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**SEDE DELLA REDAZIONE**

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# Scientific and Regulatory Approaches to "Green" Central Banking: The State of The Art from a Legal Perspective



## 1. *Introduction*

In 2015, Bank of England's former Governor Mark Carney urged central bankers to start tackling the consequences caused by climate change.[1] It is not an exaggeration to say that such speech was one of the turning points in the recent history of central banking, being it the first time that the impact of climate change on central banking and on the financial system gained institutional recognition.

The severity of climatic events that recently occurred throughout the world (especially, but not only, in 2021), combined with the mixed results of both the COP26[2] and the COP27,[3] shows – if needed – the materiality and the urgency of the several issues raised first by Mr.

[1] M. CARNEY, *Breaking the tragedy of the horizon - climate change and financial stability*, London, 29 Sept. 2015, https://www.bis.org/review/r151009a.htm.

[2] Although the evaluation of the COP26's outcomes varies across countries and the political spectrum, it can be considered generally understood that it fell short of the goals it had been aiming at (*e.g.*, M. JOSELOW, *Five big takeaways from COP26*, in *The Washington Post*, 15 Nov. 2021; R. MEYER, *Climate Hype Might be the Ticket to Decarbonization*, in *The Atlantic*, 12 Nov. 2021; *COP26 ends with a pact that is neither a triumph nor a trainwreck*, in *The Economist* 13 Nov 2021; M. WOLF, *Dancing on the edge of climate disaster*, in *Financial Times,* 23 Nov. 2021; however, compare with VIVES, *Was COP26 Cheap Talk?*, in *Project Syndicate*, 17 Nov. 2021).

[3] However, several commentators appear slightly less pessimistic with regard to the COP27 than to the COP26: D. WALLACE-WELLS, *The World Took a Bold, Toothless Step Forward on Climate Justice*, in *The New York Times*, Nov. 23, 2022; *Should rich countries pay for climate damage in poor ones?*, in *The Economist*, 24 Nov. 2022; M. BOEV, *An Annual Check-Up for the Climate Movement*, in *Project syndicate*, 4 Jan. 2023. The COP27 final statement is available at https://unfccc.int/documents/624444.

Carney's call. Consistently, the number of central banks' governors and/or officials that share Mr. Carney's view, if not to favor an even more proactive approach, has been constantly rising since.

Just to name a few, in 2018 Benoît Cœuré, then ECB's Executive Board Member, delivered a speech focused entirely on the role of central banks in respect to climate change, arguing that it is within their current mandate and powers to mitigate the financial and economic consequences of climate change.[4] In her position of ECB's President, Christine Lagarde expressed analogous remarks first in 2019, and then several times in 2020 and 2021.[5] Similar concerns echo in a publication by Bank of France's Governor Villeroy de Galhau dated 2019, as well as in a speech of his in October 2021. In November 2019, Bank of Norway's Deputy Governor presented a talk captioned "Climate change, climate risk and Norges Bank", and in October 2021 the Bank of Norway hosted a workshop titled "Climate change and central banking – a Nordic perspective".

After some years of reluctance, the other side of the Atlantic has also joined the chorus. Lael Braenard (FED Board of Governors' Member) signaled the issue first in 2019, and then repeatedly in 2020 and 2021.[6] Eventually, also FED Board of Governors' Chair Jerome Powell stated, in October 2021, that «Climate change poses significant challenges for the global economy and the financial system. The public rightly expects us to work to ensure the financial system is resilient to climate-related financial risks. We appreciate the magnitude of the challenges ahead of us and the Federal Reserve is committed to doing our part».[7]

The central banks of the biggest Asian economies have started to get involved with the topic as well. For example, on July 16th, 2021, the Bank of Japan issued a formal statement outlining its «Strategy on Climate Change». Moreover, the People's Bank of China adopted Guidelines for Establishing the Green Financial System as early as 2016.[8]

In short, it is possible to say the engagement of central banks with the consequences of climate change did not remain a mere hypothesis

[4] https://www.ecb.europa.eu/press/key/date/2018/html/ecb.sp181108.en.html.
[5] For further references, see below para. 3.2.
[6] For further references, see below para. 3.3.
[7]https://www.federalreserve.gov/newsevents/pressreleases/other20211021c.htm
[8] For further references, see below para. 3.

confined in theoretical debates or statements but has become meanwhile a matter of actual regulatory decisions, as reported more thoroughly below.

These developments caused different kinds of reactions by academics and experts, which include former governors and central banking officials. As a result, within a relatively brief span of time the topic has been examined in dozens of papers, articles, and contributions, coming from different fields of the economical and legal sciences.

In order to contribute to the further development of such elaborate debate, this paper aims at:

providing for a reasoned review of the relevant literature;

classifying the set of potential tools to be used by central banks (CBs) for "green" purposes;

reporting the activities and decisions currently carried out (or under discussion) for "green" purposes by some specific central banks, against the backdrop of their respective legislative and regulatory status.

The article is structured as follows. Para. 2 contains the results of the literature review (para 2.2), which are presented with a common frame of the questions which are most frequently addressed in the relevant studies, described in para 2.1. Para. 2.3 summarizes and briefly discusses such results and identifies some established trends. Based on the state of the art, Para. 3 defines first a set of tools which CBs can turn to in dealing with the consequences of climate change and classifies such tools in the (more or less) conventional categories of central banking activities (para. 3.1). Paragraphs 3.2-3.7. display the individual results of the regulatory overview conducted on a sample of central banks.

## 2.1. *Literature review*.

The following literature review reports the main outcomes of the relevant scientific investigations (and expert opinions) published[9] until March 2023, to the best of the author's knowledge. The information is conveyed after having identified the issues that are most frequently

[9] Even if only as preliminary working papers.

addressed by the analyzed studies. Therefore, the report presents the existing literature using a common frame structured on the basis of such issues [table 1], which represent the core of the debate on the involvement of central banking with climate change.

| **Table 1.** |
|---|
| a. Is an intervention by CBs in the consequences of climate change desirable and is it encompassed by the current mandate(s) of central banking? |
| b. Which kinds of tools can or should CBs use? |
| c. Is there a legal basis for enacting such tools? |
| d. Should the intervention be a reason of concern from the point of view of the central banks' independence/neutrality/accountability? |

If a paper does not address one or more of these questions, the corresponding line is empty. If the answer to one or more question is not given explicitly but can be implicitly derived as an assumption of the work, the corresponding line reports that as such.

As one might imagine, this way of presenting the information comes at the expense of the details that are disclosed and carries, as a result, a certain level of approximation. Nonetheless, the benefits in terms of concision aside, it has the upside of allowing an easy comparison between the several studies as well as of facilitating an assessment of the evolution of the literature over time.

The exposition follows a chronological order. However, studies published by the same group of authors (or by the same first author) are reported in a row.

The report ends with a summary of main outcomes and of the views which are generally accepted (or significantly prevailing), *on the one hand*, and of the open questions, *on the other hand*.

The outcomes of the review set the landscape for the subsequent policy and regulation survey, as the proposed classification draws on the previous literature.

2.2. *Literature*.

| | |
|---|---|
| CAMPIGLIO (2016)[10] | a. yes. |
| | b. Analyzes pros and cons of green differentiated reserve requirements as a tool to incentivize financing to low-carbon sectors as well as its interplays with monetary policy. |
| | c. |
| | d. |

| | |
|---|---|
| SCHOENMAKER and VAN TILBURG (2016)[11] | a. Governmental policy as best option. |
| | b.<br>b.1. climate stress-tests<br>b.2. large exposure limits<br>b.3. proposal of a "brown penalizing factor" in capital requirements (Pillar 1)<br>b.4. individual capital add-ons (Pillar 2) |
| | c. |
| | d. |

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|---|---|
| BATTISTON, MANDEL, MONASTEROLO, SCHÜTZE, AND VISENTIN, (2017)[12] | a. the work estimates the exposure of the European financial system to climate risk. The authors conclude that «while climate- related financial information disclosure is crucial for risk evaluation, a stable policy framework is necessary to resolve the multiplicity of possible outcomes.». |

[10] E. CAMPIGLIO, *Beyond carbon pricing: The role of banking and monetary policy in financing the transition to a low-carbon economy*, in *Ecological Economics*, 2016, 220-230.

[11] D. SCHOENMAKER and R. VAN TILBURG, *What Role for Financial Supervisors in Addressing Environmental Risks?*, in *Comparative Economic Studies*, 2016, 317-334.

[12] S. BATTISTON, A. MANDEL, I. MONASTEROLO, F. SCHÜTZE, and G. VISENTIN, *A climate stress-test of the financial system*, in *Nature Climate Change*, 2017, 283-288.

| | |
|---|---|
| | The authors do not explicitly address whether CBs should autonomously take action or not. |
| | b. |
| | c. |
| | d. |

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|---|---|
| DOMBROVSKIS (2017)[13] | a. |
| | b. Proposal of a "green supporting factor" in banking capital requirements: easing the weight of green investments/finance in the calculation of capital ratios (Pillar 1) |
| | c. |
| | d. |

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|---|---|
| DIKAU and RYAN COLLINS (2017)[14] | a. |
| | b. define "green credit allocation policies" (targeted refinancing lines, differential reserve requirements, credit quotas) and "Green prudential and macroprudential policies" (stress testing, counter-cyclical capital buffers, climate risk weighted assets, large exposure restrictions), and analyze their implementation by CBs in emerging markets (Bangladesh, Brazil, China, India, Indonesia, South Korea) |
| | c. |
| | d. |

[13] V. DOMBROSVKIS, *Greening finance for sustainable business*, 12 Dec. 2017, available at: https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_17_5235.

[14] S. DIKAU and J. RYAN COLLINS, *Green Central Banking in Emerging Market and Developing Country Economies*, New Economics Foundation, 2017, available at: www.neweconomics.org.

| | |
|---|---|
| MATIKAINEN, CAMPIGLIO, and ZENGHELIS (2017)[15] | a. yes, «monetary policy should seek to support these general economic objectives [managing of climate risk] without conflicting with their primary objective of price stability». The ECB's and Bank of England's quantitative easing, "QE" (corporate sector bond purchase program, "CSPP") are carbon-biased. This is not consistent with the declared aim of avoiding/mitigating climate financial risks. |
| | b.1. With regard to the current CSPP:<br>- transparency/disclosure on the purchased assets and on the selection process<br>- «study the implications of a structural carbon bias in their asset purchases, and whether this meaningfully affects asset prices and debt issuance, such that it contributes to asset mispricing and carbon lock-in»<br><br>b.2. In general.<br>A. «consider their role in aligning policy with the larger effort to support the transition to a low-carbon economy […] and take a more proactive approach to incorporating climate considerations into their purchase strategies»:<br>i. eligibility criteria for purchasable assets in ratings<br>ii. green QE (prioritize green assets over brown assets). Questionable, as it can cause distortions.<br>iii. purchase of (green) bonds from public development banks (EIB).<br>B. cooperation with fiscal policy makers and regulators. Oppose changes to collateral eligibility requirements, instead favoring interventions to facilitate green assets to become eligible. |

[15] S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *The climate impact of quantitative easing*, Grantham Institute Policy paper, London, 2017 available at: https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2017/05/ClimateImpactQuantEasing_Matikainen-et-al-1.pdf

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| | C. "macroprudential" regulation/intervention. Differentiated green reserve requirements; green/brown risk weighing in capital requirements. |
| | c. with regard to b.2.A.iii., questionable legal basis. |
| | d. |

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|---|---|
| MATIKAINEN (2017)[16] | a. |
| | b. argues against the introduction of a green supporting factor in capital requirements (Pillar 1), because of the lack of evidence that green assets are safer than brown ones. |
| | c. |
| | d. |

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|---|---|
| MONASTEROLO, BATTISTON, JANETOS, and ZHENG (2017) [17] | a. In aiming at assessing the financial exposure to climate risk, the authors point out how the market dynamics are impaired by the lack (i) of comparable indicators of exposure and (ii) of information regarding the market share of each participant (i.e., the individual contribution to the overall risk). |
| | b. |
| | c. |
| | d. |

[16] S. MATIKAINEN, *Green doesn't mean risk-free: why we should be cautious about a green supporting factor in the EU*, 2017, available at: https://www.lse.ac.uk/GranthamInstitute/news/eu-green-supporting-factor-bank-risk/.

[17] I. MONASTEROLO, S. BATTISTON, A.C. JANETOS, and Z. ZHENG, *Vulnerable yet relevant: the two dimensions of climate-related financial disclosure*, in *Climate Change*, 2017, 495-507.

| | |
|---|---|
| VAN LERVEN and RYAN-COLLINS (2017)[18] | a. yes, since climate change is a risk for financial stability. |
| | b.<br>- macroprudential policy (green capital ratios) (Pillar 1)<br>- lending quotas (green/brown lending)<br>- green QE, but with arrangements that would avoid potential distortive effects. |
| | c. |
| | d. |

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|---|---|
| EUROPEAN BANKING FEDERATION (2018)[19] | a. |
| | b.<br>b.1. Proposal of a "green supporting factor" in banking capital requirements: easing the weight of green investments/finance in the calculation of capital ratios (Pillar 1). Specific wording of a new provision (article 501bis) of the Capital Requirements Regulation (No 575/2013)<br>b.2. high quality green assets as collateral in CBs' financing operations |
| | c. |
| | d. |

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|---|---|
| MC DANIELS | a. |
| | b. overview |
| | c. |
| | d. |

[18] F. VAN LERVEN and J. RYAN-COLLINS, *Central Banks, Climate Change and the Transition to a Low-Carbon Economy*. New Economics Foundation, London, 2017, available at: https://neweconomics.org/uploads/files/NEF_BRIEFING_CENTRAL-BANKS-CLIMATE_E.pdf.

[19] EUROPEAN BANKING FEDERATION, *Towards a Green Finance Framework. Brussels-Frankfurt: European Banking Federation*, 2018, available at: https://www.ebf.eu/ebf-media-centre/towards-a-green-finance-framework/.

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| and ROBINS (2018)[20] | |

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|---|---|
| CAMPIGLIO, DAFERMOS, MONNIN, RYAN-COLLINS, SCHOTTEN, and TANAKA (2018) [21] | a. «The primary responsibility for managing the transition to a low- carbon economy rests with the elected governments. However, if it is true that climate change is indeed "the greatest and widest-ranging market failure ever seen", a smooth low-carbon transition will require the implementation of a comprehensive set of policies, some of which might involve the collaboration of central banks and financial regulators». «This cooperation will not require a modification of the mandate of central banks. Supporting the development of more comprehensive measures of financial risk to include climate physical and transition risks is well within their present mandate of ensuring effective functioning of financial markets. » |
| | b. overview of the set of tools and actions currently undertaken by some CBs:<br>- Assessment of climate-related financial risks<br>- Macroeconomic modelling of low- carbon transition<br>- Support to international activities on green finance<br>- Disclosure of climate-related financial risks<br>- Environmentally aligned prudential regulation policy<br>- Green central bank financing<br>- Lending quotas |

[20] J. MC DANIELS and N. ROBINS, *Greening the Rules of the Game*, New York, United Nations Environment Programme, 2018, available at: https://wedocs.unep.org/handle/20.500.11822/25525;jsessionid=E6939092151A9CAB9A75B3655E02003D.

[21] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *Climate change challenges for central banks and financial regulators*, in *Nature Climate Change*, 2018, 462-468.

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|---|---|
| | - ESG factors in asset eligibility criteria as collateral (or for purchase in a CB's own portfolio)<br>- Green QE |
| | c. |
| | d. argues against the formal broadening of CBs mandates and powers. |

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|---|---|
| DAFERMOS, NIKOLAIDI, AND GALANIS (2018)[22] | a. The fundamental changes that are expected to take place in the climate system in the next decades are likely to have severe implications for the stability of the financial system. |
| | b. «The QE that has been examined in the paper is of a very different nature compared to the current QE programmes: it has a long-run horizon and it is a kind of industrial policy rather than a cyclical tool. The simulation results showed that, by increasing the price of green corporate bonds, the implementation of such a green QE programme can reduce climate-induced financial instability and restrict global warming. However, as expected, green QE is not by itself capable of preventing a substantial reduction in atmospheric temperature. […] Hence, many other types of environmental policies need to be implemented in conjunction with a green QE programme in order to keep atmospheric temperature close to 2 °C and prevent climate-induced financial instability. These could include traditional green fiscal policies (such as carbon taxes and green public investment), other green finance policies apart from QE (such as green loans subsidies and green differentiated capital requirements) and regulatory interventions that would induce more environmentally friendly consumption norms and methods of production». [green QE assumed as «in |

[22] Y. DAFERMOS, M. NIKOLAIDI, and G. GALANIS, *Climate Change, Financial Stability and Monetary Policy*, in *Ecological Economics*, 2018, 219-234.

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| | 2020 central banks around the globe decide that they will purchase 25% of the total amount of green bonds and they commit themselves that they will keep the same share of the green bond market over the next decades.»] |
| | c. |
| | d. |

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| DAFERMOS, GABOR, NIKOLAIDI, PAWLOFF, AND VAN LERVEN (2020)[23] | a. yes («Central banks in general are hardly the only game in town when it comes to tackling environmental breakdown. Yet they do have a critical role to play in structurally realigning our financial sector with the challenges and risks posed by the climate crisis»). The ECB's QE program (CSPP) is carbon-biased and, therefore, «structurally misaligned with EU commitments to the Paris Climate Agreement and do not adequately reflect climate-related financial risks» |
| | b. revision of the CSPP, with two alternatives:<br>1. Greening the portfolio without changing eligibility requirements<br>2. Greening the portfolio and changing eligibility requirements for green assets. |
| | c. |
| | d. |

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|---|---|
| DAFERMOS, GABOR, NIKOLAIDI, and VAN | a. BoE CBSP is carbon biased. Analysis of the BoE's plan for greening the CBSP. |
| | b. The BoE's plan for greening the CBSP will cause a marginal reduction in the CBSP's carbon footprint, because the greening is based exclusively in the introduction of a green tilting factor within sectors, |

[23] Y. DAFERMOS, D. GABOR, M. NIKOLAIDI, A. PAWLOFF, and F. VAN LERVEN, *Decarbonising is Easy*, London, New Economics Foundation, 2020, available at https://neweconomics.org/2020/10/decarbonising-is-easy.

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|---|---|
| LERVEN (2022)[24] | without a change in the proportions of sectors in the program. |
| | c. |
| | d. |

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|---|---|
| DIKAU and VOLZ (2018)[25] | a. Yes. Conceptualization of "passive" green central banking (meaning to take into account the consequences of climate change for financial and price stability) and "active" green central banking (meaning to promoting the greening of the economy and, therefore, the green transition). |
| | b. Description of a set of tools.[26]<br>b.1. micro-prudential:<br>- climate risk disclosure requirements<br>- mandatory environmental risk management<br>- reserve requirements<br>b.2. macro-prudential<br>- climate-related stress testing<br>- counter-cyclical capital buffer<br>- capital requirements<br>b.3. fostering the development of green financial instruments (disclosure requirements; green bond guidelines)<br>b.4. credit allocation.<br>- green-targeted refinancing credit-lines |

[24] Y. DAFERMOS, D. GABOR, M. NIKOLAIDI, and F. VAN LERVEN, *An Environmental Mandate, now what? Alternatives for Greening the Bank of England's Corporate Bond Purchases*. SOAS University of London; University of Greenwich; University of the West of England, 2022, available at:https://eprints.soas.ac.uk/36190/1/Dafermos%20et%20al%20%282022%29%20An%20environmental%20mandate.pdf.

[25] S. DIKAU and U. VOLZ, *Central Banking, Climate Change and Green Finance*. ADBI Working Paper 867. Tokyo, Asian Development Bank Institute, 2018, available at: https://www.adb.org/publications/central-banking-climate-change-and-green-finance.

[26] This line of research is further expanded in S. DIKAU, N. ROBINS, and M. TÄGER, *Building a sustainable financial system: the state of practice and future priorities*, in *Revista de Estabilidad Financiera*, 2018, 83-104.

| | |
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| | - lending quotas<br>- preferred interest rates |
| | c. |
| | d. With regard to "passive" green central banking, no; see also the following box. |

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| DIKAU and VOLZ (2021)[27] | a.1. Yes, due to the impact on "core" central banking objectives. However, for "active" green central banking, «an explicit legal mandate is required to pursue environmental and sustainability objectives, given the potentially distributive consequences. As discussed in Section 2, central banks in most of today's advanced economies have a relatively narrow mandate with the primary objective of pursuing price stability and, in some cases, financial stability. As discussed, such narrow mandates arguably require central banks to explore climate and environmental risks with regard to these core goals, but they do not mandate them to go further and to actively promote sustainability and green finance». The intervention by the CBs in terms of credit allocation «conceptually constitutes a second-best solution to the problem of market imperfection».<br>a.2. show that 70 out of 135 investigated CBs have a direct or indirect mandate to «enhance the sustainability of economic growth» |
| | b. report on the green activities undertaken by 135 CBs against the backdrop of their respective mandates. |
| | c. |
| | d. The more political the work of central banks becomes, the more their independence will be questioned, suggesting a need for more and better communication, especially over controversial areas (Blinder et al., 2017). While most would agree that |

[27] S. DIKAU and U. VOLZ, *Central bank mandates, sustainability objectives and the promotion of green finance*, in *Ecological Economics*, 2021, 1-20.

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| | central banks can and must increase their accountability by increasing transparency (e.*g.* Buiter, 2014), it is important to recognise that transparency is a necessary but not a sufficient condition for accountability. Nevertheless, it will be crucial for central banks to explain clearly and transparently to the public what actions they take to enhance sustainability outcomes, and how they expect the adopted measures to work.». However, carbon-bias QE is already a deviation from market-neutrality. Furthermore, central banks will encounter problems if they are supposed to achieve too many objectives and have too few tools – this is the so-called Tinbergen rule. |

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| HIGH-LEVEL EXPERT GROUP ON SUSTAINABLE FINANCE (2018)[28] | a. |
| | b. discusses the proposal of a “green supporting factor” in banking capital requirements, recommending the Commission «to investigate whether there is a risk-differential justifying such a factor and, if so, how it could be implemented, considering the possible drawbacks» (Pillar 1) |
| | c. |
| | d. |

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|---|---|
| BATTISTON and MONASTEROLO (2019)[29] | a. Yes, implicitly. |
| | b. composition of the ECB’s CSPP portfolio (QE). |
| | c. |

[28] HIGH-LEVEL EXPERT GROUP ON SUSTAINABLE FINANCE, *Financing a sustainable european economy*, Final Report 2018, available at: https://finance.ec.europa.eu/publications/high-level-expert-group-sustainable-finance-hleg_en.

[29] S. BATTISTON and I. MONASTEROLO, *How could the ECB’s monetary policy support the sustainable finance transition?*, Center for Financial Networks and Sustainability University of Zurich, 2019, available at https://www.finexus.uzh.ch/en/news/cspp_sustainable_finance.html.

| | |
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| | d. |

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| ISSING (2019)[30] | a. No. |
| | b. |
| | c. |
| | d. Yes. |

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|---|---|
| JOURDAN and KALINKOWSKI (2019)[31] | a. Yes. |
| | b. Based on BATTISTON and MONASTEROLO,[32] proposal of intervention on the composition of the CSPP (QE).<br>- immediate actions: full integration of carbon footprints into the ECB’s investment strategy under the CSPP; dropping of credit rating agencies which have not integrated carbon footprint assessment systematically into their credit ratings; reduce the fraction of the sectors which emit the most carbon, and increase green assets.<br>- medium term: integration of the carbon footprint as a criterion within the collateral eligibility framework<br>- long term: full ESG assessment for collateral eligibility |
| | c. yes. |
| | d. no. Market neutrality is neither possible nor desirable. |

[30] O. ISSING, *The Problem With “Green” Monetary Policy*, in *Project Syndicate*, 2019, available at https://www.project-syndicate.org/commentary/central-banks-no-to-green-monetary-policy-by-otmar-issing-2019-11.

[31] S. JOURDAN and W. KALINOWSKI, *Aligning monetary policy with the EU’s climate targets*, Paris, Veblen Institute for Economic Reforms & Positive Money Europe, 2019, available at https://www.veblen-institute.org/IMG/pdf/aligning_monetary_policy_with_eu_s_climate_targets.pdf.

[32] S. BATTISTON and I. MONASTEROLO, *op. cit.*, 1 ff.

| | |
|---|---|
| FISHER and ALEXANDER (2019)[33] | a. Yes, because of the impact of climate-related risks (physical, transition) on price stability (primary and secondary mandates). Nonetheless, the primary responsibility is governmental. |
| | b.<br>1. monetary stability: price stability as core priority; green assets as collateral; framework for facilitating investment in green assets (green ABS).<br>2. against the greening of QE, since it would cause market distortions. Only transparency and assessment of portfolio's carbon footprint to be applied.<br>3. financial stability. Disclosure of climate-related risks by financial institutions.<br>4. prudential supervision. Green-weighted capital requirements should be avoided, because the classification of green vs. brown assets is problematic. Green criteria should be used for risk assessment, additional capital (pillar 2), and disclosure (pillar 3). |
| | c. |
| | d. |

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|---|---|
| HONOHAN (2019)[34] | a. Yes, with regard to the ECB, which has the secondary mandate of supporting the general policies of the Union. |
| | b.1. Green QE: disqualification or downgrade of brown issuers «to the extent that the associated long- |

[33] P. FISHER and K. ALEXANDER, *Climate Change: The Role for Central Banks*, Working Paper No. 2019/6. London, King's Business School, King's College London, 2019, available at: kcl.ac.uk/business/assets/pdf/dafm-working-papers/2019-papers/climate-change-the-role-for-central-banks.pdf.

[34] P. HONOHAN, *Should Monetary Policy Take Inequality and Climate Change in Account?*, PIIE Working paper 19-18, Washington, Peterson Institute for International Economics, 2019, available at: https://www.piie.com/publications/working-papers/should-monetary-policy-take-inequality-and-climate-change-account.

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| | term risks were assessed as dragging their credit quality below what the rating agencies currently record».<br>b.2. same green parameters for eligibility as collateral in ECB's refinancing operations |
| | c. |
| | d. no («Such activities are not only fully in line with the secondary goals established for most central banks in their mandates. They can also be exercised by central banks in full independence. Indeed, by emphasizing to the general public their commitment to the general good, such efforts do not represent an overreach of central bank powers, but should help underpin society's support for the independence that is essential for them to deliver on their main macroeconomic goals»). |

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| D'ORAZIO and POPOYAN (2019)[35] | a. Yes, «considering the negative externalities deriving from climate-related financial risks». |
| | b. regulatory tools.<br>- greening capital requirements (Pillar 1). «calibrate the risk-weighted capital ratios so that low-carbon activities would exert less pressure on their balance sheet and, therefore, incentivize them to finance climate-related projects»; in this framework, a «brown-penalizing factor» would be preferable than a «green-rewarding factor»<br>- the technique of differentiated reserve requirements («green RR would allow banks to hold fewer reserves against a "green" loan portfolio») is deemed suboptimal in low-income countries, not useful in Basel III countries (which is based on liquidity rather than reserves). |

[35] P. D'ORAZIO and L. POPOYAN, *Fostering green investments and tackling climate-related financial risks: Which role for macroprudential policies?*, in *Ecological Economics*, 2019, 25-37.

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| | - countercyclical capital buffer «can be used to favor financial stability in the transition process from the high-carbon to the low-carbon economy» (the same argument is used for negative capital buffer)<br>- Sectoral leverage ratio (SLR)<br>- Liquidity regulation<br>- Minimum credit floors and maximum credit ceilings (lending quotas)<br>- Large exposures limits |
| | c. Yes. Report on actual applications. |
| | d. |

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| D’ORAZIO and POPOYAN (2020)[36] | a. «we argue that the existence of climate-related financial risks, together with the need to scale up green finance, call for the development of a “synthesis” between monetary and green prudential policymaking». |
| | b. |
| | c. |
| | d. «if the green prudential regulation is considered as an “offspring” of the more general prudential policy, the “leaning against the climate-related risk” function can be undertaken without violating the Tinbergen principle.» |

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| SOLANA (2019)[37] | a. yes, with respect to the ECB, on the basis of the secondary mandate and of art. 11 TFUE. |
| | b. a “green” revision of the CSPP (amendment of eligibility criteria in order to allow green asset to be |

[36] P. D’ORAZIO and L. POPOYAN, *Taking up the climate change challenge: a new perspective on central banking*, LEM Working Paper 2020/19, Pisa, Scuola Superiore Sant’Anna, 2020, available at: http://www.lem.sssup.it/WPLem/files/2020-19.pdf.

[37] J. SOLANA, *The Power of the Eurosystem to Promote Environmental Protection*, in *Eu. Bus. L. Rev.*, 2019, 547-576.

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| | purchasable) is mandatory pursuant to art. 11 TFUE and the secondary mandate. The validity current version of the CSPP could is questionable under the standards set forth by the German *Bundesverfassungsgericht* in the *Weiss* judgment.[38] |
| | c. yes. |
| | d. |

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| TOOZE[39] | a. Yes |
| | b. - greening QE: buying of long-term debt issued by government or public investment/development banks to finance decarbonization/transition<br>- green capital requirements for banks. |
| | c. Yes |
| | d. No. Neutrality is not an issue since CB's decisions have not been neutral until now (*e.g.*, the ECB's and UK's QE programs are overexposed to the carbon industry). |

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| FENDER, MCMORROW, SAHAKYAN, and ZULAICA (2020)[40] | a. «Explicit integration [of sustainability] can be achieved by central banks that are able to specify sustainability as one of the policy purposes for holding reserves». «Implicit integration involves introducing sustainability into the pursuit of the |

[38] Bundesverfassungsgericht, Judgment of the Second Senate of 5 May 2020 - 2 BvR 859/15 -, paras. 1-237, available at: http://www.bverfg.de/e/rs20200505_2bvr085915en.html.

[39] A. TOOZE, *Why Central Banks Need to Step Up on Global Warming*, in *Foreign Policy*, 20 Jul. 2019, available at: https://foreignpolicy.com/2019/07/20/why-central-banks-need-to-step-up-on-global-warming/; ID., *How Climate Change Could Trigger the Next Global Financial Crisis*, Interview by R. MEYER, in *The Atlantic*. 1 Aug. 2019, available at: https://www.theatlantic.com/science/archive/2019/08/how-fed-could-fight-climate-change-adam-tooze/595084/.

[40] I. FENDER, M. MCMORROW, V. SAHAKYAN, and O. Zulaica, *Reserve management and sustainability: the case for green bonds?*, BIS Working Papers 849,

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| | traditional economic uses of reserves. […] One key factor is risk management. Central banks [...] may decide to tilt their reserve portfolios towards assets deemed less exposed to possible long-term financial losses arising from climate risks». |
| | b. study how green objectives can be pursued through the management of foreign exchange reserves by purchasing green bonds. |
| | c. |
| | d. |

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| LASTRA and ALEXANDER (2020)[41] | a. With respect to the ECB, yes, it falls within the secondary mandates and it has consequences on the primary mandate of price stability. Nonetheless, political institutions have the primary responsibility for addressing the economic consequences of climate change. |
| | b. green QE, within the boundaries set forth by the ECJ in Weiss (only on the secondary market and compliant with the proportionality principle) |
| | c. The authors analyze the criticalities of the PEPP, the LTRO, the TLTRO, on the basis of the *Weiss* principles. |
| | d. price stability should remain the primary concern, as it is the prerequisite for a long-term sustainable growth |

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| BOLTON, DESPRES, PEREIRA DA SILVA, | a. yes, a.1. insofar as climate change creates serious risks (physical, transition) for financial and price stability, and a.2. in order to prevent systemic breakdowns, act as a promoter/coordinator of policies |

Bank for International Settlements, 2020, available at: https://www.bis.org/publ/work849.pdf.

[41] R.M. LASTRA and K. ALEXANDER, *The ECB Mandate: Perspectives on Sustainability and Solidarity*, In-Depth Analysis Requested By The European Parliament's ECON Committee, Luxemburg, 2020.

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| SAMAMA, and SVARTZMAN (2020)[42] | which must be decided at a political level, without replacing policymakers |
| | b. measurement of climate-related systemic financial risk and coordination role between monetary, prudential, fiscal and environmental policies<br>Climate scenario stress testing and systemic capital buffers, if showed necessary<br>Brown penalizing factor for capital requirements<br>Additional *ad hoc* capital requirements<br>Disclosure of climate-related risks by financial institutions<br>Caution on introduction of green eligibility criteria in collateral framework and in QE programs, as well as into the management of foreign exchange reserves (probably within the mandate but doubts on efficacy).<br>Fostering long-termism in the financial sector<br>Calling for more fiscal policy<br>Calling for more international cooperation<br>Promoting climate/sustainability within corporate and national accounting frameworks |
| | c. |
| | d. no, if approach a. is followed |

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| FLAHERTY (2020)[43] | a. yes, with regard to the ECB's primary and secondary mandate. But governmental intervention - both at EU and national level – is necessary. |
| | b. ECB.<br>i) for the mitigation of climate-related risks: monetary policy, macroprudential capital buffers, |

[42] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *The green swan. Central banking and financial stability in the age of climate change*, Bank for International Settlements, 2020, available at: https://www.bis.org/publ/othp31.pdf.

[43] E. FLAHERTY, *Green Central Banking: Options for the ECB on Climate Change*, Dublin, The Institute of International and European Affairs, 2020 available at: https://www.iiea.com/publications/green-central-banking-options-for-the-ecb-on-climate-change.

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| | microprudential regulation (capital and liquidity requirements, remuneration policies, risk management), climate stress testing.<br>ii) mandating/nudging sustainable finance through banking regulation (green targets for lending).<br>iii) green risk weighted capital requirements (after a legislative change)<br>iv) green QE<br>v) greening ECB's portfolio.<br>vi) green foreign reserves. |
| | c. |
| | d. |

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| DE BOER and VAN 'T KLOOSTER (2020)[44] | a. On the wake of the *Weiss* judgement by the German *Bundesverwassungsgericht*, [45] the authors conduct a broad analysis of the legal foundations of the ECB's powers, also in terms of interpretation of its mandate. Within this scenario, which is mainly focused on the issue of the impact of non-conventional monetary policy tools on the ECB's democratic legitimacy, the authors refer to the market neutrality approach followed within the CSPP as having «only a shallow basis in the ECB mandate» (1709). This notwithstanding, it also argued that, though the «ECB's secondary mandate could also readily justify designing its operations to actively favour low-carbon sectors and bond issuers […] there is simply no clear legal answer to the question how, if at all, the ECB should contribute to them». The authors expand on these concepts by suggesting that the ECB's secondary market should be specified through a process of |

[44] N. DE BOER and J. VAN 'T KLOOSTER, *The ECB, The Courts and The Issue of Democratic Legitimacy After Weiss*, in *Common Market Law Review*, 2020, 1689-1724.

[45] Bundesverfassungsgericht, Judgment of the Second Senate of 5 May 2020 - 2 BvR 859/15 -, paras. 1-237, available at: http://www.bverfg.de/e/rs20200505_2bvr085915en.html.

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| | institutional coordination between the ECB and the other European institutions.[46] |
| | b. |
| | c. |
| | d. The question is indirectly examined in a broader analysis of the relationship between the scope of a CB's mandate, its independence, its democratic legitimaticy and the role played by judicial review. |

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| MARTINEZ-DIAZ and CHRISTIANSON (2020)[47] | a. Yes |
| | b. green QE. |
| | c. |
| | d. no |

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| GERLACH (2020)[48] | a. Yes, green policies are already within the ECB's mandate. |
| | b. |
| | c. |
| | d. |

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| COCHRANE (2020)[49] | no, as climate change does not have an unforeseen impact on price stability. |

[46] N. DE BOER and J. VAN 'T KLOOSTER, *The ECB's Neglected Secondary Mandate: An Inter-Institutional Solution*, Positive Money Europe, 2021, available at: www.positivemoney.eu.

[47] L. MARTINEZ-DIAZ and G. CHRISTIANSON, *Quantitative Easing for Economic Recovery Must Consider Climate Change*, Washington, World Resources Institute, 2020, available at: https://www.wri.org/insights/quantitative-easing-economic-recovery-must-consider-climate-change.

[48] S. GERLACH, *Crunch Times for Central Banks*, in *Project Syndicate*, 2020, available at: https://www.project-syndicate.org/commentary/central-banks-response-to-public-opinion-on-inequality-environment-by-stefan-gerlach-2020-09.

[49] J. H. COCHRANE, *Challenges for central banks*, Talk at the ECB Conference on Monetary Policy: bridging science and practice, 19-20 October 2020, available at:

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| | no, because the kind of decisions entailed in green central banking is highly political and require and explicit mandate; |
| | Yes. A CB's independence and freedom rely on the fact that «it stays it stays within its limited and mandated powers». |

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| BRUNNER-MEIER and LANDAU (2020)[50] | a. Yes. |
| | b.1. climate risk assessment and stress test.<br>b.2. green capital ratios («but they would need to be addressed ex ante and the proper institutional and governance arrangements put into place»)<br>b.3. greening current QE programs.<br>b.4. intervening on collateral requirements. |
| | c. to some extent, yes (banking regulation and supervision), mixed evaluation with regard to monetary policy (asset buying is within their powers, but whether green asset buying is within the mandate depends on the single CB) |
| | d. discuss the issue. |

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| FERRARI and NISPI LANDI (2020)[51] | a. being unexposed to political fluctuations allows CBs to adopt long term approaches which governments are reluctant to support. |
| | b. Green QE reduces pollution only if there is a friction preventing banks to fully exploit arbitrage between bonds issued by the green sector (green bonds) and bonds issued by the brown sector (brown bonds). This |

https://static1.squarespace.com/static/5e6033a4ea02d801f37e15bb/t/5f976ada8774773b3bf3f4b3/1603758818167/ECB_fall_talk.pdf.

[50] M.K. BRUNNERMEIER and J. LANDAU, *Central banks and climate change*, in *VoxEU.org*, 2020, available at: https://voxeu.org/print/64971.

[51] A. FERRARI and V. NISPI LANDI, *Whatever it takes to save the planet? Central banks and unconventional green policy*. ECB Working Paper 2500. Frankfurt, European Central Bank, 2020, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3748330.

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| | friction makes green and brown bonds imperfect substitutes. We can interpret this friction as a regulation or as an elevated degree of public awareness on the climate change issue that create pressures on the banking sector to hold a given share of green bonds». «[…] temporary Green QE is able to affect detrimental emissions in the brown sector, but it has small effects on the stock of pollution. The main reason is that climate change and pollution are structural problems, while a temporary Green QE is an instrument that plays a role along the business-cycle, […] We have modeled a temporary as opposed to a permanent Green QE: the latter could set the stage for a permanent lower size of the brown sector.» |
| | c. |
| | d. |

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| ILZETZKI and JIA (2021)[52] | a. Yes |
| | b. green QE. |
| | c. |
| | d. no |

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| DAVIES (2021)[53] | a. Yes («Central banks must anchor a more active climate change policy in a persuasive interpretation of their principal mandate. That should be possible, as there are respectable arguments for the proposition that climate change jeopardizes financial stability, and perhaps monetary stability as well. The ECB's new |

[52] E. ILZETZKI and J. JIA, *The ECB's green agenda*, in *VoxEU.org*, 2021, available at: https://voxeu.org/print/68103.

[53] H. DAVIES, *Central Banks' Green Goal Are Raising Red Flags*, in *Project Syndicate*, 2021, available at: https://www.project-syndicate.org/commentary/central-bank-green-goals-raising-red-flags-by-howard-davies-2021-03.

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| | climate change center should begin its work by making that case») |
| | b. |
| | c. |
| | d. |

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| SCHOEN-MAKER (2021)[54] | a. Yes, on the basis of the ECB's primary and secondary mandates, without prejudice to price stability. |
| | b. gradual incorporation of green tilting factor in eligibility criteria for asset purchases (both within QE programs and as official reserves) and collateral (with a number of arrangements aimed at preventing distortions) |
| | c. Yes |
| | d. |

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| DE ARRIBA-SELLIER (2021)[55] | a. the «ECB is bound to integrate considerations of environmental protection in its supervision and oversight of the SSM». Nonetheless, «there is a case for market neutrality if market conditions were to be endangered by supervisory authorities prioritizing green finance. A "run to green" may have destabilizing effects for the financial system and hinder investor protection. Preserving market neutrality is important given the technological uncertainty of the transition to a sustainable economy. Prioritizing green finance might hinder investor protection by wrongly promoting the development of immature or inadequate technologies and practices. For these reasons, market |

[54] D. SCHOENMAKER, *Greening monetary policy*, in *Climate Policy*, 2021, 581-592.

[55] N. DE ARRIBA-SELLIER, *Turning Gold into Green: Green Finance in The Mandate of European Financial Supervision*, in *Common Market Law Review*, 2021, 1097-1140.

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| | neutrality remains relevant for financial supervision.» (1130). Moreover, «the ECB cannot draw up its own rules to require banks under its supervision to finance the transition to a sustainable economy. Overall, there is no clear-cut mandate under primary and secondary law for supervisory authorities to "think sustainability first" or even to address the environment as part of their mandate.» «Despite the absence of a real change in EU prudential regulation, climate-related risks are becoming sufficiently material and foreseeable to be captured by the existing law. As such, supervisory authorities do not only have the possibility, but also the responsibility, to assess and respond to climate and environmental risks that could be a source of systemic risk for the financial system.» (1138). |
| | b. SREP and stress-tests in tackling climate risks is enhanced as a result of the obligations |
| | c. |
| | d. |

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| EICHENGREEN (2021)[56] | a., b., c., and d.<br>«Monetary policy has implications for issues beyond inflation and payments, including climate change and inequality. It would be disingenuous, even dangerous, for central bankers to deny those connections, or to insist that they are someone else's problem. The best way forward for central bankers is to use monetary policy to target inflation, while directing their regulatory powers at other pressing concerns» |

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| NETWORK FOR | a. *De minimis*: «central banks should carefully assess, and where appropriate adopt, additional risk |

[56] B. EICHENGREEN, *New-Model Central Banks*, in *Project Syndicate*, 2021, available at: https://www.project-syndicate.org/commentary/central-banks-have-tools-for-climate-change-and-inequality-by-barry-eichengreen-2021-02.

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| GREENING THE FINANCIAL SYSTEM[57] (2021) | management measures to protect their balance sheets against the financial risks brought about by climate change». However, «[w]here it falls within their policy remit, central banks could also consider going beyond the adjustment of their operational frameworks solely from a risk management perspective by seeking to ensure that their monetary policy operations do not undermine the transition to a low-carbon economy and/or by exploring ways in which they can actively support that transition» |
| | b. set of tools. |
| | c. see a. |
| | d. |

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| EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE (2021)[58] | a. Yes, both in pursuit of the primary goal of price stability and in implementation of the secondary mandate of supporting the general policies of the Union. |
| | b.1. assessment and modelling:<br>- Climate stress testing<br>- assessment of whether credit rating agencies include climate-risks in their ratings.<br>b.2. disclosure of climate-related information for CSPP portfolio<br>b.3. adjustment of CSPP purchase criteria:<br>- disclosure of climate-related information by issuers as eligibility requirement (or as ground for |

[57] NETWORK FOR GREENING THE FINANCIAL SYSTEM, *Adapting central bank operations to a hotter world. Reviewing some option*, Paris, Central Banks and Supervision Network for Greening the Financial System, 2021, available at: https://www.ngfs.net/sites/default/files/media/2021/06/17/ngfs_monetary_policy_operations_final.pdf.

[58] EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *Climate change and monetary policy in the euro area*, ECB Occasional Paper 271/2021, Frankfurt, European Central Bank, 2021, available at: https://www.ecb.europa.eu/pub/research/occasional-papers/html/index.en.html.

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| | differentiated treatment) for CSPP purchases as well as collateral<br>- compliance of the issuer with EU implementation of the Paris Agreement<br>b.4. Green targeted longer-term refinancing operations considered explicitly premature<br>b.5. incorporation of climate considerations into monetary policy definition (without prejudice for the primary mandate) |
| | c. With regard to the collateral eligibility framework, reference is made to art. 18 of the ESCB/ECB Statute, which requires the ECB to conduct |
| | d. |

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| PAPOUTSI, PIAZZESI, and SCHNEIDER (2021)[59] | a. ECB's CSPP is carbon-biased and not market-neutral. « This is a direct consequence of the structure of the bond market and the simple bond market neutrality formula currently followed by the ECB. Firms in the energy and certain manufacturing sectors generate relatively more emissions and also issue relatively more bonds. Firms in the service sector are cleaner, but are funded relatively more with equity and loans». |
| | b. Design asset purchase schemes (QE) which factor emissions and risk. |
| | c. |
| | d. Market neutrality («as *keeping relative costs of capital across firms* the same») is not respected in the ECB's CSPP, as «by purchasing risky bonds and funding those purchases with safe debt, a central bank favors firms that are more bond-levered or more risky». «Some non-neutrality is desirable: if the |

[59] M. PAPOUTSI, M. PIAZZESI, and M. SCHNEIDER, *How unconventional is green monetary policy?*, 2021, available at: https://ec.europa.eu/economy_finance/arc2022/documents/papers/how_unconventional_is_green_monetary_policy.pdf.

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| | central bank aims to minimize the cost of financial frictions in intermediation, firms that face larger distortions should in fact benefit more». |

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| SMITS (2021)[60] | a. insofar as climate change impacts on price stability, the ECB is required by its primary mandate to consider climate concerns in defining monetary policy. Moreover, «whenever price stability may be maintained in manners conducive to protection of the environment, the opportunity to adopt such 'green' measures may not be foregone». In-depth analysis of the relationship between the ECB's primary and secondary mandates and of the legal basis of green monetary policies. |
| | b. - recalibrating the CSPP in favor of green assets. The market neutrality principle does not require CBs to replicate dysfunctional markets, as the current market of financial assets is (since it does not factor in their climate impact). In discerning green from brown assets, the ECB could use the criteria established by the EU Taxonomy Climated Delegated Act; green eligibility criteria for collateral;<br>- «Including climate change variables and risks into account in policy-setting»;<br>- green criteria in the use of the ECB's paid-up capital, reserves, and pension-fund;<br>- green TLTROs<br>- climate risk concerns to be embedded in prudential supervision (e.g., EBA's ESG risks assessment) |
| | c. art. 11 TFUE; market neutrality principle; |
| | d. |

[60] R. SMITS, *Elaborating a Climate Change-Friendly Legal Perspective tor The ECB*, forthcoming in *Sustainable Finance – Legal Aspects*, Edward Elgar Publishing, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3913653.

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| COLAERT (2022)[61] | a. Including climate induced financial risks into supervisory considerations is not a green policy objective, rather it fits within the classic goal of financial and banking stability. Green finance policies should not undermine the pursuit of financial stability. |
| | b. Green supporting factor (or brown penalty) has the potential of conflicting with the traditional goals of financial regulation. |
| | c. |
| | d.. |

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| RAMOS MUÑOZ, CABRALES, and SANCHEZ (2022)[62] | a. - as climate climate change has an impact on price stability, tackling its consequences falls within most CBs' primary mandate; - in-depth analysis of the fitness of between climate change initiatives in "secondary" mandates under the configuration of the legal relationship between the primary and secondary mandates ("horizontal", "contextual", and "hierarchical"), on the basis of which the authors conclude that «"peripheral" mandates are not ideal to address climate change»;<br>- the authors make the case for a prompt action by CBs, arguing that a "wait and see" approach will impair their ability to control price stability; |
| | b. – greening QE programs; greening collateral eligibility requirements; TLTROs; prudential supervision and regulation (incorporating climate risks in the ICAAP and ILAAP; climate stress-testing; climate risk-weighted assets); market neutrality lacks a legal source and is already not |

[61] V. COLAERT, *The changing nature of financial regulation Sustainable finance as a new policy goal*, Working Paper No. 2022/04, Apr. 2022, available at: https://ssrn.com/abstract=4087166.

[62] D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *Central Banks and Climate Change. Fit, Opportunity and Suitability in The Law and Beyond*, EBI Working Paper Series 2022, no. 119, available at: https://ssrn.com/abstract=4054908.

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| | implemented in the real world; a brown penalizing factor is preferable to a green guided direct allocation. |
| | c. |
| | d. no; accountability is a prerequisite of independence, and ignoring the economic consequences of climate change could hamper CBs legitimacy and independence in the long-term. |

2.3. *Discussion*.

Overall, there is a growing scientific consensus on what can be called a "*de minimis* approach" (or "passive" green central banking), consisting in the need for CBs to at least take into consideration the risks created by climate change (as well as by the transition to a low-carbon economy) for financial and price stability.[63]

Furthermore, according to several studies CBs should embrace an active role in terms of favoring – or at least not hampering – the transition to a low-carbon economy.[64] Some point out how such activity

[63] S. BATTISTON and I. MONASTEROLO, *op. cit.*, 15; M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; E. CAMPIGLIO, *op. cit.*, 220 ff.; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; V. COLAERT, *op. cit.*, 22 f.; Y. DAFERMOS, M. NIKOLAIDI, and G. GALANIS, *op. cit.*, 232 f.; H. DAVIES, *op. cit.*; N. DE ARRIBA-SELLIER, *op. cit.*, 1132 ff.; S. DIKAU and U. VOLZ, *Central Banking*, cit., 2 f.; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 2; P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 27, 34; EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *op. cit.*, 29 f.; B. EICHENGREEN, *op. cit.*.; R.M. LASTRA and K. ALEXANDER, *op. cit.*, 23; P. FISHER and K. ALEXANDER, *op. cit.*, 7 f.; S. GERLACH, *op. cit.*; P. HONOHAN, *op. cit.*; S. JOURDAN and W. KALINOWSKI, *op. cit.*, 18; NETWORK FOR GREENING THE FINANCIAL SYSTEM, *op. cit.*, 12; D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 14; J. SOLANA, *op. cit.*, 549; R. SMITS, *op. cit.*, 4 ff.; F. VAN LERVEN and J. RYAN-COLLINS, *op. cit.*; differently, J. H. COCHRANE, *op. cit.*; O. ISSING, *op. cit.*

[64] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 53 ff.; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff., arguing that the CB's mandates already cover activities supporting the transition; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 16 f., though pointing out that a proactive role by CBs requires a change in their mandates; D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 21 ff., also on the basis of a broad comparative analysis of CBs' legal mandates; D. SCHOENMAKER, *op. cit.*, 582, arguing that the ECB's mandate

is material for an orderly green transition, that would severely reduce climate change's impact, as well as that of the green transition itself, on financial and price stability.[65] At the same time, also those who call for interventions by CBs underline that the main responsibility for tackling climate change and organizing the transition to a zero-carbon economy rests with elected governments, and therefore, that CBs are not in the best position to replace an effective and comprehensive climate policy.[66] Despite such concerns, many authors share the view that an engagement of CBs with climate change does not create criticalities from the point of view of CBs' accountability and market neutrality, nor is it at odds with the Tinbergen principle.[67] Rather, it is underlined that such engagement – important as it is – cannot replace a political climate and transition policy. On a different note, many authors stress that green activities should not hinder the pursuit of price stability and express some concerns on how that might affect the functioning of the market of green vs. brown assets.[68]

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already covers activities supporting the transition; R. SMITS, *op. cit.*, 28, arguing that, on the basis of the ECB's current primary and secondary mandates, «whenever price stability may be maintained in manners conducive to protection of the environment, the opportunity to adopt such 'green' measures may not be foregone»; F. VAN LERVEN and J. RYAN-COLLINS, *op. cit.*, 6.

[65] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 50 ff.

[66] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; Y. DAFERMOS, M. NIKOLAIDI, and G. GALANIS, *op. cit.*, 232 f.; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 18; R.M. LASTRA and K. ALEXANDER, *op. cit.*, 15; D. SCHOENMAKER and R. VAN TILBURG, *op. cit.*, 317 ff.; for an opposite view, see D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 3 ff.

[67] B. EICHENGREEN, *op. cit.*; P. HONOHAN, *op. cit.*; M. PAPOUTSI, M. PIAZZESI, and M. SCHNEIDER, *op. cit.*, 31 ff.; A. TOOZE, *Why Central Banks*, cit.

[68] M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; V. COLAERT, *op. cit.*, 22; H. DAVIES, *op. cit.*; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 19; see also R.M. LASTRA and K. ALEXANDER, *op. cit.*, 5, 17, arguing that the ECB's green actions should respect the proportionality principle and should not hinder the pursuit of price stability; a similar view is shared by V. COLAERT, *op. cit.*, 23 ff.; by N. DE ARRIBA-SELLIER, *op. cit.*, 1130, and by J. SOLANA, *op. cit.*, 571 f.; according to DE BOER and VAN 'T KLOOSTER, *The ECB, The Courts*, cit. (and ID., *The ECB's Neglected*, cit., 2021), though the neutrality principle does not have a strong legal basis, in order to give a clear legal basis to the enactment of green proactive measures by the ECB it would be necessary to specify its secondary mandate.

From the outlook of the legal basis of central banking activities, the idea that pursuing a "*de minimis* approach" falls within the (primary and/or secondary) mandate of most CBs prevails,[69] while there is less agreement on whether a shift to a proactive role is covered by the current scope of the tasks legally assigned to CBs.

Shifting the focus from the realm of principles to implementation, one can find in the existing literature several (and sometimes heterogeneous) ways of categorizing the tools that CBs can adopt (and/or have adopted) in pursuing such goals (as well as the potential amendments to CBs' legal framework to be enacted by legislators/regulators). They cover the whole spectrum of CBs' existing powers, from banking supervision-regulation to "core" monetary policy. *On the one hand*, some studies have been devoted to test the efficacy of some tools with quantitative methods. However, the state of the art does not indicate a single preferred tool or technique, rather a combination of those and the need of coordination between central banking and governmental activities respectively. *On the other hand*, it is debated which of such tools have a legal basis as of today and, therefore, can be used by CBs without changes to the legal framework.

The most frequently analyzed regulatory interventions are represented by *(i)* amendments of the prudential regulation of capital requirements and, to a lesser extent, the application of additional capital buffers; *(ii)* "green" quantitative easing; *(iii)* the introduction of green parameters in the eligibility criteria of assets to be accepted as collateral in central banking financing operations.

Furthermore, the materiality of the transparency of climate-related financial risks has progressively been stressed over the years. This operates both at a firm-specific level, in terms of *(iv)* disclosure of the

[69] As one might imagine, this view is not shared by the minority of authors that oppose any form of involvement by CBs in dealing with climate change (J. H. COCHRANE, *op. cit.*; O. ISSING, *op. cit.*); however, also S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 16 f., point out that a proactive role by CBs in tackling climate consequences of their actions requires a change in their mandates; similarly, DE BOER and VAN 'T KLOOSTER, *The ECB, The Courts*, cit., 1709, 1720 ff. (and ID., *The ECB's Neglected*, cit., 2021), argue that, in order to give a clear legal basis to the enactment of green proactive measures by the ECB, it would be necessary to specify its secondary mandate.

exposure to financially relevant climate risks,[70] and at a systemic one, leading to *(v)* the need for climate stress-testing.

On a different note, the consensus is that instruments typical of the era of the so-called financial repression – such as lending quotas and/or ceilings, preferred interest rates, and green loan subsidies[71] – are not consistent with regulatory systems that adopted (or are modelled on) the Basel agreements.[72]

(i) *Capital requirements*.

The regulation of capital requirements is a typical prudential measure (Pillar I) and is nowadays based on a risk-weighted capital ratios system.[73] The idea of intervening on such ratios with the purposes of favoring green lending has emerged in two forms. First, it has been proposed to reduce the risk-weight of green loans (so-called "Green

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[70] Although J. ARMOUR, L. ENRIQUES, and T. WETZER, *Mandatory Corporate Climate Disclosures: Now, but How?*, ECGI Law Working Paper N° 614/2021 (available at: https://ssrn.com/abstract=3958819) explicitly exclude from the scope of their analysis «climate-related disclosures by financial intermediaries and third parties designed to mobilize the financing of sustainable investments as part of a broader sustainable finance agenda», it has to be noted that the authors argue for a regime based on mandatory disclosure of firm-specific climate risk by equity issuers, also drawing on the debate which is the subject matter of this paper (see 11-14). Also noteworthy is that they conclude, among other things, that «the regulatory challenge presented by corporate climate disclosures is like that faced by macroprudential regulators» (33) and that «[a]t the same time, many of the risks associated with climate change are beginning to receive extensive attention from central banks, whose research departments are consequently building the relevant expertise» (34).

[71] For the analysis of the implementation of such techniques in emerging markets, see S. DIKAU and J. RYAN COLLINS, *op. cit.*, 4 ff.

[72] M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; nonetheless, the idea of green TLTRO enjoys some support: D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 81, 94; R. SMITS, *op. cit.*, 42 f.; on this proposal, see the doubts expressed by LASTRA and ALEXANDER, *op. cit.*, 18 f., with regard to its adherence with the *Weiss* principles, as well as by the EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *op. cit.*, 153 f.

[73] Though based on liquidity mechanisms, a conceptually close mechanism is the introduction of differentiated reserve requirements – to be held in proportion of deposits – depending on the (green vs. brown) destination of their lending: E. CAMPIGLIO, *op. cit.*, 226 ff.; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., table 2; P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 28 ff.

Supporting Factor").[74] As a result, financial institutions would be incentivized to grant more credit to green sectors than to brown ones, since the former would "cost" less in term of capital ratios than the latter. Due to the concerns raised by the potential distortions this could create, since green loans as such cannot be considered less risky than the other ones,[75] subsequent studies have pointed out that a so-called brown penalizing factor would be a more appropriate way to act in this area.[76] This would mean that brown loans would weigh more in the calculation of capital requirements.[77] In this context, it has been stressed that the distinction between "green" and "brown" sectors is somewhat arbitrary, besides being in need of a clear regulatory definition;[78] it is to be noted,[79] however, that several EU legal sources dealing with definitory issues have been enacted since.[80]

Less controversial is the proposal of using countercyclical capital buffers[81] and/or Pillar 2 additional capital requirement[82] to tackle the potential capital shortages encountered by intermediaries, respectively

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[74] Y. DAFERMOS, M. NIKOLAIDI, and G. GALANIS, *op. cit.*, 233; V. DOMBROVSKIS, *cit.*; EUROPEAN BANKING FEDERATION, *op. cit.*, 37 ff.; A. TOOZE, *How Climate*, cit.

[75] M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; HIGH-LEVEL EXPERT GROUP ON SUSTAINABLE FINANCE, *op. cit.*, 68 f.; S. MATIKAINEN, *op. cit.*; V. COLAERT, *op. cit.*, 22.

[76] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 52; S. DIKAU, N. ROBINS, and M. TÄGER, *op. cit.*, 88 f.; P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 29; D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 97 f.; F. VAN LERVEN and J. RYAN-COLLINS, *op. cit.*, 10; however, V. COLAERT, *op. cit.*, 20 ff., also considers the brown-penalizing factor a risk for financial stability.

[77] D. SCHOENMAKER and R. VAN TILBURG, *op. cit.*, 317 ff.

[78] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 52, 65; M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; P. FISHER and K. ALEXANDER, *op. cit.*, 22.

[79] R. SMITS, *op. cit.*, 38 ff.

[80] The Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021; the Commission Delegated Regulation (EU) 2021/2178 of 6 July 2021; the Commission Delegated Regulation (EU) 2022/1214 of 9 March 2022.

[81] S. DIKAU, N. ROBINS, and M. TÄGER, *op. cit.*, 90; S. DIKAU and U. VOLZ, *Central banking*, cit., 7 f.; P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 30.

[82] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 52; N. DE ARRIBA-SELLIER, *op. cit.*, 1136 f.; P. FISHER and K. ALEXANDER, *op. cit.*, 21 f.; D. SCHOENMAKER and R. VAN TILBURG, *cit.*, 317 ff.

at a systemic or firm-specific level, because of the exposure to climate-related risks.

(ii) *Green quantitative easing.*

The magnitude of the quantitative easing programs enacted (amongst others) by the ECB,[83] the Bank of England, and the FED surely contributed to attracting attention on the fact that the portfolios of assets purchased within such schemes are exposed to carbon-intensive sectors.[84]

Despite this general acknowledgement, not everyone supports the proposal(s) of "greening" the quantitative easing. The concern is that this could lead to the mispricing of "green" asset and eventually to a bubble.[85] The current carbon-bias, in fact, is a result of the implementation of the market neutrality principle, inasmuch as CBs buy a sectoral percentage of corporate bonds of the total *eligible* bonds. The underrepresentation of green bonds in CBs' asset portfolios derive mostly from brown bonds having better credit ratings than green ones, due to the underassessment of climate-risks by credit rating agencies.[86] Therefore, the first step generally favored by the existing literature is

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[83] For a description, see also also P. SPOLAORE, *Ownership and Governance of Central Banks: Insights from the Italian Experience*, in *European Company and Financial Law Review*, 2020, 619-656.

[84] S. BATTISTON and I. MONASTEROLO, *op. cit.*, 6 ff.; Y. DAFERMOS, D. GABOR, M. NIKOLAIDI, A. PAWLOFF, and F. VAN LERVEN, *op. cit.*, 9 ff.; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 18; DE BOER and VAN 'T KLOOSTER, *The ECB, The Courts*, cit., 1709; EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *op. cit.*, 152 f.; P. HONOHAN, *op. cit.*; S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *op. cit.*; M. PAPOUTSI, M. PIAZZESI, and M. SCHNEIDER, *op. cit.*, 10 ff.; D. SCHOENMAKER, *op. cit.*, 581; A. TOOZE, *Why Central Banks*, cit.; ID., *How Climate*, cit.; F. VAN LERVEN and J. RYAN-COLLINS, *op. cit.*, 8.

[85] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; N. DE ARRIBA-SELLIER, *op. cit.*, 1130; P. FISHER and K. ALEXANDER, *op. cit.*, 13 ff.; S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *op. cit.*; F. VAN LERVEN and J. RYAN-COLLINS, *op. cit.*, 11.

[86] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *op. cit.*; F. VAN LERVEN and J. RYAN-COLLINS, *op. cit.*, 12, though ultimately in favor of the solution and proposing arrangements to prevent such outcome; Y. DAFERMOS, D. GABOR, M. NIKOLAIDI, A. PAWLOFF, and F. VAN LERVEN, *op. cit.*, 14 f.

the disclosure by CBs of the carbon footprint of their portfolios.[87] Those who propose a greening of the current QE programs in terms of actual portfolios' composition suggest starting (or increasing) the purchases of green assets without changing eligibility criteria;[88] and/or to change the eligibility criteria in a fashion that would facilitate green assets to become purchasable[89] and/or penalize the brown ones, [90] *e.g.* by making the eligibility contingent upon the disclosure of the carbon footprint of each asset.[91]

Nonetheless, recent lines of research question the validity of the market neutrality principle both from the point of view of its legal basis[92] and in terms of its intrinsic soundness.[93] As a result, such school of thinking vigorously favor a review of the current asset purchase programs, mostly the ECB's and the BoE' ones.

[87] EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *op. cit.*, 149; P. FISHER and K. ALEXANDER, *op. cit.*, 15 f.; S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *op. cit.*

[88] Y. DAFERMOS, D. GABOR, M. NIKOLAIDI, A. PAWLOFF, and F. VAN LERVEN, *op. cit.*, 16 ff.

[89] Y. DAFERMOS, D. GABOR, M. NIKOLAIDI, A. PAWLOFF, and F. VAN LERVEN, *op. cit.*, 16 ff.

[90] S. BATTISTON and I. MONASTEROLO, *op. cit.*, 16; EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *op. cit.*, 152; P. HONOHAN, *op. cit.*; S. JOURDAN and W. KALINOWSKI, *op. cit.*, 20; M. PAPOUTSI, M. PIAZZESI, and M. SCHNEIDER, *op. cit.*, 45 ff.; D. SCHOENMAKER, *op. cit.*, 583 f., however stating that a «broad asset and collateral base contributes to minimizing the impact on the functioning of markets and price formation … It is thus very important not to target particular assets (for example, only green bonds) or even asset prices of low-carbon sectors. That would impair the price stability objective of monetary policy and might erode support for central bank independence».

[91] EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *op. cit.*, 149 f.; S. JOURDAN and W. KALINOWSKI, *op. cit.*, 18.

[92] I. SCHNABEL, *From market neutrality to market efficiency*, Frankfurt a. M., 14 Jun 2021, available at: https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210614~162bd7c253.en.html; EUROPEAN CENTRAL BANK WORK STREAM ON CLIMATE CHANGE, *op. cit.*, 147; D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 84 f.; DE BOER and VAN 'T KLOOSTER, *The ECB, The Courts*, cit., 1709; R. SMITS, *op. cit.*, 33 ff.; for a defense of the market neutrality principle, N. DE ARRIBA-SELLIER, *op. cit.*, 1130 ff.

[93] D. SCHOENMAKER, *op. cit.*, 583; I. SCHNABEL, *op. cit.*; M. PAPOUTSI, M. PIAZZESI, and M. SCHNEIDER, *op. cit.*, 31, 45; S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *op. cit.*, 9 f.; see also P. FISHER and K. ALEXANDER, *op. cit.*, 14.

Furthermore, the efficacy of a green QE has been investigated from a quantitative point of view. Dafermos, Nikolaidi, and Galanis[94] first analyzed the effects of a hypothetical green QE program defined as the following: «in 2020 central banks around the globe decide that they will purchase 25% of the total amount of green bonds and they commit themselves that they will keep the same share of the green bond market over the next decades». In such model, the green QE «can reduce climate-induced financial instability and restrict global warming. However, as expected, green QE is not by itself capable of preventing a substantial reduction in atmospheric temperature». Similarly, Ferrari and Nispi Landi indicate that a temporary green QE has modest consequences on the overall amount of pollution, though being able to reduce the amount of emission by the brown sector, provided that brown and green bonds are not fungible (because of regulatory choices or social moral suasion).[95] Nonetheless, Ferrari and Nispi Landi hint that a permanent Green QE «could set the stage for a permanent lower size of the brown sector».[96] Schoenmaker shows that the introduction of a green tilting factor in eligibility criteria would increase the share of low-carbon bonds held in the ECB's portfolio from 0.33 to 0.58, and reduce that of medium and high-carbon bonds to 0.25 and 0.17 respectively, thereby decreasing the ECB's CSPP portfolio carbon footprint by 44%.[97] M. Papoutsi, M. Piazzesi, and M. Schneider, analyze the correlation between the way in which asset purchase programs are designed and their carbon footprint, observing that current approaches lead to higher emissions (and reward higher leveraging) than those a model which factors in climate risks would cause.[98]

(iii) *Collateral eligibility*.

It has been proposed to modulate the eligibility requirements of assets to be accepted as collateral in central banking financing operations according to the characteristics (green vs. brown) of the

[94] Y. DAFERMOS, M. NIKOLAIDI, and G. GALANIS, *op. cit.*, 225 ff.
[95] A. FERRARI and V. NISPI LANDI, *op. cit.*, 21 ff.
[96] A. FERRARI and V. NISPI LANDI, *op. cit.*, 7, 27.
[97] D. SCHOENMAKER, *op. cit.*, 589, table 4.
[98] M. PAPOUTSI, M. PIAZZESI, and M. SCHNEIDER, *op. cit.*, 9 ff., 40 ff.

asset.[99] More specifically, an ESG factor could be introduced as an additional eligibility requirement or as a parameter for determining the "haircuts" to be applied.[100] Lately, European Central Bank Work stream on climate change indicates that collateral rules should duly reflect the climate-related financial risks of the asset (also in the short term):[101] this would likely have a penalizing effect for brown assets.

While some worry about the potential distortive effect that such a move might cause,[102] others doubt its overall efficacy because of the actual shortage of green assets.[103]

(iv) *Assessment and transparency*.

Besides the transparency of CBs portfolios held for monetary purposes, it is generally acknowledged that the first basic action to be taken is gaining a more detailed understanding of the magnitude of the climate-(and transition) related financial risks.[104] This results, in the first place, in the need for an assessment of such risks by financial institutions at an individual level.[105] Overall, the literature tends to favor

[99] EUROPEAN BANKING FEDERATION, *op. cit.*, 29; P. FISHER and K. ALEXANDER, *op. cit.*, 12; P. HONOHAN, *op. cit.*

[100] M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; S. JOURDAN and W. KALINOWSKI, *op. cit.*, 4, 19.

[101] D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 150.

[102] S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *op. cit.*

[103] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 55.

[104] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 2, 52, 62; S. BATTISTON, A. MANDEL, I. MONASTEROLO, F. SCHÜTZE, and G. VISENTIN, *op. cit.*; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, *Recommendations of the Task Force on Climate-related Financial Disclosures*, Financial Stability Board, 2017, available at: https://assets.bbhub.io/company/sites/60/2021/10/FINAL-2017-TCFD-Report.pdf.; I. VISCO, *Talk at the Joint Banca d'Italia - Bank of England research conference: The macro-financial impacts of climate change and the net-zero transition*, Milan, 19-20 Oct. 2021, available at: https://www.bancaditalia.it/media/notizie/2021/BdI-BoE_climate_conference_summary.pdf?language_id=1.

[105] BASEL COMMITTEE ON BANKING SUPERVISION, *Consultative Document Principles for the effective management and supervision of climate-related financial risks*, Bank for International Settlements, 2021, available at:

the disclosure of such information on a mandatory (or highly recommended) basis,[106] which is a condition for market discipline to take place. To this regard, the literature stresses the importance of the development of common standards of disclosure for the comparability of information.[107]

Furthermore, the consensus is now that the understanding of the exposure of the financial system to climate and transition risks requires systemic climate stress testing.[108] Climate prudential stress tests are

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https://www.bis.org/bcbs/publ/d530.pdf; P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 33 ff.; M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*, 61 f.; P. FISHER and K. ALEXANDER, *op. cit.*, 17 f.; TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, *Recommendations*, cit., and TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, *Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures*, Financial Stability Board, 2021, available at: https://assets.bbhub.io/company/sites/60/2021/07/2021-TCFD-Implementing_Guidance.pdf; N. DE ARRIBA-SELLIER, *op. cit.*, 1113; D. SCHOENMAKER and R. VAN TILBURG, *cit.*, 317 ff.

[106] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 2, 52, 62; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; S. DIKAU and U. VOLZ, *Central Banking*, cit., 6; P. FISHER and K. ALEXANDER, *op. cit.*, 17; FSB TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, *Implementing*, cit.

[107] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.; I. MONASTEROLO, S. BATTISTON, A.C. JANETOS, and Z. ZHENG, *op. cit.*; BASEL COMMITTEE ON BANKING SUPERVISION, *op. cit.*; P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 49; M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; P. FISHER and K. ALEXANDER, *op. cit.*, 23; TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, *Recommendations*, cit., and TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, *Implementing*, cit.; D. SCHOENMAKER and R. VAN TILBURG, *op. cit.*, 317 ff.

[108] BASEL COMMITTEE ON BANKING SUPERVISION, *op. cit.*, Principle 18; S. BATTISTON, A. MANDEL, I. MONASTEROLO, F. SCHÜTZE, and G. VISENTIN, *op. cit.*; M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff., highlighting the criticalities faced by traditional stress-testing models; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 17; P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 27; for an in-depth analysis also of the technical features of climate stress testing, see P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 37 ff.

portrayed frequently as a prerequisite for the activation of Pillar 1 and/or Pillar 2 capital adequacy rules.[109]

3. *Regulatory overview*.

This part of the review aims at determining whether steps in the direction of green central banking have been taken (if any) by legislators and regulators.

Existing research analyzes examples and case studies of some tools that have been developed and implemented by CBs until now. Classifications are provided for by Campiglio, Dafermos, Monnin, Ryan-Collins, Schotten, and Tanaka, [110] D'Orazio and Popoyan,[111] Network for Greening the Financial System,[112] Dikau and Volz,[113] and by Ramos Muñoz, Cabrales, and Sanchez.[114] Most recently, Dikau and Volz collected data on 135 national CBs and reported that the majority of green central banking decisions taken until now are functional to primary mandates – price and financial stability.[115] D'Orazio and Popoyan[116] report and classify the implementation of green prudential regulatory tools based on a unique dataset.

This paper builds on these reports and expands this line of research by also:

1. proposing a formal categorization of green central banking tools and techniques, which represents an encompassing blueprint that can be used by future studies (para 3.1).

2. specifically analyzing the individual situations of some CBs, selected because of *(i)* the size of the economies on which they have jurisdiction and/or *(ii)* their level of advancement in carrying out green central banking policies (para 3.2).[117]

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[109] N. DE ARRIBA-SELLIER, *op. cit.*, 1137 f.

[110] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.

[111] P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 28 ff.

[112] NETWORK FOR GREENING THE FINANCIAL SYSTEM, *op. cit.*, 18 ff.

[113] S. DIKAU and U. VOLZ, *Central Banking*, cit., 5 ff.

[114] D. RAMOS MUÑOZ, A. CABRALES, and Á. SANCHEZ, *op. cit.*, 78 ff.

[115] S. DIKAU and U. VOLZ, *Central bank mandates*, cit., table 1.

[116] P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 33 ff.

[117] Needless to say, it is not a statistically significant sample.

### 3.1. *Set of tools*.

Building on the categorization by Campiglio, Dafermos, Monnin, Ryan-Collins, Schotten, and Tanaka,[118] Network for Greening the Financial System,[119] Dikau and Volz,[120] D'Orazio and Popoyan,[121] Mc Daniels and Robins,[122] it is possible to conceptually identify different kinds of interventions that can be put in place with the purpose of conducting green central banking activities. Aside from the hypothesis that changes to the central banking legal setting brought about the legislative power (point A, table 2),[123] efforts undertaken by CBs themselves can occur in a heterogenous array of alternatives (point B, table 2).

To this regard, a very elementary distinction concerns the existence or absence of a general climate-related policy. Of course, a CB can be active in dealing with climate-related consequences even without formalizing a general policy/strategy, and rather acting through single decisions.

A first group of CBs' climate-related actions is characterized by their signaling effect (point B.1, table 2). Such decisions, which span from tackling the issue in official speeches to joining the Network for Greening the Financial System («NGFS»), do not have immediate regulatory consequences, but usually pave the way for future developments, and potentially, interventions. A further step consists in conducting a technical assessment of the exposure of the CB itself to climate and transition risks, by testing the resilience of the CB's balance sheet to climatic and transitional shocks (point B.2, table 2). It shall be observed that both point B.1 and B.2., though surely generating a signaling effect (and thereby an indirect external effect), can be considered *internal* to the CB, as the implementation of their subject-

[118] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.

[119] NETWORK FOR GREENING THE FINANCIAL SYSTEM, *op. cit.*, 18 ff.

[120] S. DIKAU and U. VOLZ, *Central Banking*, cit., 5 ff.

[121] P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 28 ff.

[122] J. MC DANIELS and N. ROBINS, *op. cit.*, 14 ff.

[123] Currently infrequent in developed countries, with the notable exception of the UK: see below para 3.4.

matter does not involve *directly* either the supervised entities or the real economy.

In contrast, points B.3., B.4, and B.5, refer to decisions which, by their own definition, carry actual external consequences. From this point of view, *on the one hand* B.3 reports what are usually referred to as regulatory actions, *i.e.*, rules issued by CBs in their capacity as banking (and/or financial) regulator and/or supervisor. In some cases, this item can overlap with point A, if the function of banking supervision and regulation is assigned, entirely or partially, to an entity different from the CB. *On the other hand*, B.4 lists measures which are part of the classic CBs' function, *i.e.*, setting monetary policy. To this regard, it can be noticed that most of such measures represent so-called "unconventional" monetary policy operations, such as the eligibility of assets issued by the private sector as collateral in refinancing operation and/or under QE programs.

| **TABLE 2.** | |
|---|---|
| CB | Notes |
| **A.** legislative/regulatory changes outside the sphere of the CB. | *This item refers to relevant changes introduced by the legislative power and/or by regulatory entities different from the CB. Proposals not currently in force are included as such.* |
| **B.** Decisions by the CB. | *This item includes both general policy decisions as well as specific decisions. Moreover, sometimes a general policy is disclosed without referring to a formal policy/regulatory act.* |

| | |
|---|---|
| **<u>B.1.</u>** signaling of the issue in official policy statements.[124] | *This item includes all kinds of decision or formal activities which signal that the CB takes or plans to take into consideration the consequences of climate change. Recurring examples are reported in the three sub-items, which however are not exhaustive.* |
| B.1.1. signaling of the issue in official policy statements.[125] | |
| B.1.2. setting up of dedicated internal department/units | |
| B.1.3. NGFS membership. | |
| **<u>B.2.</u>** assessment of climate-related financial risks for the CB's own balance sheets | |
| **<u>B.3.</u>** banking and financial supervision-regulation[126] | |
| B.3.1. assessment of climate-related financial risk for the financial system | |
| B.3.1.a. disclosure of climate-related financial risks by financial institutions | |
| B.3.1.b. climate stress-testing | |
| B.3.1.c. climate-risks-weighted capital prudential regulation | *This item includes any kind of climate-weighted prudential* |

[124] See also E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff., footnotes 6 ff.; S. DIKAU, N. ROBINS, and M. TÄGER, *op. cit.*, table 2.

[125] See also E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff., footnotes 6 ff.; S. DIKAU, N. ROBINS, and M. TÄGER, *op. cit.*, table 2.

[126] On the relationship between "micro" and "macro" prudential, see P. D'ORAZIO and L. POPOYAN, *Taking*, cit., footnote 1; E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff., list climate risk-weighted capital requirements as macroprudential.

| | |
|---|---|
| | *rule (both "Pillar 1" and "Pillar 2").* |
| **B.4.1.** monetary policy. | |
| B.4.1.1. credit operations | |
| B.4.1.2. collateral | *This item includes any kind of rule which provides for a climate-differentiated treatment of collateral eligible assets in refinancing operation.* |
| B.4.1.3. asset purchases under QE programs [127] | *This item includes any kind of rule which provides for a climate-differentiated treatment of assets eligible under QE programs.* |
| **B.5.** Foreign reserves management. | *Regardless of the denomination ("official reserves")* |

3.2. *The European Central Bank.*

The relevant initiatives carried out by the ECB are currently part of an elaborate strategy on the engagement of the Bank with climate change, which was approved by the ECB's Governing Council on July 8th, 2021 («Climate action plan»).[128] Such plan includes a roadmap with a detailed indication of the actions to be taken and the related timing. Prior to that, the ECB had already started to consider the issue at several levels but lacked an organic plan.

On November 4th, 2021 – *i.e.*, during the COP26 – the ECB officially pledged to act in compliance with the Paris agreement and with the purpose of «mitigating the consequences of climate change».[129] Said document once again discloses the specifics of the forms of engagement with climate-related risks, enacted and/or planned by the ECB. The

[127] NETWORK FOR GREENING THE FINANCIAL SYSTEM, *op. cit.*, 18.

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

[129] https://www.ecb.europa.eu/pub/pdf/other/ecb.pledge_climate_change_action211103~6af74636d8.en.pdf?8b1bc8a34bc3780cd41ff9802343d01e

ECB's roadmap is further summarized and accessible, also for the layman, at a dedicated webpage of the ECB's website.[130]

It is worth noting that the first step of the ECB's roadmap – not explicitly reported in the table – is almost "cognitive". In fact, it consists in developing «new indicators» for assessing a number of relevant factors, such as green financial instruments, the financial sector's exposure to climate risks, and the financial institutions' carbon footprints, *on the one side*; and incorporating climate risks into the ECB's macroeconomic modelling used for monetary policy decisions, *on the other side*.

Concerning a measure whose adoption has been pushed by many commentators as a lead-by-example policy,[131] the ECB declares that its own funds and staff's pension fund portfolios have followed a sustainable investment strategy since 2020.

As recalled by the literature reported above, the ECB's mandate is enshrined in art. 127 TFUE, according to which «[t]he primary objective of the European System of Central Banks (hereinafter referred to as 'the ESCB') shall be to maintain price stability. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union as laid down in Article 3 of the Treaty on European Union». As a result, price stability is the primary mandate, while the support of the general economic policies is the secondary one.

| | |
|---|---|
| **A.** legislative/regulatory changes outside the sphere of the CB. | Mandatory disclosure of "green asset ratio" by banks, starting from July 2022[132]<br>Proposal of EU Regulation for climate disclosure as an eligibility requirement in collateral framework and asset purchases, mentioned in ECB's roadmap, bullet no 5. |

[130] https://www.ecb.europa.eu/ecb/climate/roadmap/html/index.en.html

[131] P. BOLTON, M. DESPRES, L.A. PEREIRA DA SILVA, F. SAMAMA, and R. SVARTZMAN, *op. cit.*, 49, 54; S. DIKAU, N. ROBINS, and M. TÄGER, *op. cit.*, 92 f.

[132] Commission Delegated Regulation (Eu) 2021/2178 was issued on July 6th, 2021, and entered into force on January 1st, 2022.

| | |
|---|---|
| | Proposal to introduce green supporting factor in capital requirements mentioned by DOMBROVSKIS[133], currently abandoned[134] |
| **B.** Decisions by the CB. | «Climate action plan», ECB Governing Council on 8.7.2021<br>The ECB pledge on climate change action, 4.11.2021 |
| **B.1.** decisions with signaling effects. | |
| B.1.1. signaling of the issue in official policy statements. | Constant in Ms. Lagarde's speeches/posts (*e.g.* see: 18.11.2022, 9.11.2021, 4.11.2021, 25.1.2021, 27.2.2020)[135] as well as in Mr. Elderson's[136] and in Ms. |

[133] V. DOMBROVSKIS, *op. cit.*

[134] https://www.europarl.europa.eu/doceo/document/A-8-2018-0242_EN.html https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_17_5235

[135] All available at: https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

[136] Amongst others, see: 21.10.2021 (https://www. .europa.eu/press/key/date/2021/html/ecb.sp211020~03fba70983.en.html); 23.9.2021 (https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210923~0c7bd9c596.en.html); 13.2.2021 https://www.ecb.europa.eu/press/blog/date/2021/html/ecb.blog210213~7e26af8606.en.html

| | |
|---|---|
| | Schnabel's;[137] previously, Cœuré,[138] Draghi,[139] and Mersch.[140] |
| B.1.2. setting up of dedicated internal department/units | Yes, ECB «climate change centre», established in January 2021[141] |
| B.1.3. NGFS membership. | Yes, joined May 2018 |
| **B.2.** assessment of climate-related financial risks for the CB's own balance sheets | Assessed and disclosed on 28.3.2023[142], including the results of a climate stress test of the Eurosystem's corporate sector holding for monetary purposes[143] |
| **B.3.** banking and financial supervision-regulation | |
| B.3.1. assessment of climate-related financial risk for the financial system | ECB's roadmap, bullets no 1-3 |

[137]https://www.ecb.europa.eu/press/key/date/2023/html/ecb.sp230110~21c89bef1b.en.html; https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210614~162bd7c253.en.html; https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210303_1~f3df48854e.en.html;
https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp201217~2ba78083cf.en.pdf?5e1547ca24c2bf6b6fad76bed62ffcf4; ecb.europa.eu/press/key/date/2022/html/ecb.sp220108~0425a24eb7.en.html

[138]https://www.ecb.europa.eu/press/key/date/2018/html/ecb.sp181127.en.html

[139]https://www.europarl.europa.eu/cmsdata/151961/Monetary%20Dialogue%2009072018_FR.pdf, 11.

[140]https://www.ecb.europa.eu/press/key/date/2018/html/ecb.sp181127.en.html

[141]https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210125_1~3fc4ebb4c6.en.html

[142]https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog.230324~f417b719fd.en.html

[143]https://www.ecb.europa.eu/pub/pdf/other/ecb.climate_related_financial_disclosures_eurosystem_corporate_sector_holdings_monetary_policy_purposes2023~9eae8df8d9.en.pdf?44e1ca0d64e12148df58cb8acaed6f4a

| | |
|---|---|
| B.3.1.a. disclosure of climate-related financial risks by financial institutions | - Supervisory expectations relating to risk management and disclosure, 2020<br>- ongoing assessment on banks' compliance. Further actions possible.<br>- see also A. |
| B.3.1.b. climate stress-testing | - results of an economy wide climate stress test published first in Sept. 2021[144]; results of the 2022 climate risk stress test of the Eurosystem balance sheet published in March 2023[145]<br>- supervisory climate stress test of individual banks planned for 2022 (roadmap, bullet no 6) |
| B.3.1.c. climate-risks-weighted capital prudential regulation | |
| B.3.2. Lending quotas | No |
| | |
| **B.4.1.** monetary policy. | |
| B.4.1.1. credit operations | No |
| B.4.1.2. collateral | - climate disclosure on assets eligible as collateral. Detailed plan in 2022 q4<br>- favoring green assets in collateral eligibility. Detailed plan in 2022 q4<br>- incorporation of climate risk in ratings. Planned by mid 2022.<br>- «Since the beginning of 2021, we accept certain sustainability-linked |

[144] https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op281~05a7735b1c.en.pdf
[145] https://www.ecb.europa.eu/pub/economic-bulletin/focus/2023/html/ecb.ebbox202302_06~0e721fa2e8.en.html

| | |
|---|---|
| | bonds as collateral and for our asset purchases»[146] |
| B.4.1.3. asset purchases under QE programs | - review of current portfolio, incorporate climate risk in APP-CSPP (see also above, point B.2)<br>- disclosure of climate information of the current CSPP portfolio (see above, point B.2)<br>- introduction of climate criteria for future purchases[147]<br>- «Since the beginning of 2021, we accept certain sustainability-linked bonds as collateral and for our asset purchases» [148] |
| **B.5.** Foreign reserves management. | Pledge: Disclosure of climate-related information on ECB *non-monetary policy portfolios* in cooperation with the other Eurosystem central banks |

3.3. *The US Federal Reserve System.*

It is a widespread belief that the US Federal Reserve is lagging the international central banking best practices.[149] This usually goes

[146] https://www.ecb.europa.eu/ecb/climate/roadmap/html/index.en.html; https://www.ecb.europa.eu//press/pr/date/2020/html/ecb.pr200922~482e4a5a90.en.html

[147] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 465 «For instance, the European Investment Bank (EIB) dedicates a minimum of 25% of its lending to climate action projects. Thus, the ECB might already be indirectly supporting low-carbon investments, although to a limited extent, through the inclusion of EIB-issued bonds in its quantitative easing programme».

[148] https://www.ecb.europa.eu/ecb/climate/roadmap/html/index.en.html; https://www.ecb.europa.eu//press/pr/date/2020/html/ecb.pr200922~482e4a5a90.en.html

[149] R. MEYER, *The Planet Needs Jerome Powell*, in *The Atlantic*, 21 Sep. 2021, available at: https://www.theatlantic.com/science/archive/2021/09/climate-case-for-

together with the concept that the Fed's mandate[150] does not cover climate change.[151]

Be that as it may, the Fed has now started to address climate change.[152] Such a move is likely to have been caused both by political pressures as well as by the general acceptance of the idea that a mandate of guaranteeing price stability does include the task of taking adequate measures when such goals are jeopardized by climate related financial risks. In December 2020, the Fed joined the NGFS. The need to address climate related financial risks has been mentioned in several speeches by both the Chairman of the Board of Governors – Mr. Powell – and Ms. Lael Brainard, a member of the Board of Governors.

Most recently, a perspective on likely future developments is contained in the Report on Climate-Related Financial Risk of the Financial Stability Oversight Council (FSOC), which was published on October 21st, 2021. The publication of the report led to a statement by Mr. Powell, which explicitly supported the report and stated that the «Federal Reserve will address climate-related risks in an analytically rigorous, transparent, and collaborative way». It is useful to recall that the FSOC was established by the Dodd-Frank Wall Street Reform and Consumer Protection Act as the body responsible for the institutional coordination and cooperation between the plethora of federal regulators, as well as the relevant state regulators, involved with the financial sector. Therefore, recommendations by the FSOC are likely to result in regulatory and/or supervisory decisions by the individual participating agencies, among which is the Fed.

Furthermore, on September 29th, 2022, the Fed Board announced that «six of the nation's largest banks will participate in a pilot climate scenario analysis exercise designed to enhance the ability of supervisors and firms to measure and manage climate-related financial risks».[153]

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jerome-powell/619944/?utm_source=email&utm_medium=social&utm_campaign=share; A. TOOZE, *Why Central*, cit.

[150] «So as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates».

[151] M.K. BRUNNERMEIER and J. LANDAU, *op. cit.*; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., table 1 and 2.

[152] S. DIKAU and U. VOLZ, *Central bank mandates*, cit.; R. MEYER, *The Planet*, cit.

[153] https://www.federalreserve.gov/newsevents/pressreleases/other20220929a.htm

| | |
|---|---|
| **A.** legislative/regulatory changes outside the sphere of the CB. | |
| **B.** Decisions by the CB. | |
| **B.1.** decisions with signaling effects. | |
| B.1.1. signaling of the issue in official policy statements. | Brainard, Feb 2021,[154] Oct 2021,[155] Nov 2019.[156] Powell, Oct 2021[157] |
| B.1.2. setting up of dedicated internal department/units | - Supervision Climate Committee, established in Jan 2021<br>- Climate related Financial Risk Committee of the Financial Stability Oversight Council |
| B.1.3. NGFS membership. | Yes, since December 2020 |
| | |
| **B.2.** assessment of climate-related financial risks for the CB's own balance sheets | |
| | |
| **B.3.** banking and financial supervision-regulation | |
| B.3.1. assessment of climate-related financial risk for the financial system | - Climate scenario analysis proposed by Brainard[158];<br>- on 29.9.2022, the Fed Board announced that «six of the nation's largest banks will participate in a pilot climate scenario analysis |

[154] https://www.federalreserve.gov/newsevents/speech/brainard20210218a.htm
[155] https://www.federalreserve.gov/newsevents/speech/files/brainard20211007a.pdf
[156] https://www.federalreserve.gov/newsevents/speech/brainard20191108a.htm
[157] https://www.federalreserve.gov/newsevents/pressreleases/other20211021c.htm
[158] See also the overview on the sentiment by banking top executives: https://www.reuters.com/business/cop/wall-street-sees-first-fed-climate-change-review-2023-2021-11-17/.

| | |
|---|---|
| | exercise designed to enhance the ability of supervisors and firms to measure and manage climate-related financial risks»[159]<br>- FSOC's Recommendations 1.4., 2.2. |
| B.3.1.a. disclosure of climate-related financial risks by financial institutions | - FSOC's Recommendation 3.2. |
| B.3.1.b. climate stress-testing | |
| B.3.1.c. climate-risks-weighted capital prudential regulation | |
| B.3.2. Lending quotas | |
| | |
| **B.4.1.** monetary policy. | |
| B.4.1.1. credit operations | |
| B.4.1.2. collateral | |
| B.4.1.3. asset purchases under QE programs | |
| **B.5.** Foreign reserves management. | |

3.4. *The Bank of England*

As noted above (para. 1), the Bank of England was the first CB to officially state that central banking cannot ignore the systemic consequences of climate change and transition.[160] Therefore, it is not surprising that the BoE has implemented a climate-related policy which entails a wide-ranging array of tools. The BoE's climate policy is described also in a dedicated webpage of the bank's institutional website.[161]

[159]https://www.federalreserve.gov/newsevents/pressreleases/other20220929a.htm
[160] M. CARNEY, *cit*.
[161] https://www.bankofengland.co.uk/climate-change.

Furthermore, in 2021 climate concerns have been explicitly incorporated in the BoE's mandates of supporting the economic policy subject to the safeguarding of price stability. Section 12 of the Bank of England Act (1998) requires the Treasury to specify «(a) what price stability is to be taken to consist of, or (b) what the economic policy of Her Majesty's Government is to be taken to be» on a yearly basis.[162] Pursuant to such provision, the remit for the Monetary Policy Committee issued by the Treasury on the March 3rd, 2021, requires the BoE to «reflect the government's economic strategy for achieving strong, sustainable and balanced growth *that is also environmentally sustainable and consistent with the transition to a net zero economy*» (emphasis added).[163]

Such move is noteworthy in the first place for its symbolic value, as it is unprecedented in developed economies. In addition, it has caused an ongoing shift in the BoE's approach to climate risks. While, before that, the BoE appeared to be inclined to focus mostly on supervisory measures - differently from the ECB's approach -, it has turned to monetary policy tools as well. In fact, in May 2021, the discussion paper, «Options for Greening the Bank of England's Corporate Bond Purchase Scheme» was published. Subsequently, the BoE published a

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[162] Which are respectively the primary and secondary BoE's mandates according to Section 11 of the Bank of England Act (1998).

[163] https://www.bankofengland.co.uk/-/media/boe/files/letter/2021/march/2021-mpc-remit-letter.pdf?la=en&hash=C3A91905E1A58A3A98071B2DD41E65FAFD1CF03E. It is worth noting that, albeit the two subsequent remits (on 27.10.2021 and on 17.11.2022) do not explicitly include such indication, they confirm previous inflation targets as well as the materiality of price stability in pursuing the government economic policies (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1028597/CX_LETTER_TO_GOVENOR_MPC_REMIT_271021.pdf; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1118261/MPC_Remit_Autumn_Statement_2022.pdf). While the October 2021 Remit explicitly included in such policies the «transition to an environmentally sustainable and resilient net zero economy», the November 2022 does not refer it. This evolution reflects both the changes in the composition of the English government and the aggravated inflation scenario.

detailed plan for greening the scheme[164] (deemed insufficient by Dafermos, Gabor, Nikolaidi, and van Lerven).[165]

| | |
|---|---|
| **A.** legislative/regulatory changes outside the sphere of the CB. | Treasury Remit for the Monetary Policy Committee (March 2021) |
| **B.** Decisions by the CB. | Supervisory statement April 2019<br>The Bank of England's climate-related financial disclosure, June 2021<br>Climate-related financial risk management and the role of capital requirements, Oct 2021 |
| **B.1.** decisions with signaling effects. | |
| B.1.1. signaling of the issue in official policy statements. | Carney 2015 |
| B.1.2. setting up of dedicated internal department/units | Climate Steering Group |
| B.1.3. NGFS membership. | Founding member |
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| **B.2.** assessment of climate-related financial risks for the CB's own balance sheets | Yes, disclosed (June 2021 doc, 18 ff.) |
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| **B.3.** banking and financial supervision-regulation | |
| B.3.1. assessment of climate-related financial risk for the financial system | Supervisory expectations April 2019 |

[164] https://www.bankofengland.co.uk/markets/greening-the-corporate-bond-purchase-scheme

[165] Y. DAFERMOS, D. GABOR, M. NIKOLAIDI, and F. VAN LERVEN, *op. cit.*, 1 ff.

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| | 2021 Climate Biennial Exploratory Scenario (CBES), started Jun 2021[166] |
| B.3.1.a. disclosure of climate-related financial risks by financial institutions | «Consistent with existing requirements on regulated firms to disclose material risks in their Pillar 3 reports, firms will be required to disclose material climate-related financial risks from the end of 2021». Oct 2021, p. 19 |
| B.3.1.b. climate stress-testing | 2021 Climate Biennial Exploratory Scenario (CBES) |
| B.3.1.c. climate-risks-weighted capital prudential regulation | - as ad hoc capital add-ons determined by the PRA, «Where progress [by supervised entities] remains insufficient and assurance or remediation is needed» (in alternative, «appointment of a Skilled Persons Review under Section 166 of FSMA»)<br>- «[B]y the end of 2022 the PRA intends to provide an update on the following: […] on whether changes to the regulatory capital regimes, or their application, are required to address climate related financial risks».<br>• capital is not the right tool to address the causes of climate change, but that it should be used to provide resilience against its consequences. |

166 Furthermore, the Oct 2021 document states that from 2022 onwards «the management of climate-related financial risks will become subject to formal supervisory assessments. In continuous assessment meetings and supervisory reviews, boards, firm executives and senior managers will be expected to be able to demonstrate their understanding of the risks climate change poses to their areas of responsibility and their plans to address them» (20).

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| | • the use of capital, or change in capital frameworks, could address relevant gaps [internal modelling, microprudential, macroprudential] [Oct 2021, 20-21, 28 ff.] |
| B.3.2. Lending quotas | |
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| **B.4.1.** monetary policy | |
| B.4.1.1. credit operations | |
| B.4.1.2. collateral | |
| B.4.1.3. asset purchases under QE programs | Framework for Greening the CBPS |
| **B.5.** Foreign reserves management. | |

### 3.5. *The Bank of Norway (Norges Bank)*

The mandate of the central Bank of Norway (Norges Bank) is defined in sections 1 and 2 of the Act relating to Norges Bank and the Monetary System (Central Bank Act) (enacted with Resolution June 21st, 2019, No. 804) and in section 1 of the Regulation on Monetary Policy, enacted with Royal Decree of 13 December 2019).

More specifically, according to the Central Bank Act, «[t]he purpose of the central banking activities is to maintain monetary stability and to promote the stability of the financial system and an efficient and secure payment system» (section 1). Furthermore, «the central bank shall contribute to high and stable output and employment» (section 2). The Regulation on Monetary Policy specifies that «monetary policy shall maintain monetary stability by keeping inflation low and stable» (section 1).

Norges Bank states that its «operational target […] in interest rate setting is inflation close to 2 percent over time. As the primary objective of monetary policy is low and stable inflation, it can be said that Norway has an inflation-targeting monetary policy regime. […] When shocks occur, a short-term trade-off may arise between reaching the inflation target and supporting high and stable output and employment.

Monetary policy should achieve a reasonable trade-off between these considerations».[167]

The most elaborate description of Norges Bank's approach to climate and transition-related risks is to be found in its response to the consultation started by the Norwegian Climate Risk Commission in 2019[168]. The section «Climate change and Norges Bank's core tasks» of the bank's institutional website contains a brief version of such policy,[169] which appears to be focused on an enhanced assessment of climate and transition risks for the financial system and the economy. This also requires a regime of disclosure of climate risks by financial entities, that Norges Bank is currently developing.

In addition, it needs to be noted that Norges Bank manages Norway's sovereign fund (Government Pension Fund Global, GPFG). Such fund is bound by sustainability criteria in its investment process [170]. In this respect, one can reasonable argue that Norges Bank indirectly acts as an active steward in dealing with the consequences of climate change,[171] whose reach is considerable to the tremendous magnitude of the managed wealth.

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| **<u>A.</u>** legislative/regulatory changes outside the sphere of the CB. | |

[167] https://www.norges-bank.no/en/topics/Monetary-policy/Mandate-monetary-policy/

[168] https://www.norges-bank.no/en/news-events/news-publications/Submissions/2019/2019-03-15/. See S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 13.

[169] https://www.norges-bank.no/en/topics/about/climate-and-the-economy/climate-change-and-banks-core-tasks/

[170] https://www.nbim.no/contentassets/fef0e2802b3f423ba2e514cfde1277d7/government-pension-fund-global_2020_responsible-investment_web.pdf. See E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.

[171] See also Norges Bank's response to the European Commission Consultation on the Renewed Sustainable Finance Strategy, available at: https://www.norges-bank.no/contentassets/5b045b08d7ef47a8bc586f08e26b9e2f/eu-renewed-strategy-on-sustainable-finance_innspill-nb.pdf?v=06/17/2020085122&ft=.pdf

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| **B.** Decisions by the CB. | - Section «Climate change and Norges Bank's core tasks» on institutional website |
| **B.1.** decisions with signaling effects. | |
| B.1.1. signaling of the issue in official policy statements. | Oct 2021,[172] Nov 2019[173] |
| B.1.2. setting up of dedicated internal department/units | |
| B.1.3. NGFS membership. | Since 2018 |
| | |
| **B.2.** assessment of climate-related financial risks for the CB's own balance sheets | |
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| **B.3.** banking and financial supervision-regulation | |
| B.3.1. assessment of climate-related financial risk for the financial system | Assessment based on generally available data (not through an *ad hoc* stress testing), 2021 (financial stability report 2021) |
| B.3.1.a. disclosure of climate-related financial risks by financial institutions | Programmed (Oct 2021 speech) |
| B.3.1.b. climate stress-testing | Programmed (Oct 2021 speech) |
| B.3.1.c. climate-risks-weighted capital prudential regulation | |
| B.3.2. Lending quotas | |
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| **B.4.1.** monetary policy | |
| B.4.1.1. credit operations | |
| B.4.1.2. collateral | |

[172] https://www.bis.org/review/r211112g.pdf
[173] https://www.norges-bank.no/en/news-events/news-publications/Speeches/2019/2019-11-08-matsen/

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| B.4.1.3. asset purchases under QE programs | |
| **B.5.** Foreign reserves management. | |

3.6. *The Bank of Japan*

The Bank of Japan conducts currency and monetary control, aiming at achieving price stability, thereby contributing to the sound development of the national economy (secondary mandate).[174]

On July 27th, 2021, the Bank of Japan published an official Strategy on Climate Change. A first implementation of such policy is the decision on Transactions for Climate Response Financing Operations, issued in November 2021. However, similar measures had been already in place since 2016, when the BoJ adopted the Loan Support Program, according to which the CB «offers loans at below market rate to financial institutions to support several lending priority sectors, including environmental businesses».[175]

Moreover, for a complete evaluation of BoJ's green activities it needs to be considered that «the Bank has been making investment in the Asian Bond Fund launched by EMEAP for the purpose of supporting the development of local currency-denominated bond markets in Asia. Aimed at helping to catalyze further deepening of the local currency-denominated green bond market» (July 2021).

Albeit Matikainen, Campiglio, and Zenghelis suggest that the BoJ's QE program is less carbon-intensive than the ECB's and Bank of England's ones, the same study still shows that the former is concentrated mostly on manufacturing.[176]

[174] Article 2 of the Bank of Japan Act (Act No. 67 of 1942).

[175] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 462 ff.

[176] S. MATIKAINEN, E. CAMPIGLIO, and D. ZENGHELIS, *op. cit.*

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| **A.** legislative/regulatory changes outside the sphere of the CB. | |
| **B.** Decisions by the CB. | The Bank of Japan's Strategy on Climate Change. Speech-Statement 27 July 2021. |
| **B.1.** decisions with signaling effects. | |
| B.1.1. signaling of the issue in official policy statements. | The Bank of Japan's Strategy on Climate Change. Speech-Statement 27 July 2021. |
| B.1.2. setting up of dedicated internal department/units | Climate Coordination Hub («internal network»)<br>«Climate change» page on the institutional website |
| B.1.3. NGFS membership. | Since 2019 |
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| **B.2.** assessment of climate-related financial risks for the CB's own balance sheets | |
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| **B.3.** banking and financial supervision-regulation | |
| B.3.1. assessment of climate-related financial risk for the financial system | Pilot Scenario Analysis Exercise on Climate-Related Risks published in August 2022[177] |
| B.3.1.a. disclosure of climate-related financial risks by financial institutions | Encouraged by the bank (since July 2021) |
| B.3.1.b. climate stress-testing | |
| B.3.1.c. climate-risks-weighted capital prudential regulation | |

[177] https://www.boj.or.jp/en/finsys/cofsa/data/rel220826a.pdf.

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| B.3.2. Lending quotas | D'ORAZIO and POPOYAN[178] report of voluntary lending limits |
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| **B.4.1.** monetary policy | |
| B.4.1.1. credit operations | Transactions for Climate Response Financing Operations (Nov 2021)[179] Financing is contingent on climate disclosure by receiving institution Financeable operations: (1) Green loans, (2) Green bonds (including sustainability bonds), (3) Sustainability-linked loans with performance targets related to efforts on climate change, (4) Sustainability-linked bonds with performance targets related to efforts on climate change, (5) Transition finance[180] |
| B.4.1.2. collateral | |
| B.4.1.3. asset purchases under QE programs | |
| **B.5.** Foreign reserves management. | Preference for green bonds issued by governments and other institutions (July 2021) |

3.7. *The People's Bank of China*.

According to Article 3 of the Law of the People's Republic of China on The People's Bank of China (18 March 1995), The People's Bank of China has the following mandate: «The objective of monetary policy

[178] P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 33.
[179] https://www.boj.or.jp/en/mopo/measures/mkt_ope/ope_x/opetori22.htm/
[180] Three auctions for funds disbursement on the basis of said framework have been published by the BoF, for a total of 7.247,5 billion yen: https://www.boj.or.jp/en/about/climate/index.htm, https://www.boj.or.jp/en/mopo/mpmdeci/mpr_2023/mpr230127a.pdf.

is to maintain the stability of the value of the currency and thereby promote economic growth».[181]

The PBC, who is also a NGFS founding member, has drawn the attention of the literature since it was the first CB to formally adopt green parameters in collateral eligibility criteria in 2018.[182] While this might sound somewhat unexpected, given the reluctance showed by the PRC to commit to green targets in international fora,[183] it has been noticed that the Chinese CB is at the forefront in many "innovative" fields of central banking, such as not only green finance,[184] but also digital currencies.[185]

Fang et al. 2020 collects data related to the (green) bonds that became eligible as collateral after the PBC's collateral eligibility decision in 2018. They find that the eligibility determines a decrease in the bond spread both in the secondary and in the primary markets. Macaire and Naef come to similar conclusions by comparing the variations in yields of respectively green and non-green bonds after the PBC's collateral eligibility in 2018.[186]

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[181]http://www.pbc.gov.cn/eportal/fileDir/english/resource/cms/2015/08/2015082610501049304.pdf, in English.

[182] S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 10 f.; P. FISHER and K. ALEXANDER, *op. cit.*, 10; C. MACAIRE and A. NAEF, *Greening Monetary Policy: Evidence from the People's Bank of China*, Banque de France Working Paper 812, Paris, Banque de France, 2021 (available at: https://publications.banque-france.fr/en/greening-monetary-policy-evidence-peoples-bank-china) report also that, according to that decision, green bonds enjoy preferential status *ceteribus paribus*).

[183] L. KUO and M. BIRNBAUM, *China declares coal peak, India readies pollution lockdown days after U.N. climate summit*, in *The Washington Post*, 15. Nov. 2021; The Economist, *Amid extreme weather, China avoids mention of climate change*, in *The Economist*, 31 Jul. 2021; E. WHITE, *Global climate fight hinges on China's $6.5tn green investments challenge*, in *Financial Times*, 16 Nov 2021.

[184] J. MC DANIELS and N. ROBINS, *op. cit.*, 13, 15; HIGH-LEVEL EXPERT GROUP ON SUSTAINABLE FINANCE, *op. cit.*, 10, 63; A. TOOZE, *Why Central Banks*, cit.

[185] R. AUER, G. CORNELLI, and J. FROST, *Rise of the central bank digital currencies: drivers, approaches and technologies*, BIS Working Papers 880, Bank for International Settlements, 2020, available at: https://www.bis.org/publ/work880.pdf; The Economist, *China aims to launch the world's first official digital currency*, in *The Economist*, 25 Apr. 2020. See People's Bank of China, Progress on Research and Development of E-CNY [digital fiat currency] in China, July 2021.

[186] C. MACAIRE and A. NAEF, *op. cit.*

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| **A.** legislative/regulatory changes outside the sphere of the CB. | |
| **B.** Decisions by the CB. | Guidelines for Establishing the Green Financial System 2016[187] |
| **B.1.** decisions with signaling effects. | |
| B.1.1. signaling of the issue in official policy statements. | Latest, March 2023[188] |
| B.1.2. setting up of dedicated internal department/units | |
| B.1.3. NGFS membership. | Founding member |
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| **B.2.** assessment of climate-related financial risks for the CB's own balance sheets | |
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| **B.3.** banking and financial supervision-regulation | |
| B.3.1. assessment of climate-related financial risk for the financial system | |
| B.3.1.a. disclosure of climate-related financial risks by financial institutions | |
| B.3.1.b. climate stress-testing | - Monetary Policy Report Quarter 4 2017: green financing included in the assessments of implementation |

[187] http://www.pbc.gov.cn/english/130721/3131759/index.html
The first efforts in the field date back to the Green Credit Policy of 2007, jointly issued by the PBC, the China Banking Regulation Commission (now China Banking and Insurance Regulatory Commission), and the Ministry of Environmental Protection (S. DIKAU, N. ROBINS, and M. TÄGER, *op. cit.*, 94; R. D' SOUZA and T. RANA, *The Role of Monetary Policy in Climate Change Mitigation*, ORF Issue Brief No. 350, April 2020, Observer Research Foundation.

[188] http://www.pbc.gov.cn/en/3688110/3688175/4848508/index.html

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| | of the general credit policy in the macro-prudential assessment[189]<br>- consultation paper on green finance performance evaluation of the banking sector, July 2020[190] |
| B.3.1.c. climate-risks-weighted capital prudential regulation | |
| B.3.2. Lending quotas | |
| | |
| **B.4.1.** monetary policy. | |
| B.4.1.1. credit operations | |
| B.4.1.2. collateral | Green bonds as collateral for the Medium-term Lending Facility, since 2018[191] |
| B.4.1.3. asset purchases under QE programs | |
| **B.5.** Foreign reserves management. | |

3.8. *Main results of the regulatory overview.*

Purpose of this section is to identify, *on the one hand*, common trends among the policies enacted by the examined CBs and, *on the other hand*, sectors or actions in which some of them stand out.

First, most of the CBs involved in this review have adopted some form of climate action plan which explicitly codifies their approach to climate change and climate financial risks (as monetary policy setter and/or as financial supervisor), the main exception to this being the Fed. Most frequently, such plans entail (i) the setting up of internal structures

[189] E. CAMPIGLIO, Y. DAFERMOS, P. MONNIN, J. RYAN-COLLINS, G. SCHOTTEN, and M. TANAKA, *op. cit.*, 465; P. D'ORAZIO and L. POPOYAN, *Fostering*, cit., 33; S. DIKAU and U. VOLZ, *Central bank mandates*, cit., 10.

[190] pbc.gov.cn/tiaofasi/144941/144979/3941920/4059904/index.html

[191]http://www.pbc.gov.cn/en/3688110/3688172/4048314/3711516/index.html

or bodies that are specifically entrusted with different kind of tasks in the area of climate change and (ii) the carrying out of stress-testing or scenario analysis with the purpose of assessing the exposure of the banking and financial system to climate-related financial risks. All the CBs examined are NGFS member.

By contrast, only the ECB and the BoE assessed their own exposure to such risks and only under EU and English rules the disclosure of individual climate-related risks is mandatory for financial entities, although it is recommended also by the US FSOC.

In the field of prudential supervision, the idea of tilting capital requirements with the purpose of incentivizing green investment (with the introduction of either a green supporting factor or a brown penalizing factor) does not seem currently to be on the menu of alternatives taken into consideration by CBs. Only the BoE does not rule out the possibility of imposing additional capital requirements (pillar 2) on the basis of entity-specific climate risks.

With regard to monetary policy, only the ECB and the PBC have amended the eligibility criteria of assets admissible as collateral in lending operations in order to facilitate “green” over “brown” ones, while the BoJ is the only one to have turned to outright credit operations as well as to lending quotas.