high present costs of mitigation and adaptation. See: <https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability>

³ <https://www.ecb.europa.eu/ecb/climate/html/index.en.html>

⁴ <https://www.ecb.europa.eu/mopo/implement/app/html/cspp-ga.en.html>

⁵ As the ECB purchases bonds in the eligible segment of the European bond market, in line with its criteria for defining the investable universe of bonds, two effects are at play which have, as a result, been driving down yield to maturity and thus firms' financing costs. First, direct purchase by the ECB in primary and secondary markets leads to a lower yield to maturity given the large amount of purchases, and fixed or limited increase in supply for eligible bonds. Second, as the ECB absorbs most of the supply in the eligible segment of the market, bond investors are crowded out from the eligible bond segment towards other securities and, in particular, towards non-eligible bonds, which are a close substitute but with higher expected returns. All in all, ECB purchases in the eligible segment, by the portfolio rebalancing channel of crowded-out investors, also lower the financing cost of firms with non-eligible bonds, thus also easing the financing conditions for the market's non-eligible segment.

⁶ The following sections are dedicated to providing additional details and references to the ECB and BoE actions.



- green bonds in the Eurozone repriced significantly following the ECB 'green shift' announcement;⁷
- the issuance of green bonds by firms domiciled in the Eurozone increased significantly compared with firms in nearby jurisdictions, but outside the Eurozone.

While they typically have less capacity to play an influential macroeconomic role, developing and emerging countries' central banks can have a significant impact in their local markets when acting to address climate change challenges. Given that some of these central banks are not as strongly bound by their policy mandates as their counterparts in developed countries, they can use a wider range of instruments in their policy set and have the potential to play a broader role in decarbonizing their countries' economies while supporting sustainable development (Dikau and Ryan-Collins, 2017).

In this paper, we review the variety of actions taken by central banks to incorporate climate considerations into their operations and mandates. The spectrum of policy instruments is quite broad: a first tool is the provision of internationally harmonized frameworks related to the expansion of climate-related information available to market players, for example through mandatory disclosure in line with the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD).⁸ ⁹ Krueger et al. (2021) find that mandatory environmental, social and governance (ESG) disclosures have positive effects on both informational and real outcomes, leading in particular to a decrease in the number of ESG-related stock price crashes.¹⁰ Central banks and supervisory institutions could also develop some policies to introduce monetary incentives to make financing for low-carbon instruments more advantageous, or adopt collateral policies tilted towards green assets and financing instruments. The latter approach is less likely to be adopted by central banks in developed countries, as their mandates are predominantly focused on price stability. However, prudential approaches need not be without force and can also have an indirect effect on the adoption of green finance, as detailed in Sections II and III for the ECB and the BoE respectively.

Given their ability to affect financing conditions, central banks are set to play a major role in the energy transition. On the one hand, the primary role for central banks is to ensure financial stability and prevent sudden and potentially damaging shocks to the economy. This is particularly relevant in the context of a fragile geopolitical environment and the potential damaging consequences of either a delayed or a sudden transition. Recent research on the financial implications of a sudden or delayed transition by the Bank of France and European Central Bank shows that this could cost the global economy between 6 to 12 per cent of real GDP (Allen et al., 2020). On the other hand, the increasingly significant role played by central banks in financial markets provides the opportunity for policies in favour of segments of the market, which as a by-product supports the energy transition. Beyond direct support, such measures have the potential to generate positive externalities in the form of further adoption and channelling of private capital towards low-carbon projects. Recent estimates by the IEA show that 70 per cent of future investments directed towards renewable energy infrastructure need to be sourced from the private sector (IEA, 2020). Furthermore, sizeable investments are also needed for transition in transport, industry and energy storage, to name but a few.

Against this background, central banks' involvement can notably have an impact via the green bond market. As green bonds allow capital providers to be linked to renewable energy projects, central banks

⁷ In July 2021, the ECB announced the conclusion of its monetary policy strategy review which set a new pathway for inclusion of climate considerations within ECB operations. See for instance:

https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708_1-f104919225.en.html

⁸ <https://www.fsb-tcfd.org/>

⁹ Several initiatives are in motion in this regard. Examples are the SEC's upcoming Climate Disclosure Rules in the US (<https://corpgov.law.harvard.edu/2021/09/01/the-secs-upcoming-climate-disclosure-rules/>) and the EU in which, in April 2021, the European Commission adopted a proposal for a Corporate Sustainability Reporting Directive (CSRD) (https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en).

¹⁰ Krueger et al. (2021) define ESG-related stock crashes as: 'when accumulated bad ESG news reaches a tipping point and are released to the market all at once, such batch releases can result in sharp stock price declines. For instance, the stock price of Volkswagen dropped by more than 20 per cent in 2015 after the firm admitted to have cheated on emission over an extended period of several years.'



can directly support the channelling of capital where it is most urgently needed to achieve an orderly transition. In addition, providing incentives to transform the energy system reduces the risks of a delayed or sudden transition and, as a by-product, enhances financial stability. These measures are particularly relevant for developing countries. By incentivizing green bonds, projects with environmental benefits could attract capital at a cheaper cost and for longer terms. Furthermore, given the recent growth of green bonds as internationally accepted financing instruments, with robust and recognized transparency and assurance measures, these instruments could represent an effective way to channel private capital (especially from foreign investors in developed countries) towards the energy transition in developing economies (Maino, 2021).

The rest of the paper is structured as follows. Section I discusses the role of central banks in ‘greening’ the financial system. Section II discusses the ECB’s climate policies. Section III discusses the BoE’s climate policies. Section IV discusses the role central banks can play in developing countries, and in particular which benefits they could bring to support the energy transition. Section 5 concludes the report.

I. The role of central banks in greening the financial system

The rationale behind central banks’ work to promote a ‘greener’ financial system is twofold. Central banks’ actions can help minimize the financial stability risk of climate transition (Allen et al., 2020),¹¹ minimize future physical climate risks (Kiley, 2021),¹² and contribute towards achieving an orderly energy transition. Central banks and regulators also need to lead by example (NGFS, 2021), by ensuring that their own actions and activities are aligned with net-zero government policies and commitments. Clear signals and forward guidance to market players can allow central banks to promote further adoption of green finance and, at the same time, ensure timely implementation of decarbonization of the economy and thus financial stability.

These actions also build on the principle of ‘double materiality’ by which institutions need to gauge not only the risks arising on their balance sheet but also the extent to which their actions contribute to climate change (Täger, 2021).

The double materiality concept is particularly relevant in the context of unconventional monetary policy action taken by central banks. Research conducted by Papoutsi et al. (2021) studies the environmental impact of the ECB large-scale corporate bond purchase programme, the CSPP.¹³ Its current implementation paradigm is based on the principle of ‘market neutrality’, according to which central banks buy bonds in proportion to the amount of bonds outstanding. The authors argue that implementing a market-neutral approach would keep the relative costs of capital across firms the same and would require weighing the impact of central banks’ programmes on the firms’ cost of capital and the share of capital funded by bonds. As bond issuers are on average larger firms with a high proportion of tangible capital, central banks’ portfolios are tilted towards more bond-levered firms when following the current ‘market neutrality’ guiding principle, as shown in Figure 1. Since firms that use more bonds in their financing mix also generate relatively more emissions, it leaves the ECB portfolio tilted towards more carbon-intensive firms, which are also more exposed to climate transition risks.

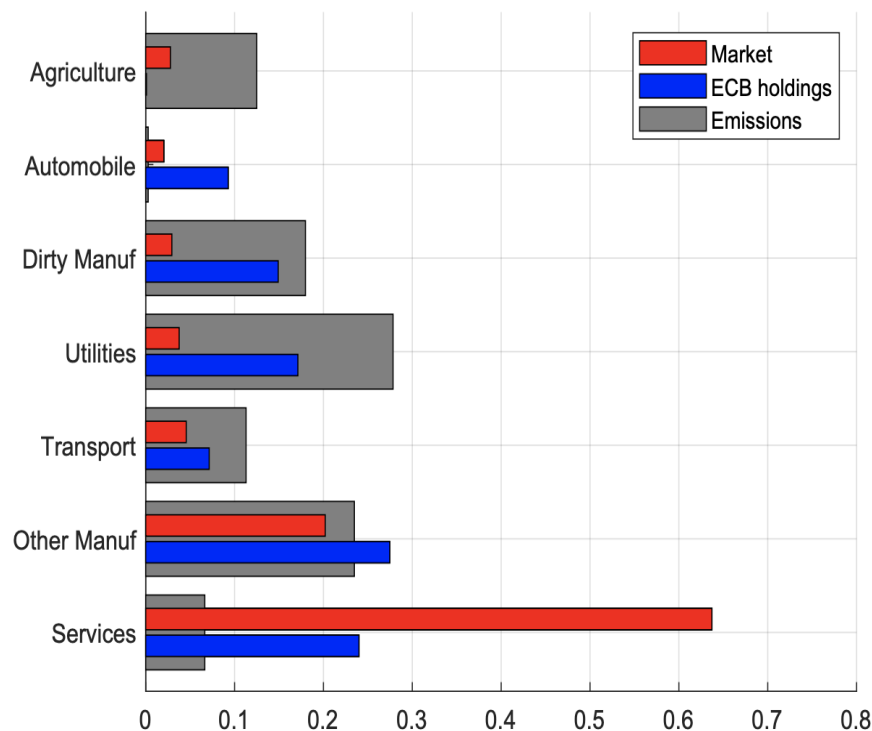
¹¹ The Task Force on Climate-Related Financial Disclosures (TCFD) recommends that firms and financial institutions report their exposure to i) climate transition risk and ii) climate physical risk. In terms of the impact of climate-related financial risks on financial stability, the Eurosystem has been raising increasing concerns about the possible implication of missing the window for an orderly transition and the consequence of a delayed or sudden transition on the economy. See the recent ECB monetary policy review report at: <https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op271~36775d43c8.en.pdf> and the Bank of France related report at: <https://publications.banque-france.fr/en/climate-related-scenarios-financial-stability-assessment-application-france>

¹² Recent estimates by Federal Reserve officials find that climate transition risk can have long-lasting negative effects on economies: <https://www.federalreserve.gov/econres/feds/files/2021054pap.pdf>

¹³ Further information on the CSPP is available on the ECB website: <https://www.ecb.europa.eu/mopo/implement/app/html/cspp-qa.en.html>
<https://www.ecb.europa.eu/mopo/implement/app/html/index.en.html>

While action could be taken to change unconventional monetary policy rules to provide financing to companies with lower emissions, or to tie eligibility criteria to some emission reduction targets, such adjustments have to be realized according to central banks' monetary policy mandates. Understanding whether climate change actions actually fall within the scope of their mandates is thus crucial for central bankers, and has led to some controversy.

Figure 1: Sector shares of the market portfolio, ECB holdings, and emissions



Source: Papoutsis et al., 2021.

Note: This figure is constructed based on the year-end 2017 data. Market shares are measured as capital income by sector (capital income = value added – wages). Emissions are measured as Scope 1 air emissions by sector. The ECB portfolio includes only securities held under the corporate sector purchase programme (CSPP) that was initiated in March 2016. All sector shares sum up to one. Data sources: SHS (ECB), Orbis, and Eurostat. Definition of sectors: Dirty Manufacturing includes oil and coke, chemicals, basic metals, non-metallic minerals manufacturing; Other Manufacturing includes food, beverages, tobacco, textiles, leather, wood, paper, pharmaceuticals, electronics, electrical equipment, machinery, furniture, construction, and other manufacturing.

The debate has been championed by ECB President Christine Lagarde who, shortly after her appointment as President of the ECB, launched a monetary policy strategy review with the objective of recalibrating the central bank's targets to the current economic conjuncture.¹⁴ Climate change considerations and, in particular, potential ECB actions to incorporate climate into its policies, have unexpectedly materialized at the heart of the strategy review.¹⁵ Executive Board Member Isabel Schnabel has also argued in favour of 'green' actions by the ECB, citing evidence that climate change is 'poised to affect price stability and the transmission of monetary policy to the real economy'. More generally, ECB officials have defended such a shift, also citing the bank's second mandate, namely that 'Without prejudice to the objective of price stability, the Eurosystem shall support the general economic policies in the EU'.

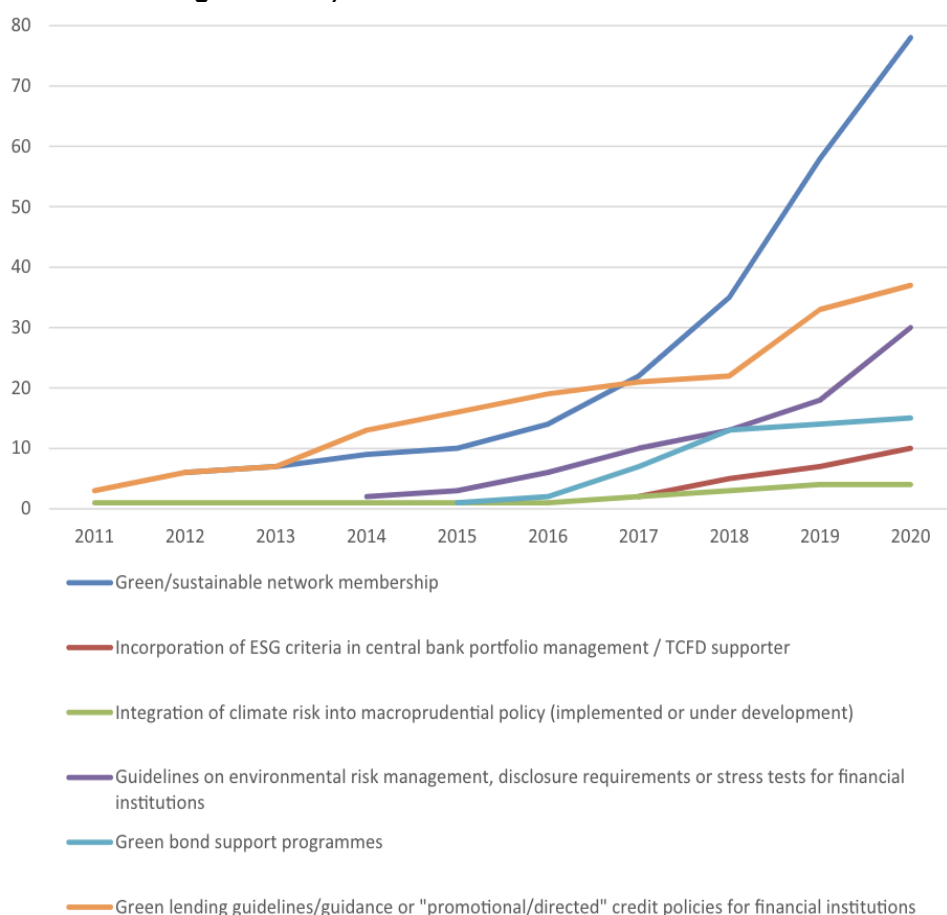
¹⁴ <https://www.ecb.europa.eu/ecb/climate/roadmap/html/index.en.html>

¹⁵ https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708_1~f104919225.en.html

Opponents of such a shift, such as former Bundesbank President Jens Weidman, instead argue that democratic legitimacy to steer the economy to net zero lies in the governments' and parliaments' hands and not in the hands of central banks. According to him, while central banks can and should incorporate climate in risk management, they should refrain from steering 'the behaviour of companies and financial institutions for political reasons', as it may threaten their independence. In addition, incorporating climate criteria might come into conflict with primary price stability mandates, for example if monetary policy would require a central bank to rein in asset purchases while climate change considerations would call for them to continue.

This debate is not exclusive to the Eurosystem, and many central banks worldwide are faced with a similar dilemma. Dikau et al. (2021) study the extent to which climate change mitigation and adaptation policies fall within central banks' mandates. They reveal that out of 135 central banks only 12 per cent have explicit sustainability mandates but 40 per cent have secondary objectives to support governments' policies. They note that the general trend is for central banks to incorporate climate risks into their monetary and supervisory policies as a safeguard to financial stability. Financial regulators' and policymakers' support for green and sustainable finance has increased significantly according to a recent report by McDaniels et al. (2018). Figure 2 shows the number of central banks which have adopted initiatives in relation to climate change mitigation and adaptation since 2011, using data on central banks' mandates from the IMF Central Bank Legislation Database and collected by Dikau and Volz (2021). Figure 2 also shows that central banks have engaged in various green activities.

Figure 2: Evolution of the number of central banks that have adopted 'green' activities (by type of 'green' central banking activities)



Source: Dikau and Volz (2021).

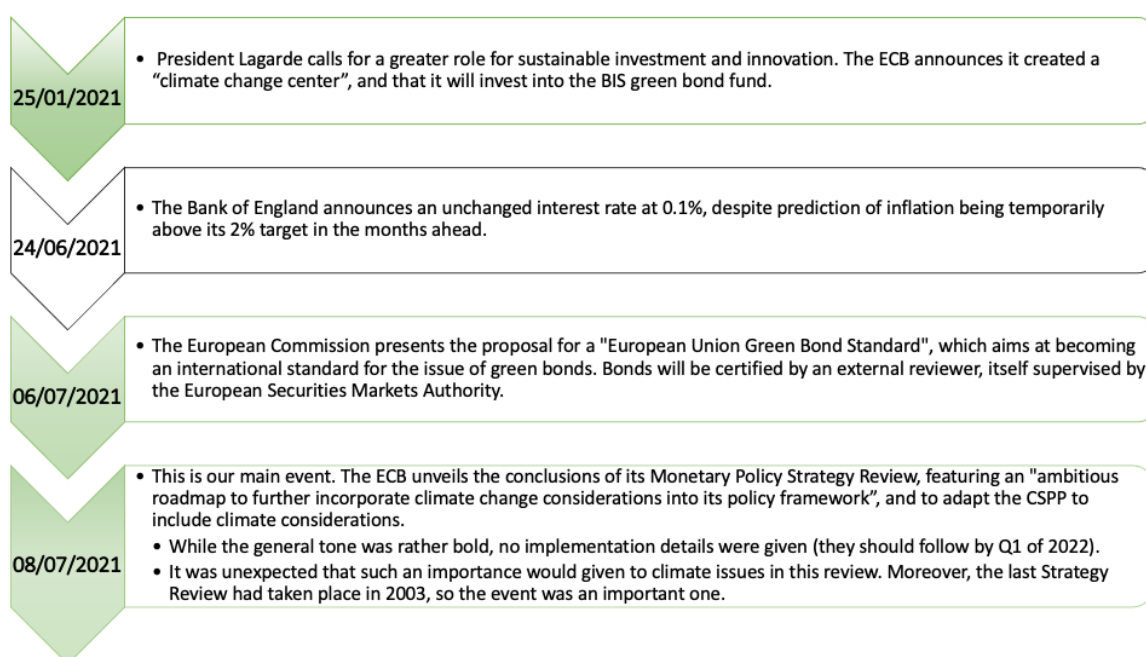
II. ECB climate policies

As stated above, the ECB, BoE and, more generally, central banks' climate-related actions need to be understood within the scope of their mandates. In the case of the ECB, this is represented by the Treaty on the Functioning of the European Union and in particular its Article 127, which defines the objectives and tasks in the ECB's area of responsibility. The breadth and speed of actions that the ECB may undertake thus depend on the understanding of the impact that climate change is having on its primary and secondary objectives, as stated in Article 127:

- I. maintaining price stability in the Eurozone; and
- II. supporting the economic policies of the European Union.

Against this background, ECB actions are closely linked to the recognized effects of climate change on price stability because if accounting for climate change is considered a necessary condition for the ECB to maintain price stability, and thus fulfil its primary mandate, any ECB action in that respect would be pursuing its primary objective rather than sustainability objectives per se. While recent events, as detailed below, have seen the ECB step up its efforts and involvement in the climate change discussion, its stance remains uncertain and thus so does the breadth of its climate-related activities.

Figure 3: Timeline of ECB announcements related to climate change considerations within ECB operations



Source: ECB website and Eliet-Doillet and Maino (2021).

However, since September 2020, through a sequence of announcements detailed in Figure 3, ECB officials have gradually set out their roadmap for including climate change in the ECB Asset Purchase Programmes (APP), Banking Supervision scheme and Collateral Framework. These announcements have culminated with the conclusion of its monetary policy strategy review in July 2021.¹⁶ To stress the importance attached to the role of climate change within the 2020–2021 monetary policy strategy review, we cite an extract of the press release:

¹⁶ https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708_1~f104919225.en.html



With this decision, the Governing Council underlines its commitment to more systematically reflect environmental sustainability considerations in its monetary policy. The decision follows the conclusion of the strategy review of 2020–21, in which the reflections on climate change and environmental sustainability were of central importance. (ECB, 2021).

Monetary policy actions

On the monetary policy side, one tool that stands out in this green agenda is the CSPP. Under the new framework, the ECB plans to incorporate climate criteria in its corporate bond purchasing scheme.

Several practical and legal requirements are still under discussion in terms of fully defining the scope of the ECB's actions. An important issue pertains to the lack of a clear definition of what constitutes 'green assets'. In this respect, the recent initiatives by the European Commission (EC) introducing an EU green taxonomy¹⁷ move exactly in that direction by providing a solid foundation for other initiatives tilted towards sustainable finance.¹⁸

An instrument that could prove particularly significant are 'green bonds', whose proceeds finance projects with positive environmental benefits. These bonds are used to signal a company's commitment to the environment and their issuance is typically followed by a reduction in the issuer's carbon emissions (Flammer, 2021). An EC initiative aimed at promoting greater transparency in the green bond market, in line with the European Green Deal, led to the publication on 6 July 2021 of a proposal for the European Green Bond Standard (EUGBS), paving the way for a green bond label with high voluntary standards that could become the norm in the EU (Maino, 2021).

While the ECB has already been purchasing green bonds within the CSPP¹⁹ it has been doing so by applying the same eligibility criteria based on outstanding amounts as for its eligible conventional bonds, and thus completely ignoring the 'greenness' of those bonds. Figure 4 shows on the left axis the total number of unique ISINs²⁰ included in the CSPP portfolio, while the right axis shows the total number of unique ISINs of green bonds in the CSPP portfolio. Given the importance of the ECB as a large-scale investor for EU debt capital markets, the new framework will likely affect the EU green bond market and, even though the ECB will give some more details and start to implement its new approach only later in 2022, the effects are already expected to be incorporated by market participants.

Todorov (2020) studies the effects of the launch of the CSPP programme on the issuance of eligible corporate bonds in March 2016. He finds that firms' issuance of CSPP-eligible corporate bonds increased and that liquidity and pricing for eligible securities rose significantly in the aftermath of the programme's announcement and subsequent implementation.

Focusing on the 'green shift' announcement by the ECB in its July 2021 monetary policy strategy review, Eliet-Doillet and Maino (2022) find that a similar pattern was observed, with a decrease in eligible green bond yields and an increase in green bonds from issuers domiciled in the Eurozone, in particular issuers that are eligible for the CSPP. Figure 5 shows the changes in yield to maturity (YTM) of Euro-denominated eligible green bonds when compared with quasi-eligible Swedish-crown denominated green bonds (these bonds are labelled as 'quasi-eligible' given that the only criteria for non-eligibility is the currency denomination which is not the Euro).

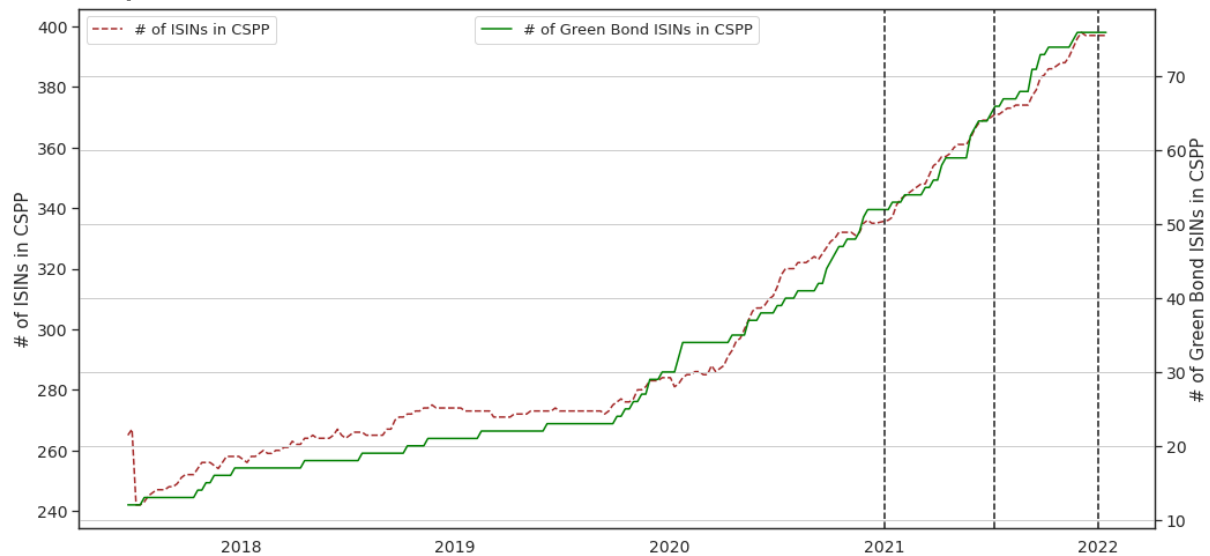
¹⁷ https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

¹⁸ See the EU Green Bond Standard at https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3405

¹⁹ https://www.ecb.europa.eu/pub/economic-bulletin/focus/2018/html/ecb.ebbox201807_01.en.html

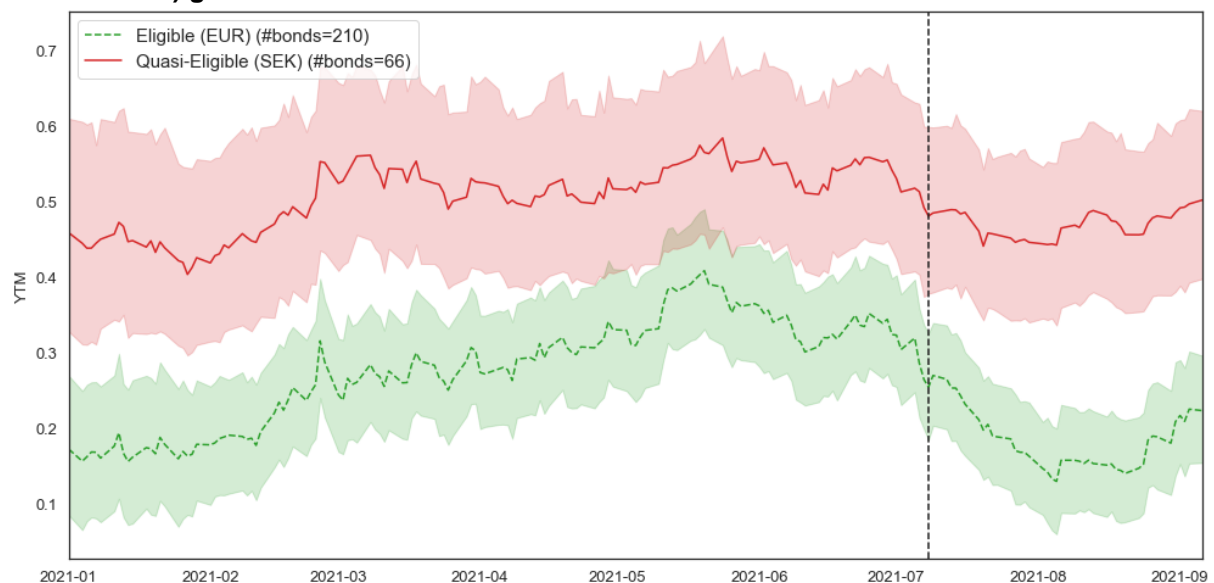
²⁰ In the bond market an International Securities Identification Number (ISIN) is a unique 12-digit alphanumeric code used to identify a security.

Figure 4: Evolution of the total number of distinct bonds and green bonds held by the ECB in its CSPP portfolio



Source: ECB website and authors' calculations.

Figure 5: Evolution of the average yield to maturity of eligible (investment-grade, Euro-denominated) green bonds, compared with quasi-eligible (investment-grade, Swedish-crown denominated) green bonds after the ECB announcement



Source: Eliet-Doillet and Maino (2022). The dashed vertical line represents the day of the announcement on 8 July 2021.

While special importance will likely be given to green bonds, whether the ECB will choose to abandon market neutrality is another crucial issue that is still unclear at this stage. The current market neutrality paradigm, designed to keep relative prices constant despite the central bank's massive intervention on the bond market, has been criticized as it tilts central banks' portfolios towards more emitting sectors and firms in the economy (Papoutsis et al., 2021). Proponents for keeping this implementation principle, such as former Bundesbank President Jens Weidmann, argue instead that it is not the central banks' role to 'correct market distortions'. While the issue is still debated, Eliet-Doillet and Maino (2022) find that the ECB 'green shift' announcement did not lead to an increase in the cost of conventional bond



financing for high carbon emitters, suggesting that, for now, investors do not find it credible that the ECB would abandon market neutrality.

In addition to unconventional monetary policy tools, the collateral framework is also critical, as it lies at the heart of the ECB's (conventional) monetary policy implementation. The ECB uses collateralized lending to provide liquidity, and the collateral framework thus defines the rules via which central banks inject money into the banking system. The ECB framework is particularly criticized in that context because:

- as in the case of large-scale corporate bond purchases, the eligibility criteria favour high-emitting companies as they are the main issuers of bonds eligible under this framework;
- the average haircut²¹ applied in non-carbon-intensive sectors is higher than in carbon-intensive sectors (Dafermos et al., 2021).

Dafermos et al. (2021) argue in favour of changing this framework and propose different scenarios, ranging from a milder option of aligning haircuts with the bond's climate footprint to exclude bonds issued by either fossil fuel companies or other carbon-intensive issuers as collateral, and instead accept only green bonds for those companies in order to accelerate their transition to low-carbon activities.

Supervisory actions

Central banks' climate-related supervisory actions are linked to transforming the banks' risk management practices to incorporate measurement of climate-related risk and, as a consequence, build up supervisory capital in relation to those risks. In the EU, the ECB has the leadership in banking supervision, even though supervisory tasks are separated from monetary ones and carried out through the Single Supervisory Mechanism (SSM).

In relation to climate-related supervisory actions, in November 2020 the ECB published a guide²² on climate-related and environmental risks for banks, and regularly continues to update its supervisory expectations. The ECB has identified climate risks as a key risk driver in the SSM Risk Map²³ for the EU banking system, and named them a 'key vulnerability' in its 2022–2024 supervisory priorities. Banks were expected to perform a self-assessment of climate risk based on ECB expectations in 2021, and as at 2022 the supervisory stress tests will also focus on climate-related risks. With respect to the regulatory disclosures, the ECB is expecting financial institutions to provide climate-related risk exposure in their reporting, in line with the EC guidelines on non-financial reporting.²⁴ However, early checks of banks' self-assessment by the ECB also showed that EU banks lag behind in terms of disclosure of climate-related risks and awareness of the impact on their business strategy (ECB, 2022).²⁵

This observation is important in light of the previous discussion of the importance of aligning bank capital towards a greener sector of the economy, given the substitutability of bond capital and syndicated loan capital. Without orienting the banks' capital towards greener sectors of the economy and properly incorporating risk management climate risks, the banks could underestimate the potential risks arising from climate change and pursue inefficient capital allocation.

On the mounting awareness and urgency to take concrete action to incorporate climate-related risks into the ECB supervisory framework, the European Banking Authority (EBA) was mandated to assess how ESG factors could be incorporated into the pillars of prudential supervision. The EBA has since

²¹ Haircuts are defined as 'The percentage deducted from the collateral value to establish the borrowing potential' and are a primary risk management tool in central banks' collateralized lending operations with banks. See <https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op189.en.pdf> for further details of the functioning of the collateral framework and the use of haircuts in the Eurosystem collateral framework.

²² <https://www.bankingsupervision.europa.eu/press/pr/date/2020/html/ssm.pr201127~5642b6e68d.en.html>

²³ <https://www.bankingsupervision.europa.eu/banking/priorities/html/index.en.html>

²⁴ [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019XC0620\(01\)&from=EN](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019XC0620(01)&from=EN)

²⁵ https://www.bankingsupervision.europa.eu/banking/priorities/html/ssm.supervisory_priorities2022~0f890c6b70.en.html



published an Action Plan on Sustainable Finance and a Discussion Paper²⁶ on the integration of ESG into regulatory and supervisory frameworks.

The banks' exposure to sectors of the economy responds to their perceived and priced risks as well as risk budgeting constraints imposed by regulators.²⁷ Beyene et al. (2021) finds that carbon-intensive firms substitute corporate bonds for syndicated loans in anticipation of heightened climate transition concerns in the bond market, which translates into higher pricing of the climate externality.

The differential pricing of climate policy exposure from the banking sector, and the consequential larger allocation of bank credit towards sectors of the economy which are more exposed to climate risk, shows that banks are also set to play a pivotal role in channelling funds towards net-zero-aligned projects and assets. The extent towards which this shift may materialize is dependent on the regulatory framework that financial regulators are expected to set for financial institutions. Without orienting the banks' capital towards greener sectors of the economy and properly incorporating climate risks into their risk management, banks could underestimate the potential risks arising from climate change and pursue inefficient capital allocation.

At the international level, the NGFS has provided climate risk scenarios based on possible climate policy implementation, and sets the foundation for central banks and supervisory authorities around the world. The NGFS has published a report-mapping progress update by regulators on the implementation of its guide for supervisors published in 2020.²⁸ The NGFS finds that supervisors have made considerable progress in integrating climate-related risks into their risk frameworks. On the back of that progress, they have identified 12 areas for supervisors to focus on in future:²⁹

1. Supervisory scope, strategy and organizational framework
 - a. Focus Area 1: use adequate definitions of climate-related and environmental risks;
 - b. Focus Area 2: incorporate climate-related and environmental risks into supervisory strategies;
 - c. Focus Area 3: incorporate climate-related and environmental risks into organizational structure;
 - d. Focus Area 4: build capacity through awareness raising and expertise development.
2. Risk transmission and assessment
 - a. Focus Area 5: develop clear understanding of sources of climate-related and environmental risks;
 - b. Focus Area 6: understand the transmission channels from climate-related and environmental risks to the economy and financial system;
 - c. Focus Area 7: assess financial exposures arising from climate-related and environmental risks through quantitative and qualitative approaches;
 - d. Focus Area 8: assess potential loss and impact using forward-looking methodologies.
3. Supervisory expectations and enforcement
 - a. Focus Area 9: develop supervisory expectations, factoring in key aspects including governance, business strategy, risk management, scenario analysis and disclosure;

²⁶https://www.eba.europa.eu/sites/default/documents/files/document_library/EBA%20Action%20plan%20on%20sustainable%20finance.pdf

<https://www.eba.europa.eu/eba-launches-consultation-incorporate-esg-risks-governance-risk-management-and-supervision-credit>

²⁷ See for example the Basel III capital requirement for banks: <https://www.bis.org/bcbs/basel3.htm>

²⁸ https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_for_supervisors.pdf

²⁹ https://www.ngfs.net/sites/default/files/media/2021/11/08/progress_report_on_the_guide_for_supervisors.pdf



- b. Focus Area 10: engage supervised entities on the implementation of supervisory expectations;
 - c. Focus Area 11: integrate climate-related and environmental risks into supervisory frameworks and processes.
4. Supervisory expectations with regard to disclosures
- a. Focus Area 12: promote comparable, consistent and reliable climate-related and environmental disclosures, including by considering aligning with commonly accepted baseline frameworks or standards and future international reporting standards.

III. Bank of England climate policies

The BoE has taken a proactive approach in incorporating climate change considerations within its goal of maintaining monetary and financial stability. Since 2015, Mark Carney, former governor of the BoE, has highlighted the increasing threat arising from climate change, which he referred to as the 'Tragedy of the Horizon'. Climate physical risk is a long-term risk whose effects will be catastrophic beyond the traditional horizon of most decision-makers and socio-economic cycles, such as the business cycle, political cycle, and the cycle of technocratic authorities such as central banks, and would impose costs on future generations which current generations have limited incentives to resolve.

Building on these insights, the BoE has developed five key goals in its climate change policy:

- I. ensuring financial resilience to climate-related financial risks;
- II. supporting an orderly economy-wide transition to net-zero emissions;
- III. promoting the adoption of TCFD-aligned climate disclosure;
- IV. contributing to a coordinated international approach to climate change;
- V. demonstrating best practice through the BoE's own operations.³⁰

Monetary policy actions

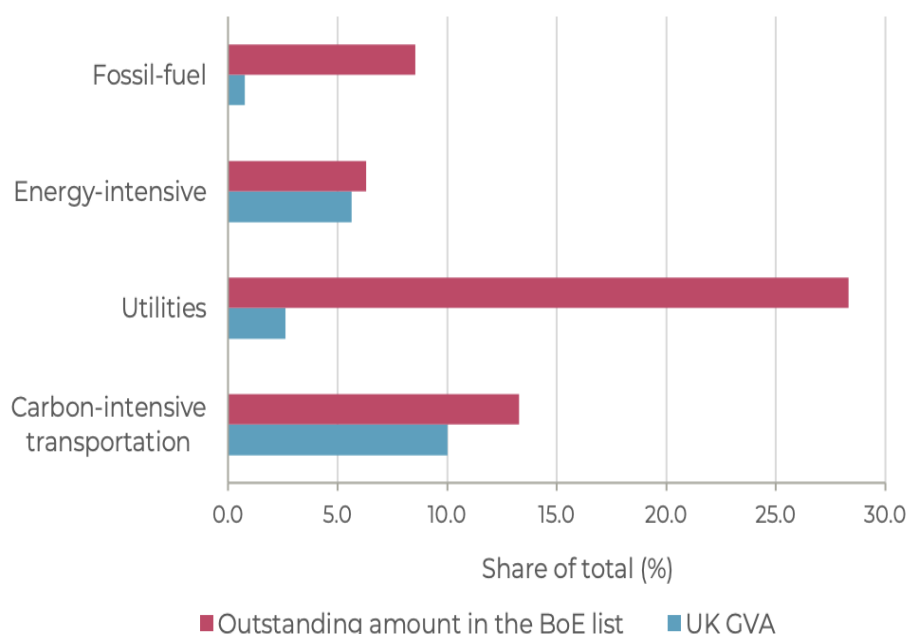
Among the measures undertaken by the BoE, notable is the initiative to green the Corporate Bond Purchase Scheme (CBPS)³¹, starting with the reinvestment phase in November 2021. This 'greening' initiative is driven by growing concerns about the environmental impact of corporate bond purchases. A recent paper by Dafermos et al. (2020) provides a mapping of BoE portfolio composition in terms of GHG emissions, UK employment and UK gross value added (GVA), and shows that the current portfolio is weighted towards the most carbon-intensive sectors such as fossil fuel and utilities, as shown in Figure 6.

In line with the UK's commitment to a net-zero target by 2050, the BoE has taken proactive action within the scope of its CBPS. The CBPS is a purchasing programme for investment-grade corporate bonds initiated in 2016 with the objective of easing the financing condition for UK firms, and resembles the ECB's CSPP on a much smaller scale. It is worth about 20 billion pounds sterling, while CSPP holdings at the end of February 2022 are worth about 323 euros. As with the ECB's CSPP, it has been implemented following a 'market neutrality' paradigm. Starting from November 2021, in its reinvestment phase, the BoE has set out changes which are expected to provide incentives for companies to improve their carbon footprint and green practices.

³⁰ See <https://www.bankofengland.co.uk/climate-change> for additional details.

³¹ The CBPS was launched in 2016 in response to the aftermath of the financial crises to support monetary stimulus in light of an already low interest rate environment, with the objective of reaching the inflation target level. Similar to other CBs, the BoE corporate quantitative easing specifies the list of eligible securities according to a set of eligibility criteria. The purchases are then guided by the principle of 'market neutrality' according to which purchases are intended to replicate the corporate bond market portfolio.

Figure 6: Carbon-intensive sectors in the BoE list of eligible bonds and UK gross value added



Source: Dafermos et al., 2020. Sources: Bank of England (bond ISIN codes, as at 4 June 2020), TR Eikon (NACE 4-digit sectors and bond outstanding amount, June 2020), ONS, Annual Business Survey (GVA, 2018) and authors' calculations.

The BoE's new measures for its CBPS include some updated eligibility criteria for issuers, as well as some portfolio tilts. On the eligibility side, issuers with any coal-mining activities will be fully excluded, while higher-emitting sectors, such as energy and utilities, will have to provide some public emission reduction targets in order not to be removed from the list of eligible issuers.³² In addition, there will be some re-investments tilted towards best in-sector performers, according to a new measure designed by the BoE: the Weighted Average Carbon Intensity (WACI), together with a measure of past reduction in absolute emissions. The overall objective is to incentivize companies to place the climate transition at the core of their business strategy. However, contrary to the ECB, the BoE updated criteria will not include preferential reference to green bonds.

In addition, while the plan has the merit of making the BoE a precursor, as it is the first central bank to announce some detailed rules for greening its portfolio, it is considered by external observers to be lacking in terms of ambition. By retaining market neutrality, and only excluding a small subset of carbon-intensive firms, the decline in WACI will only be marginal. It has been estimated by Dafermos et al. (2022) that it would lead to a 7 per cent decline compared with the scenario before tilting.

Supervisory actions

The BoE has also been active in terms of its supervisory role of UK companies. Physical and transition climate risks represent a threat to the stability of the UK financial system, which falls within the supervisory mandate of the BoE implemented by its supervisory authority, the Prudential Regulation Authority (PRA). The BoE is a founding member of the NGFS and, like the ECB, it follows its recommendations for integrating climate-related and environmental risks into prudential supervision.

Following the 2015 insurance report and the 2018 banking report, the BoE became the first supervisory authority to set climate risk-related supervisory expectations for banks and insurance companies in the UK, asking firms to provide an implementation plan for managing climate-related financial risks.

³² <https://www.bankofengland.co.uk/markets/greening-the-corporate-bond-purchase-scheme>



The modest progress made by firms in subsequent years in their risk management and scenario analysis schemes led the BoE to intensify its climate-related supervisory work, incorporating climate change into its core supervisory approach. From 2022, UK banks and insurers will be required to demonstrate further progress in their ability to understand and manage climate risks, and the PRA will check that the expectations set in the previous supervisory guidelines have not only been met, but also exceeded. However, the PRA has made clear that further work is required as there remains a lack of consistency across the financial industry.

IV. Green central banks in developing economies

Developing countries also face considerable climate-related challenges as they are the most vulnerable to these risks, and thus face challenges in decarbonizing their economies while maintaining sustainable economic development. Banga (2019) highlights the potential of green bonds in mobilizing adaptation and mitigation finance for countries where the role of the green bond market remains limited. However, in some emerging economies such as China and India, the green bond market is flourishing, and is mature enough to attract capital from international capital markets, and in particular from foreign institutional investors.

This seems crucial, as debt financing is an important component of a firm's capital structure and provides the capital needed for investments, in particular if it is provided on a long-term basis and on economically incentivizing terms. A recent article by Geelen et al. (2021) shows that debt financing is a significant factor contributing to innovation in firms and economies, and in particular that debt stimulates innovation by entrants. In relation to green innovation and renewable energy technology, Noailly and Smeets (2021) find that firms operating in the green-tech sector are more financially constrained, a condition which could lead to under-investment in this sector.

However, some major challenges exist for developing countries due to a variety of barriers, both on the institutional and market fronts. For example, green bond issuance entails some additional transaction and certification costs, especially in a context where many projects are small and barely reach the minimum size required by investors for green bond transactions.

In developing countries, central banks could help scale up green finance and create some favourable conditions to increase the supply of green bonds. For example, central banks' policies designed to improve financial conditions for investments in energy transitions, and alleviate financial constraints for firms in the energy sector, are expected to boost innovation and growth in these economic sectors and thus contribute to the achievement of the energy transition. By targeting green bonds directly as preferential assets in their market operation, central banks can improve financing conditions for green bond issuers and increase the number of viable green projects.

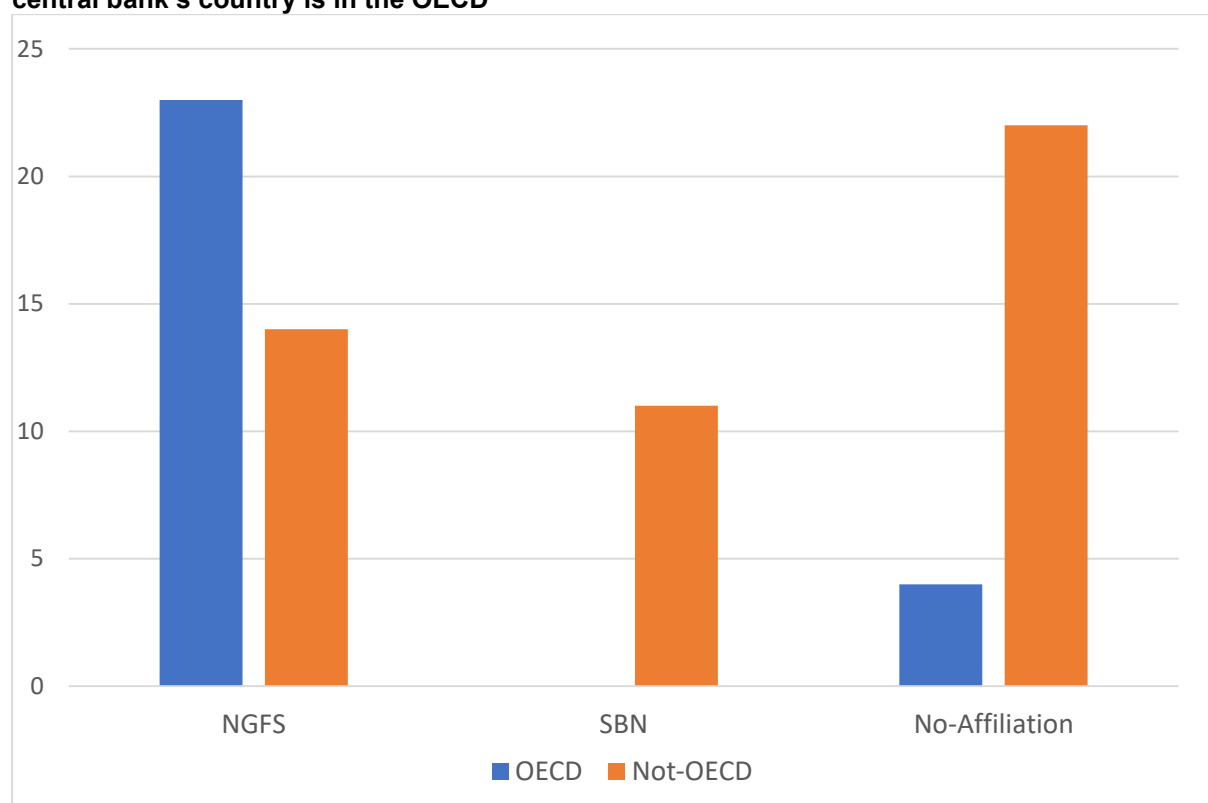
Central banks in developing countries have already launched several initiatives to support sustainable finance within their operations. Dikau and Volz (2021) show the growing number of non-OECD countries which have included sustainable finance policies within their central banks' operations. Figure 7 shows the number of non-OECD countries which have become part of the NGFS and the Sustainable Banking Network (SBN), a knowledge-sharing and capacity-building sustainable finance network focused on developing economies.³³

An interesting example lies in the case of the People's Bank of China (PBoC), which has become a pioneer in developing green finance. Relying on close cooperation with governmental agencies, it has developed some classifications as well as a range of policies that enable support for green finance. The first tool that was used was 'window guidance', which is defined as a 'benevolent compulsion' to guide commercial banks' lending volumes. From 2006, some green targets were included in 'window guidance' to discourage lending to carbon-intensive industries. This policy was a first step and, while it was on the informal side, it proved effective in mainstreaming green finance in the country. Since 2020, the PBoC decided to phase out 'green window guidance' and instead pushed towards formalizing its sustainable finance policy. First, in 2018, it decided to include green financial bonds in the pool of assets

³³ <https://www.sbfnetwork.org/>

eligible as collateral for its medium-term lending facility, leading to a decrease in green bond yields (Macaire and Naef, 2021). In 2021, it also launched a Carbon Emission Reduction Facility (CERF), which will provide targeted and discounted refinancing for loans in three areas: clean energy, energy conservation and environmental protection. The CERF will be a more specialized (i.e. directed to green segments) version of targeted refinancing operations that were put in place by central banks after the Great Financial Crisis, such as the targeted longer-term refinancing operations (TLTROs)³⁴ in the Eurozone.

Figure 7: Number of central banks affiliated to the NGFS and SBN, depending on whether the central bank's country is in the OECD



Sources: Data based on Dikau and Volz, 2021 and the authors' Table A-1 in the Appendix.

India is another interesting example of private sector initiatives that are leveraging green bonds and would be facilitated by measures targeting further incentive building on green finance. In 2021, the two major Indian industrial conglomerates, the Reliance New Energy Solar Limited (RNESL) and Adani Green Energy Limited (AGEL) plan to invest USD 80.1 billion and USD 50–70 billion respectively in the next ten years.³⁵ These significant investments are supported by considerable financing via green bonds. AGEL has raised more than USD 1.1 billion in green bonds between 2019 and 2021.³⁶

While helpful, green central banking is not a silver bullet and it needs to be part of a wide range of measures developing countries must adopt to set the conditions for private capital to be directed where it is most needed. Implementing green industrial policies and a sound regulatory environment around green and sustainable finance are some of the measures that would accelerate capital and investment build-up. In particular, public measures are needed considering the high subsidies in traditional energy

³⁴ <https://www.ecb.europa.eu/mopo/implement/omo/tltro/html/index.en.html>

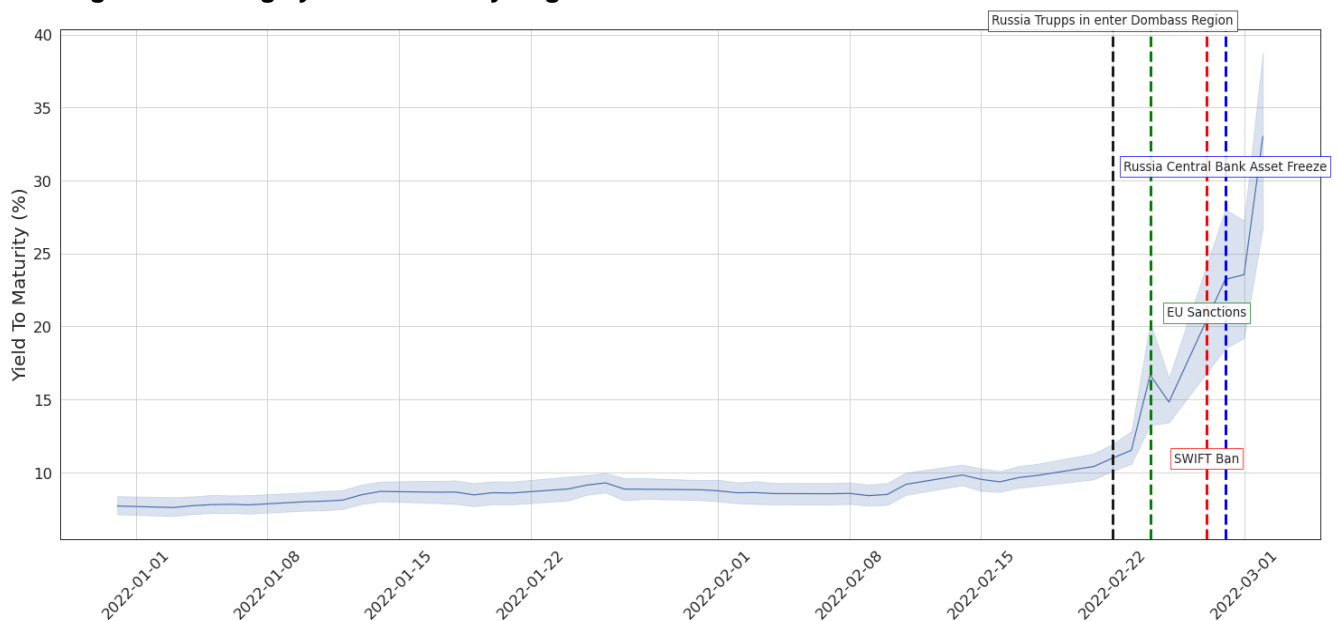
³⁵ See <https://www.financialexpress.com/industry/massive-green-push-reliance-industries-to-invest-rs-75000-crore-in-3-years/2278016/> and <https://www.bloomberg.com/news/articles/2021-10-04/adani-says-total-green-investments-to-top-50-billion-by-2030>

³⁶ See <https://mercomindia.com/adani-green-raises-million-green-bond/>

sectors. Recent analysis at global level by the IMF estimates subsidies at 6.8 per cent of global GDP as at 2020 (Parry et al., 2021). Estimates of current versus efficient fuel prices for coal, natural gas, petrol and road diesel, show that, as at 2020, BRICS countries are strongly reliant on explicit and implicit subsidies on fuels,³⁷ according to figures compiled by IMF staff.

Furthermore, recent events following the Russian invasion of Ukraine are a stark reminder for foreign investors and institutions in emerging markets with exposure to countries with high governance, political, and institutional risks. Green finance and green bonds in particular are no exceptions. Figure 8 shows the sharp increase in average YTM of green bonds issued in roubles between the end of 2021 and the first quarter of 2022, with the dashed black line marking the date of the Russian invasion of Ukraine. The YTM moved in a few days from the 10 per cent range to 40 per cent following sharp downward pressure on the rouble as the result of western sanctions on Russia. Figure A-1 in the Appendix compares the average YTM of BRICS countries. Given heightened geopolitical tensions and an uncertain environment, foreign investors might give higher priority to country and governance risks in their due diligence process when investing in green bonds, especially when denominated in local currencies. This should not come as a surprise given that, ultimately, green bonds are in most of cases unsecured claims to the entire issuing firm's operations and are, as such, exposed to firm, country and governance level risk (Maino, 2021). Furthermore, for green bonds which are issued in foreign currencies, FX risk remains an important consideration, in particular for emerging currencies.

Figure 8: Average yield to maturity of green bonds issued in roubles as at March 2022



Source: Bloomberg Fixed Income Database and Datastream. Authors' calculations.

Finally, another important element to monitor closely in developing and developed countries is the role of public debt and the fiscal budget in light of the recent pandemic and the need for green public and private investments. In the EU, the 2019 National energy and climate plans estimated a public funding share on green investments of 28 per cent on average, which translated to 0.6 per cent of EU GDP, representing a major fiscal effort.³⁸ Similar considerations are expected to hold for developing countries and are even possibly more stringent due to the higher costs of accessing debt capital markets. A recent

³⁷ Parry et al. (2021) define the efficient price of fuel as the price that includes both the supply and environmental cost of fuel use. Subsidies are broken down into explicit subsidies i.e. the portion which reflects undercharging for supply costs and implicit subsidies, and the portion which reflects undercharging for environmental costs and foregone consumption taxes.

³⁸ <https://voxeu.org/article/how-reconcile-increased-green-public-investment-needs-fiscal-consolidation>



study by the World Bank reviews the challenges of fiscal consolidation in the aftermath of the coronavirus pandemic, leaving countries with the dilemma of debt restructuring or embarking on additional fiscal easing but facing a potential and higher likelihood of debt distress³⁹ (see Figure A-2 in the Appendix). These considerations limit the extent of capital that public and private entities can channel into green investments, especially in the short term. In that context of limited fiscal capacity, the role of central banks' green policies in supporting green financing can overcome some of these financing challenges.

V. Conclusions

The scale and urgency of the energy transition has renewed the focus on public policies aimed at supporting incentives and a regulatory landscape able to channel public and private capital where it is most needed. In this paper, we review the role of central banks in implementing sustainability policies in their monetary and supervisory operations. This is particularly important in the context of green financing instruments, such as green bonds and sustainability-linked bonds, given the effects that central banks' policies have on financing conditions.

The European Central Bank and the Bank of England have been among the most active central banks in developed economies. The recent establishment and growth of the NGFS shows the widening consensus and attention that sustainability considerations are receiving from central banks internationally. However, the extent of measures implemented vary widely, with the ECB to date representing the most ambitious example, following the recent announcement in June 2021 of the key role played by climate change considerations in its monetary policy strategy review.

Emerging countries face even greater challenges in their energy transitions in which economic growth needs to be balanced with the transition to lower carbon-intensive economies. Coupled with limited fiscal capacity, a rise in public debt following the coronavirus pandemic, and heightened governance and country risks, the emerging countries' priority in attracting private capital relies on establishing an appropriate investment environment. In this context, central banks can play a major role in providing incentives for green financing instruments to support the channelling of private capital into sustainable investment projects and assets.

³⁹ <https://thedocs.worldbank.org/en/doc/cb15f6d7442eadedf75bb95c4fdec1b3-0350012022/related/Global-Economic-Prospect-2022-Topical-Issue-1.pdf>



References

- Allen, T., Dees, S., Boissinot, J., Caicedo Graciano, C. M., Chouard, V., Clerc, L., de Gaye, A., Devulder, A., Diot, S., Lisack, N., Pegoraro, F., Rabaté, M., Svartzman, R., Vernet, L. (2020). 'Climate-Related Scenarios for the Financial Stability Assessment: An Application to France', Banque de France Working Paper Series No. 774.
- Banga, J. (2019). 'The green bond market: a potential source of climate finance for developing countries'.
- Beyene, W., Ongena, S., Delis, M., de Greiff, K. (2021). 'Too big to strand? Bond versus bank financing in the transition to a low carbon economy'.
- Dafermos, Y., Nikolaidi, M., van Lerven, F., Gabor, D. (2020). 'Decarbonizing the Bank of England's Pandemic QE', New Economics Foundation.
- Dafermos, Y., Gabor, D., Nikolaidi, M., Pawloff, A., van Lerven, F. (2021). 'Greening the Eurosystem Collateral Framework', New Economics Foundation.
- Dafermos, Y., Gabor, D., Nikolaidi, M., van Lerven, F. (2022). 'An Environmental Mandate, Now What?', Inspire.
- Dikau, S., Volz, U. (2021). 'Central bank mandates, sustainability objectives and the promotion of green finance', *Ecological Economics*.
- Dikau, S., Ryan-Collins, J. (2017). 'Green Central Banking in Emerging Market and Developing Country Economies', New Economics Foundation.
- Eliet-Doillet, A., Maino, A. (2022). 'The Effects of Greening Unconventional Monetary Policy', Swiss Finance Institute Working Paper Series.
- Flammer, C. (2021), 'Corporate Green Bonds', *Journal of Financial Economics*.
- Geelen, T., Hajda, J., Morellec, E. (2021). 'Can Corporate Debt Foster Innovation and Growth?', *The Review of Financial Studies*.
- International Energy Agency (2020), 'World Energy Investment Report 2020'.
- International Energy Agency (2021), 'World Energy Outlook 2021'.
- International Energy Agency (2021), 'Net Zero by 2050'.
- Kiley, M. T. (2021). 'Growth at Risk from Climate Change', Finance and Economics Discussion Series.
- Krueger, P., Sautner, Z., Tang, D. Y., Zhong, R. (2021). 'The Effects of Mandatory ESG Disclosures Around the World', European Corporate Governance Institute – Finance Working Paper.
- Macaire, C., Naef, A. (2021), 'Greening Monetary Policy: Evidence from the People's Bank of China', Banque de France Working Paper no. 812.
- Maino, A. (2021). 'Financing the Energy Transition: The Role, Opportunities and Challenges of Green Bonds', Oxford Institute for Energy Studies.



McDaniels, J., Robins, N., 'Greening the Rules of the Game. How Sustainability Factors Are Being Incorporated into Financial Policy and Regulation', UNEP Inquiry into the Design of a Sustainable Financial System, Geneva (2018)

NGFS (2021). 'Guide on climate-related disclosure for central banks', NGFS Publications.

Noailly, J., Smeets, R. (2021). Financing Energy Innovation: Internal Finance and the Direction of Technical Change. *Environmental and Resource Economics*.

Papoutsis, M., Piazzesi, M., Schneider, M. (2021). 'How unconventional is green monetary policy'.

Parry, I., Black, S., Roaf, J. (2021). 'Proposal for an International Carbon Price Floor Among Large Emitters'.

Parry, I., Black, S., Vernon, N. (2021). 'Still Not Getting Energy Prices Right: A Global and Country Update of Fossil Fuel Subsidies'.

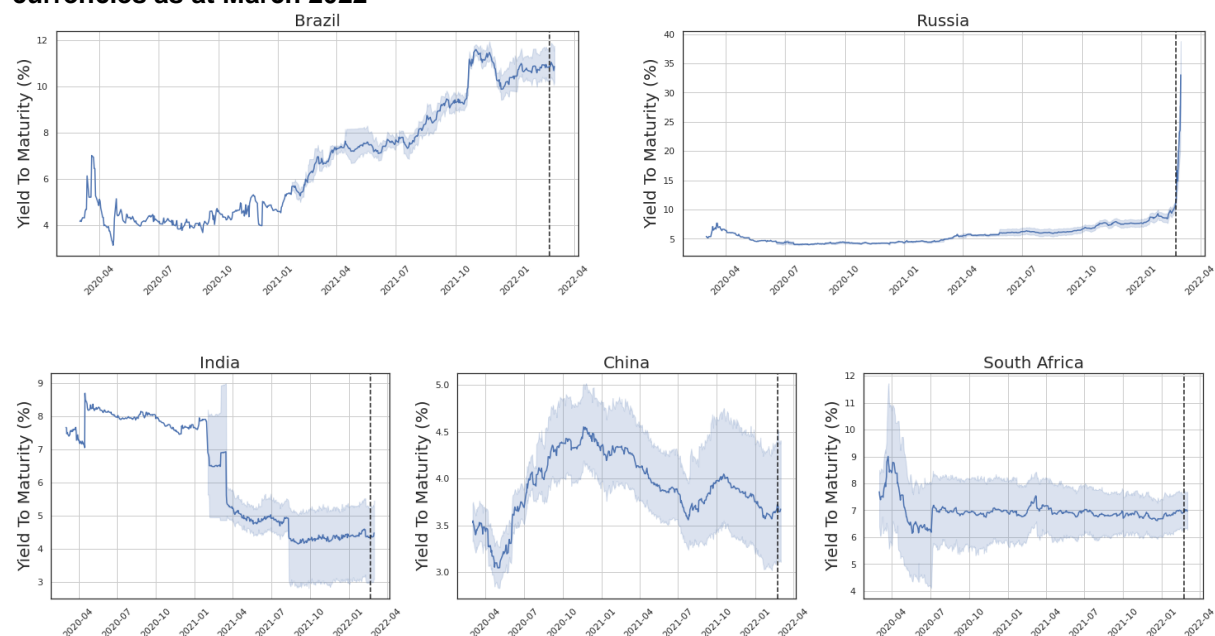
Täger, M. (2021). 'Double Materiality': what is it and why does it matter?', Grantham Research Institute.

Todorov, K. (2020). 'Quantify the quantitative easing: Impact on bonds and corporate debt issuance', *Journal of Financial Economics*.

Zaghini, A. (2019). 'The CSPP at work - yield heterogeneity and the portfolio rebalancing channel', ECB Working Paper Series.

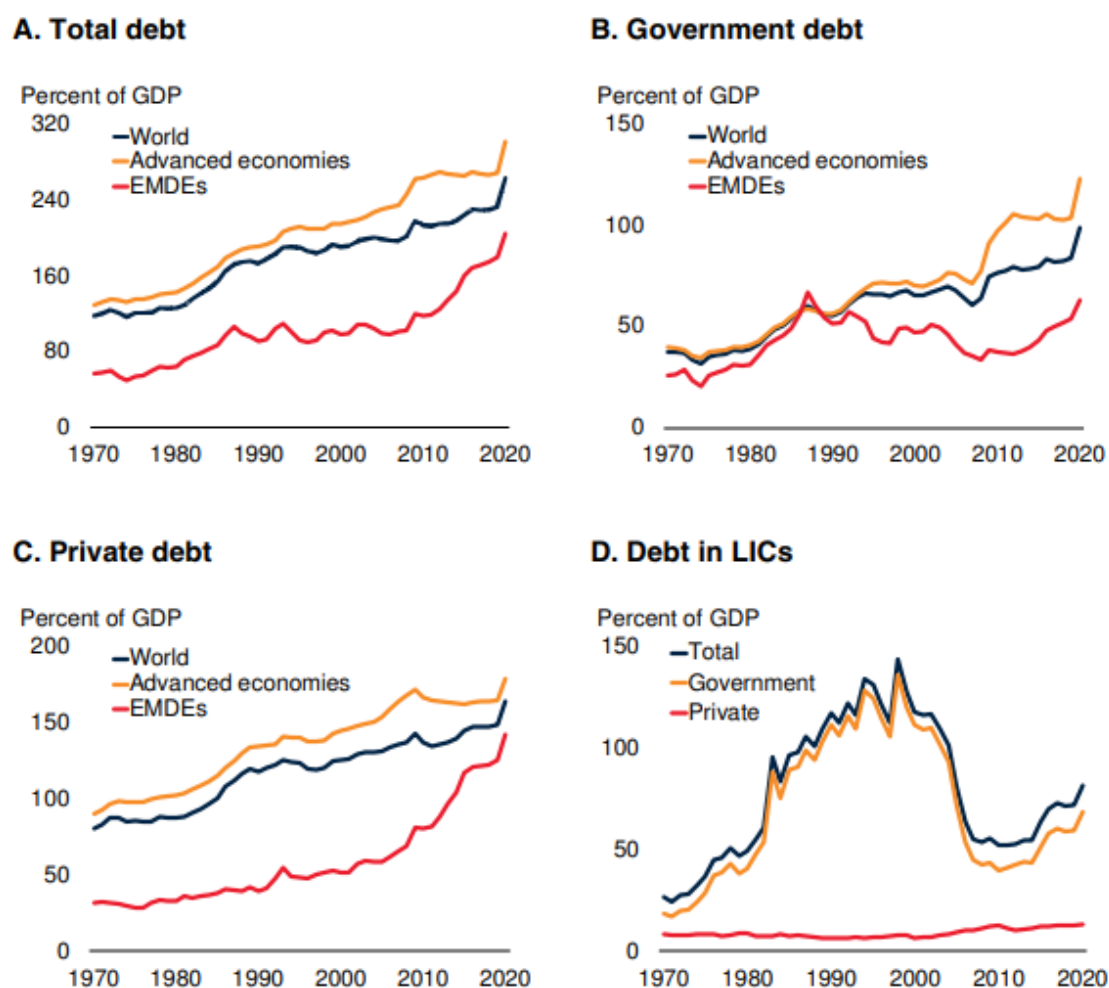
Appendix

Figure A-1: Average yield to maturity of green bonds issued in BRICS countries – local currencies as at March 2022



Source: Bloomberg Fixed Income Database and Datastream. Authors' calculations.

Figure A-2: Evolution of the level of debt as a percentage of GDP in developing and developed countries



Sources: Kose et al. (2017, 2021); World Bank.

A. Data are available until 2020 for up to 191 countries. Nominal GDP-weighted averages.

B. Data are available until 2020 for 191 countries. Nominal GDP-weighted averages.

C. Data are available until 2019 for 184 countries. Nominal GDP-weighted averages.

D. Data are available until 2020 for 26 LICs. Nominal GDP-weighted averages.

Source: World Bank, Global Economic Prospects, January 2022.

Table A-1: Comparison of OECD and non-OECD affiliation to the NGFS and SBN Networks

OECD countries		Non-OECD countries					
Central bank	NGFS	Central bank	NGFS	SBN	Central bank	NGFS	SBN
Austria	Yes	Botswana	No	No	Myanmar	No	No
Belgium	Yes	Brazil	Yes	Yes	Namibia	No	No
Czechia	No	Bulgaria	No	No	Nepal	No	Yes
Denmark	Yes	Cambodia	Yes	No	Paraguay	Yes	Yes
Estonia	Yes	Congo (DRC)	No	No	Philippines	Yes	Yes
Finland	Yes	Croatia	No	No	Qatar	No	No
France	Yes	Cyprus	Yes	No	Romania	Yes	No
Germany	Yes	Egypt	No	Yes	Russian Federation	Yes	No
Greece	Yes	Fiji	No	Yes	San Marino	No	No
Hungary	Yes	Gambia, the	No	No	Serbia, Republic of	No	No
Iceland	No	Georgia	Yes	Yes	Singapore (monetary authority)	Yes	No
Ireland	Yes	Ghana	No	Yes	South Africa	Yes	No
Israel	Yes	Indonesia	Yes	No	Tanzania	No	No
Italy	Yes	Iraq	No	Yes	Ukraine	No	Yes
Latvia	Yes	Kenya	No	No	West African Monetary Union (WAMU)	Yes	No
Lithuania	Yes	Kosovo	No	No	Zimbabwe	No	No
Luxembourg	Yes	Liberia	No	No			
Netherlands	Yes	Macedonia	No	No			
Poland	No	Madagascar	No	No			
Portugal	Yes	Malawi	No	No			
Slovak Republic	Yes	Malaysia	No	No			
Slovenia	Yes	Malta	Yes	No			
Spain	Yes	Mauritania	No	No			
Sweden	Yes	Moldova	No	No			
Switzerland	Yes	Montenegro	No	No			
Turkey	No	Morocco	Yes	Yes			
United Kingdom	Yes						

Source: authors, based on Dikau and Volz (2021).