

# Greening the Swiss National Bank's **Portfolio**

# Rüdiger Fahlenbrach

École Polytechnique Fédérale de Lausanne (EPFL), Swiss Finance Institute, ECGI, and Enterprise for Society Center, Switzerland

# Eric Jondeau

University of Lausanne, Swiss Finance Institute, and Enterprise for Society Center, Switzerland

Central banks are increasingly concerned about climate-related risks and want to ensure that the financial system is resilient to them. As they integrate these risks into financial stability monitoring, they also discuss how to apply environmental criteria to their own policy portfolio management, without compromising their policy mandate. We describe different strategies and assess their relevance for central banks, using the Swiss National Bank's (SNB) equity portfolio as a laboratory. We develop a carbon-conscious screening approach that is likely consistent with its policy mandate. The approach reduces the portfolio's carbon footprint by 20%, with little impact on diversification or performance. (JEL E58, G11)

Received January 26, 2022; editorial decision March 5, 2023 by Editor Andrew Ellul

Central banks and banking supervisors all over the world have started to advocate climate risk management in the financial sector. They launched the Network for Greening the Financial System (NGFS) to support their efforts in 2017.<sup>1</sup> In its 2019 report titled "A call for action: Climate change as a source of financial risk," the NGFS developed six nonbinding recommendations (NGFS 2019a). These recommendations include ambitious goals,

We thank Andrew Ellul (the editor), an anonymous referee, Jean-Pierre Danthine, Kevin Rageth, and Karl Schmedders, as well as seminar participants at the International Virtual Research Seminar in Finance and the Swiss National Bank for helpful comments and suggestions. Fahlenbrach gratefully acknowledges financial support from the Swiss Finance Institute. Fahlenbrach and Jondeau thank the Enterprise for Society (E4S) Center, a joint initiative of EPFL, HEC Lausanne, and IMD, for their generous financial support. Send correspondence to Eric Jondeau, eric.jondeau@unil.ch.

The NGFS describes itself as "a group of Central Banks and Supervisors willing, on a voluntary basis, to exchange experiences, share best practices, contribute to the development of environment and climate risk management in the financial sector, and to mobilize mainstream finance to support the transition toward a sustainable economy." See https://www.ngfs.net/en, accessed on May 6, 2021.

The Review of Corporate Finance Studies 00 (2023) 1-42

<sup>©</sup> The Author(s) 2023. Published by Oxford University Press on behalf of The Society for Financial Studies. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (https:// creativecommons.org/licenses/by/4.0/), which permits unrestricted reuse, distribution, and reproduction in any medium, provided the original work is properly cited. https://doi.org/10.1093/rcfs/cfad011

such as the integration of climate-related risks into financial stability monitoring and micro-supervision, as well as more operational recommendations, such as robust climate-related disclosure. Importantly, the NGFS realized early on that, should central banks want to be taken seriously, they would have to lead by example and integrate sustainability factors into their own portfolio management (recommendation 2 in NGFS 2019a).

Therefore, the NGFS also published a sustainable and responsible investment (SRI) guide for central banks' portfolio management (NGFS 2019b), followed by a progress report a year later (NGFS 2020b). The overall conclusion from the 2020 progress report points to a lack of consensus on how central banks should address ESG and climate-related risks in their portfolio management, as many central banks were still trying to understand how sustainable investing fits within their specific mandates. We believe that as of this publication, there is still no consensus. Whether and if so, how, a central bank should address ESG-related issues in their own portfolio management remains an important and open question.

In this paper, we use the large equity portfolio of the Swiss National Bank (SNB) as a laboratory to discuss the possibilities for and limitations to a more climate conscious investment approach in central banks' policy portfolios. Our objective is twofold. First, we develop the different strategies that a central bank, such as the SNB, could follow regarding carbon emissions in its policy portfolio while maintaining its primary price stability mandate. Second, we quantify the impact of a more carbon conscious investment approach, consistent with the central bank's policy mandate, on the portfolio's carbon footprint and financial performance. We show that a best-in-class screening approach would reduce the portfolio's carbon footprint by 20%, with little impact on diversification or performance.

Central banks find themselves in a predicament. On the one hand, central banks are subject to public scrutiny if they fail to address, within their role as guardians of financial stability, the increasing climate change-related concerns of their countries' citizens or politicians. The problem is compounded if a central bank (or bank supervisor) wants the financial sector to address climate-related risks, but fails to appropriately address the same risks in its own operations. On the other hand, central banks have a monetary policy (and not a climate or ESG) mandate for their policy portfolios, and also do not want to influence markets with their investment policy and operate as neutrally as possible.

The SNB's policy portfolio mostly consists of currency reserves and is large by all standards. At the end of 2020, the SNB held foreign currency reserves in the total amount of CHF 910 billion.<sup>2</sup> Equity investments represent

<sup>&</sup>lt;sup>2</sup> The SNB's foreign currency reserves arose from the frequent currency interventions made to fulfill its monetary policy mandate since 2011, in particular during the period of the enforcement of a minimum exchange rate visà-vis the euro between 2011 and 2015.

20% of the currency reserves and the SNB's equity portfolio of approximately CHF 180 billion makes the SNB an important global equity investor. According to its annual reports, the SNB manages its equity portfolio passively, based on a strategic benchmark comprising a combination of equity indexes in various markets. It does not invest in systemically important banks worldwide (for obvious conflicts of interest reasons) and in companies that seriously violate fundamental human rights, systematically cause severe environmental damage, or are involved in the production of internationally condemned weapons. Other ESG aspects are deliberately not considered, and the SNB is frequently criticized for the lack of a more pro-ESG portfolio management approach.

An important question is what the ultimate goal of an ESG-conscious investment approach is. Bonnefon et al. (2022) provide a useful summary of the two main views of investors' ethical preferences. They distinguish between value-alignment and impact-seeking preferences. An investor with value-alignment preferences has an aversion to owning shares of companies that do not have a business model in line with her own moral values. An investor with impact-seeking preferences values the social consequences of her own investment decisions (also known as additionality). For example, a value-alignment investor is content excluding carbon-intensive firms from her portfolio. An impact-seeking investor wants to invest in a way such that carbon-intensive firms reduce their carbon emissions. Some financial economists and more and more proponents of sustainable finance believe that additionality is a quintessential component of a climate-conscious investment approach, because it is the only way to reduce global emissions.

Yet, it is not obvious how to characterize the preferences and the role of the Swiss National Bank as an investor and as a public institution. The fact that the SNB excludes companies from its portfolio that are involved in the production of condemned weapons, or violate human rights speaks for valuealignment preferences, where the values are defined by those of the Swiss society. However, some proponents of a more active role of the SNB in the ESG debate voice views that are more in line with impact seeking and additionality.

We discuss different climate conscious investment styles that range from negative screening over best-in-class/tilting to shareholder engagement and thematic impact investing and conclude that screening and tilting approaches are particularly well suited for central banks because they do not require politically delicate assessments of individual companies. More active strategies, such as shareholder engagement with individual companies or thematic impact investment that are more consistent with additionality, also may be difficult to reconcile with the current primary mandate of the SNB, which is to ensure price stability.

We believe there are two main reasons a more active exclusion or a tilting policy, especially climate-related, may be permissible under the current mandate of the SNB. First, central banks seem to have reached a consensus that climate change is a threat to financial stability (Bolton et al. 2020). In particular, the transition to a low-carbon economy could imply that a large fraction of reserves of fossil fuels cannot be extracted. The resultant fall (if currently mispriced) in the value of firms involved in fossil fuel extraction would negatively affect the value of the SNB's portfolio. Adopting a precautionary principle to the management of these climate-related financial risks may imply the exclusion, or at least, the downweighting of such firms in the portfolio. Second, in its 2020 annual report, the SNB announced that it would from now on exclude companies primarily active in the mining of coal from its portfolio, following the broad consensus in Switzerland in favor of phasing out coal. This decision suggests that the SNB can adopt a more expansive exclusion policy within its current mandate if it believes that there is sufficient consensus (value alignment) in Swiss society.

Of the many different ESG issues, we focus on carbon emissions because of the climate emergency and media attention. In addition, the Greenhouse Gas (GHG) Protocol established a comprehensive global standardized framework to measure and manage emissions, and many publicly listed companies report their carbon emissions, according to the GHG Protocol (Greenhouse Gas Protocol 2004).

We first compare the carbon footprint of the SNB's portfolio to that of two benchmark portfolios. Finding the proper benchmark is not obvious; no other central bank holds an equity portfolio of a similar size, and other central banks have only just begun to implement or consider implementation of green tilts of their corporate bond policy portfolios (e.g., the Bank of England or the European Central Bank). We use the portfolio of the world's largest asset manager, BlackRock, as well as the portfolio of the Norwegian Government Pension Fund Global (GPFG), Norway's sovereign wealth fund, as benchmark portfolios.

Most of Blackrock's assets under management (AUM) are in passive, index-tracking portfolios and thus are invested similar to SNB's AUM. Blackrock has issued statements suggesting they offer investment products consistent with value-aligned preferences. We will describe these statements in detail later. BlackRock is also very large and visible, and their experimentation with a more active environmental portfolio management approach has recently revealed important reputation risks. For example, BlackRock was part of a list of financial companies that, in the view of Texas Comptroller Glenn Hegar, boycott Texan energy companies and should be banned from doing business with, among other entities, Texas public pension funds. Hegar's official statement is exactly the type of statement in which a central bank would not want to be mentioned.<sup>3</sup>

<sup>&</sup>lt;sup>3</sup> In the statement, Hegar is quoted as follows: "The environmental, social and corporate governance (ESG) movement has produced an opaque and perverse system in which some financial companies no longer make

We believe that GPFG is also a good benchmark, because it is large and visible, is well known for its ESG-conscious approach, and is managed by the investment arm of Norges Bank, the Norwegian central bank, although GPFG is of course not the portfolio that arises from the monetary policy mandate.<sup>4</sup> The primary GPFG management objective is to generate the highest possible return net of costs, but an additional mandate is that responsible management shall form an integral part of the investment portfolio strategy. Responsible management is defined in accordance with internationally recognized principles and standards. Exclusion decisions are based on recommendations from a Council on Ethics, which is an independent body appointed by the Ministry of Finance. We show that GPFG's preferences are likely somewhere between value-based and impact seeking. The governance and investment mandate of the GPFG, with formal rules following internationally recognized principles, also could be a politically feasible model for central banks' own portfolio management. In fact, the equity portion of Norges Bank's foreign exchange reserves (i.e., part of its policy portfolio) is managed according to guidelines similar to those governing the GPFG (NGFS 2019b, p. 24).

In our empirical analysis, we use Standard and Poor's (S&P) Trucost data to attribute the Scope 1—2 carbon emissions of U.S. companies to their equity investors.<sup>5</sup> We find that the SNB "owns" approximately 7.9 million tonnes (metric tons) of carbon through its U.S. equity investments in 2020. In terms of carbon footprint (carbon emissions per million U.S. dollar invested), the SNB's portfolio does as well as BlackRock's once one accounts for the fact that the SNB does not invest in large systemic banks, which have low Scope 1—2 carbon emissions. The SNB's portfolio has a significantly worse carbon footprint than the more actively managed portfolio of GPFG.

We examine several carbon-conscious strategies, based on the carbon intensity (carbon emissions per million U.S. dollars of revenue) of portfolio companies. We first show that a small subset of portfolio companies has a particularly large environmental impact. In 2020, the 20 (118) portfolio firms with the highest carbon intensity correspond with 1% (5%) of the market value of the SNB's U.S. equity portfolio, but cause 27.3% (61.7%) of its carbon emissions.

The first strategy we discuss is a global exclusion strategy, in which the SNB divests the companies with the highest carbon intensity, and overweights

decisions in the best interest of their shareholders or their clients, but instead use their financial clout to push a social and political agenda shrouded in secrecy." See Texas Comptroller of Public Accounts (2022).

<sup>&</sup>lt;sup>4</sup> Norges Bank conducts Norway's central banking operations. Norges Bank Investment Management (NBIM) has a separate investment mandate from the Norwegian Ministry of Finance to manage Norway's sovereign wealth fund GPFG.

<sup>&</sup>lt;sup>5</sup> Our empirical analysis focuses on the carbon footprint of the SNB's U.S. equity portfolio. The SNB generally does not disclose detailed holdings data of its portfolio. The exception is the U.S. equity portfolio, because the U.S. regulator forces the SNB to disclose its holdings of all publicly listed U.S. companies. The SNB's U.S. equity portfolio was valued at approximately CHF 130 billion at the end of 2020, representing 74% of the total value of the global equity portfolio and 14.4% of the total currency reserves of the SNB.

companies with the lowest carbon intensity. In 2020, the exclusion of the 20 companies mentioned above, from a portfolio of 2,064 companies, would reduce financed carbon emissions by 27.3%. The exclusion of the 118 companies with the highest intensity would reduce financed carbon emissions by 61.7%.

The SNB replies to requests for a more environmentally active approach that it is not its mandate and that it is not allowed to disadvantage specific economic sectors.<sup>6</sup> We therefore examine two additional strategies that maintain sectoral balance.

The first strategy is global exclusion with sectoral best-in-class reinvestment. With this strategy, the SNB would exclude firms with the highest carbon intensities overall and reinvest in companies with the lowest carbon intensities in the same sectors as the excluded firms. Such a strategy maintains the sectoral exposure of the portfolio and retains all diversification benefits. Following this strategy and excluding the same 20 most polluting firms and reinvesting the proceeds in the least polluting firms in the same sectors leads to a reduction of the total financed carbon emissions by 24.9% in 2020 (52% for the same 118 companies).

Alternatively, the SNB could exclude, in each sector, the same proportion of firms with the highest sector-specific carbon intensities, and reinvest the proceeds in the best-in-class companies in that sector. We show that such a strategy has relatively little impact on total emissions because the most polluting companies are concentrated in a few sectors (utilities, energy, and materials).

None of the strategies we analyze would meaningfully affect the overall performance of the SNB's portfolio and hence would not have affected the annual distributions of the SNB to its stakeholders. We find that the annual return differences arising from our carbon emission reduction strategies are less than 0.1%. As the list of the companies with the worst environmental impact is also stable across the years, and our strategies would exclude few companies, we estimate that the cost of implementation is small.

In a robustness test, we also investigate carbon emissions reduction strategies based on the carbon footprint (carbon emissions per million U.S. dollars of market capitalization) instead of the carbon intensity. We find economically and statistically similar results.

Overall, a global exclusion and sectoral reinvestment (best-in-class) strategy would be very effective at greening the SNB's portfolio and may potentially be carried out within the current mandate. However, the strategy is a

In its annual report 2021, the SNB states: "It should be noted that the constitutional and legislative authorities have deliberately not tasked the SNB with using its asset management activities to selectively influence the development of certain economic sectors. The SNB's investment policy therefore cannot be geared to pursuing structural policies, i.e. advantaging or disadvantaging specific economic sectors via positive or negative selections, or promoting or inhibiting economic, political or social change." See the SNB's 2020 annual report (SNB 2021, p. 95).

value-alignment strategy and does not provide additionality, because the SNB would execute the trades to implement its exclusion strategy in secondary markets, and hence sell the shares of high carbon intensity companies to different investors, with little direct impact on the polluting companies.

## 1. Central Banks' Own Portfolios and Climate Change

The NGFS encourages the finance community to play a key role in addressing climate change, and believes central banks have a responsibility to provide leadership and to help coordinate international efforts along this endeavor. As leadership requires leading by example, the NGFS published a sustainable and responsible investment (SRI) guide for central banks' own portfolio management (NGFS 2019b), in which it described SRI objectives, strategies, and monitoring and reporting for central banks' own portfolios.<sup>7</sup> In this section, we first define the policy portfolio of a central bank and its underlying primary mandate. We then develop the different possible SRI objectives for the policy portfolio of a central bank as well as the benchmark portfolios. We finally assess the applicability to central banks of different strategies to reduce portfolio carbon emissions, and relate them to the large academic literature on ESG investments.

### 1.1 Climate considerations versus policy mandates

Although the NGFS distinguishes between different portfolios of central banks (e.g., policy portfolios, pension portfolios, or third-party portfolios), we focus in our paper on the policy portfolio because it is typically the largest central bank portfolio and also the area with potentially the most tension between a monetary policy mandate and climate actions. Policy portfolios are held for foreign exchange intervention, asset purchase programs, or other monetary policy goals. The investments of the policy portfolios must meet high standards with respect to liquidity and credit quality, and are governed by a mandate. As one example, consider how the SNB states in various publications the primacy of its monetary policy mandate and the implications for its asset management: "The Swiss National Bank (SNB) conducts the country's monetary policy as an independent central bank. [...] Its primary goal is to ensure price stability [...] Asset management is governed by the primacy of monetary policy."<sup>8</sup> Any SRI strategy must be consistent with the primary mandate.

<sup>&</sup>lt;sup>7</sup> The NGFS also argues that climate change is of importance to central banks, because climate change will affect the central banks' price stability mandate. Boneva, Ferrucci, and Mongelli (2021) provide many examples of why climate change may threaten price stability, from greater macroeconomic uncertainty over supply shocks to stranded assets affecting growth. Here, we focus on climate change and the policy portfolios of central banks.

<sup>&</sup>lt;sup>8</sup> See SNB (2022).

Similarly, the European Central Bank (ECB) announced in July 2021 its Monetary Policy Strategy Review (MPSR). It clearly states that the primary objective of the ECB is to maintain price stability in the euro area. Climate change and the policy portfolio are explicitly mentioned, but not until the second-to-last point of the MPSR.<sup>9</sup> Executive board member Isabel Schnabel reflected in several speeches on whether central banks should or could consider climate change in their monetary policy operations.<sup>10</sup> While the ECB eventually decided to implement a green tilt in corporate sector asset purchases (more below), she also explained the limits for the ECB: "Clearly, the ECB cannot be transformed into an environmental agency conducting climate policies autonomously. [...] The ECB was created to maintain price stability in the euro area, and the mandate foresees a clear hierarchy of objectives, with price stability taking precedence over other objectives."

## 1.2 SRI objectives for a central bank's policy portfolio

The two reports on sustainable and responsible investments for central banks' portfolio management (NGFS 2019b; NGFS 2020b) survey central banks on their motivations to implement SRI in their portfolios (with 27 participating central banks in 2019, and 42 in 2020). Table 1 shows the results of the survey.

We derive three important observations from the table. First, central banks seem to want to lead by example, and they are worried about reputational risks vis-à-vis their own constituents if they invest in companies that are in the headlines for a negative environmental impact. Second, central banks are concerned about the potential negative impact on the performance of their portfolios arising from physical or transition risks. Third, generating a positive impact is not among the core priorities of central banks when it comes to socially responsible investments in their own portfolios. The survey results of Table 1 are helpful for making inferences about the preferences of central banks. Bonnefon et al. (2022) distinguish between value-alignment and impact-seeking preferences. An investor with value-alignment preferences has an aversion to owning shares of companies that do not have a business model in line with her own moral values. An investor with impact-seeking preferences has a concern about additionality, or the social consequences of her investment decisions. An investor who is concerned about the potential negative impact of climate-related risks on her portfolio is somewhere in the middle. She thinks about the consequences of, for example, excessive fossil

<sup>&</sup>lt;sup>9</sup> In its review, the ECB states that "Climate change has profound implications for price stability through its impact on the structure and cyclical dynamics of the economy and the financial system. [...] the Governing Council will adapt the design of its monetary policy operational framework in relation to disclosures, risk assessment, corporate sector asset purchases and the collateral framework."

<sup>&</sup>lt;sup>0</sup> See some speeches made by Schnabel (2021a,b) in 2021.

#### Table 1 NGFS SRI survey

Motivation for SRI	2020 rank	2019 rank
Reputational risk	1	1
To set a good example	2	3
Protecting against sustainability risks	3	2
(e.g., physical or transition risks)		
Enhancing the risk-return profile	4	4
Complying with international standards	5	6
or frameworks		
Generating positive impact (e.g., by	6	N/A
investing in line with the Paris Agreement, SDGs)		
Required by beneficiaries / stakeholders	7	5
Fiduciary duty	8	7
Other	9	8
Legal requirements	10	N/A

Motivations for socially responsible investing (SRI) as ranked by central banks in the 2019 and 2020 surveys of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) *Sources*: NGFS (2019b, 2020b).

fuel consumption, but the main concern is about her own portfolio's bottom line, not the societal impact of the resultant emissions.

Bonnefon et al. (2022) argue that value-alignment preferences are often modeled in the portfolio choice literature (e.g., Heinkel, Kraus, and Zechner 2001; Pastor, Stambaugh, and Taylor 2021; Pedersen, Fitzgibbons, and Pomorski, 2021). For example, in the model of Pastor, Stambaugh, and Taylor (2021), agents derive utility from holding green firms and disutility from holding brown firms. In equilibrium, green assets have low expected returns because investors enjoy holding them and because green assets hedge climate risk. Note that in their model, there is a positive aggregate impact through a cost of capital channel, even though agents do not have direct preferences for it. Similarly, Heinkel, Kraus, and Zechner (2001) find in an equilibrium model with polluting firms that negative screening reduces the pool of available investors, which limits risk sharing and increases the cost of capital.

Models of impact-seeking preferences and investments assume that corporate externalities enter an investor's utility function unconditional of the stocks they own (examples include Oehmke and Opp 2022; Broccardo, Hart, and Zingales 2021; Landier and Lovo 2020). For example, in the model of Oehmke and Opp (2022) a necessary condition for impact is that socially responsible investors internalize the social costs generated by firms regardless of whether they are actual investors in these firms. Similarly, to explain social action, Broccardo, Hart, and Zingales (2021) assume that some investors are socially responsible in the sense that they put a positive weight on the wellbeing of others affected by the investment decision.

Based on the survey results in Table 1, we believe that, currently, the preferences of participating central banks can be better described as value-

alignment preferences (and risk management) rather than impact-seeking preferences. The Swiss National Bank is quite specific in its 2021 annual report when it describes nonfinancial factors that influence portfolio selection: "The SNB also takes account of Switzerland's fundamental standards and values in its investment policy" (SNB 2022).

## 1.3 SRI objectives of the benchmark portfolios

Blackrock states on its website that "Our investment conviction is that climate risk is investment risk, and that integrating climate and sustainability considerations into investment processes can help investors build more resilient portfolios and achieve better long-term, risk-adjusted returns."<sup>11</sup> The statement suggests to us that, at the overall family level, Blackrock thinks about ESG as an input into the investment process, and not as an output as would be required for impact-seeking preferences. Partially driven by the recent public controversies, such as the one mentioned in the introduction, Larry Fink, CEO of Blackrock, was quite careful in discussing Blackrock's view on corporate sustainability in his 2022 letter to CEOs of portfolio companies.<sup>12</sup>

Overall, Blackrock offers different solutions to different clients. Blackrock's clients can choose passive portfolios that align their investments with their values. There might even be products that satisfy investors with impact-seeking preferences. But Blackrock as a whole does not use its clout for a consistent push toward additionality.

NBIM, as the administrator of GPFG, states on its web page that its motivation for responsible investment is to achieve the highest possible return with moderate risk. NBIM excludes companies based on clear criteria and maintains a public list of excluded companies, including the reason for exclusion.<sup>13</sup> Exclusion recommendations are made by an independent body, the Council on Ethics.<sup>14</sup> The charter of the council and the governance model leading to exclusion speak for value-based preferences.

However, NBIM went one step further in September 2022 and announced its climate action plan 2025.<sup>15</sup> In the plan, NBIM outlines how it will work with portfolio companies on a plan toward net zero. Crucially, as the climate

<sup>&</sup>lt;sup>11</sup> See https://www.blackrock.com/ch/individual/en/themes/sustainable-investing.

<sup>&</sup>lt;sup>12</sup> In his letter, Fink writes that "We focus on sustainability not because we're environmentalists, but because we are capitalists and fiduciaries to our clients. That requires understanding how companies are adjusting their businesses for the massive changes the economy is undergoing. As part of that focus, we are asking companies to set short-, medium-, and long-term targets for greenhouse gas reductions. These targets, and the quality of plans to meet them, are critical to the long-term economic interests of your shareholders. [...] Divesting from entire sectors — or simply passing carbon-intensive assets from public markets to private markets — will not get the world to net zero. And BlackRock does not pursue divestment from oil and gas companies as a policy. We do have some clients who choose to divest their assets while other clients reject that approach." See https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter, accessed April 20, 2023.

<sup>13</sup> https://www.nbim.no/en/the-fund/responsible-investment/exclusion-of-companies/.

<sup>14</sup> https://etikkradet.no/en/.

<sup>&</sup>lt;sup>15</sup> https://www.nbim.no/en/the-fund/responsible-investment/2025-climate-action-plan/.

action plan mentions, "We believe that our engage-to-change approach will yield the best financial results for the fund. It will also contribute to improved real-world outcomes." The climate action plan explicitly mentions additionality as a byproduct of the effort to mitigate risks and achieve high financial returns and is thus, at least partially, consistent with impact-seeking preferences.

### 1.4 SRI strategies for central banks' policy portfolios

Amel-Zadeh and Serafeim (2018) survey investors on how they use ESG information, and classify different investment styles. These styles range from negative screening, that is, not investing in companies that do not meet specific ESG criteria, over best-in-class, that is, investing in companies that perform better on ESG criteria than their competitors do, over shareholder engagement to thematic impact investing. The NGFS guide on SRI in central banks' own portfolio management (NGFS 2020b) uses a similar classification of investment styles.

**1.4.1 Negative screening.** Hong and Kacperczyk (2009) report that managers of institutions, such as pension funds and endowments, have screened their investments to rule out sinful stocks, such as alcohol, tobacco, and gaming companies, for more than 20 years. The global sustainable investment alliance reports that negative screening is among the most commonly applied sustainable investment strategies (Global Sustainable Investment Alliance 2018). McCahery, Sautner, and Starks (2016) document widespread governance-motivated exits among institutional investors. Gibson et al. (2020) report on the tools used by signatories of the Principles for Responsible Investment (PRI) and show that negative screening is one of the most commonly applied tools.

Does negative screening affect the cost of capital? Fabozzi, Ma, and Oliphant (2008) and Hong and Kacperczyk (2009) find a positive abnormal return for sin stocks and Bolton and Kacperczyk (2021) find a positive abnormal return for carbon-intensive firms. Their evidence seems to confirm that carbon-intensive firms need to compensate investors for their exposure to carbon emission risk. Berk and van Binsbergen (2022) though caution, through a calibration of their model to current data, that the change in the cost of capital that results from a divestiture strategy is too small to meaningfully affect real investment decisions.

Central banks worry with negative screening about losing the benefit of diversification if they exclude too many firms or entire sectors. Central banks also worry about market neutrality and unduly influencing markets when considering exclusion filters. When central banks apply negative screens, they tread carefully and often set their exclusionary filters on the basis of (inter)national laws, conventions, principles, and standards, such as the international treaties on controversial weapons (NGFS 2020b). Often, the decision to exclude companies is outsourced to specialized providers.<sup>16</sup>

**1.4.2 Best-in-class/tilting approaches.** Best-in-class is an approach to sustainable investing that focuses on investing in companies that perform better on sustainability issues than their peers do (Amel-Zadeh and Serafeim 2018). An alternative but similar approach is to strategically tilt the weight of securities with a high sustainability rating while maintaining minimal exclusions.

The European Central Bank has recently considered best-in-class and tilting approaches for their bond policy portfolios, and how such approaches would be consistent with market neutrality. Market neutrality has been historically implemented by purchasing corporate bonds in proportion to outstanding quantities of bonds to keep relative prices across securities the same. Yet, Papoutsi, Piazzesi, and Schneider (2022) use micro data on bond holdings, firm characteristics and emissions to show that the ECB's corporate bond portfolio is tilted toward brown sectors relative to a market portfolio of sectoral capital stocks, mainly because brown firms are much more likely to access bond markets. Schoenmaker (2021) develops a method to tilt the European Central Bank's (ECB) asset and collateral framework toward low-carbon assets. He finds that a careful tilting approach that does not interfere with the transmission mechanism of monetary policy can reduce carbon emissions in the ECB's corporate and bank bond portfolio by over 50%.

Bremus, Schuetze, and Zaklan (2021) and Eliet-Doillet and Maino (2022) show that the announcement of the ECB that it will consider a green tilt of its Corporate Sector Purchase Programme portfolio had an effect on yields in the European green bond market and thus on companies' cost of capital. It suggests that a central bank can potentially influence allocation of capital to green projects through its monetary policy tools.

The Bank of England has a similar monetary policy tool, the Corporate Bond Purchase Scheme (CBPS), that purchases investment grade sterling corporate bonds. In March 2021, the Chancellor of the Exchequer announced that the economic strategy of the U.K. Government, which the monetary policy committee is expected to support as a "secondary objective," includes supporting the transition to a net zero emission economy. With such a secondary objective, the Bank of England could adjust its CBPS portfolio to

<sup>&</sup>lt;sup>6</sup> For example, at the SNB the process for the exclusion of companies that violate fundamental human rights, cause severe environmental damage, produce condemned weapons, or have a business model primarily based on coal mining is as follows: "A specialised external service provider reviews the SNB's investment universe to specifically identify companies involved in the manufacturing of condemned weapons. With regard to companies that focus on coal mining, the SNB bases its assessment on a classification by a specialised index provider. Companies that fall under other exclusion criteria are identified in a two-phase process. The first phase consists of examining and processing public information in order to identify companies whose activities are very likely to fall under the exclusion criteria. During the second phase, a detailed assessment is performed on each identified company to ascertain whether it should be excluded or not. The SNB relies on the recommendations made by the specialised external service providers in deciding on the exclusion of companies, and reviews its decisions on a regular basis."

support the transition to net zero, without undermining its primary monetary policy purpose. It did so by announcing to tilt future CBPS purchases within sectors toward the debt of eligible firms that are performing relatively strongly in support of net zero.

Some central banks are also open to a best-in-class approach in equities, albeit within their pension portfolios (and not policy portfolios). The NGFS (NGFS 2020b) reports that some central banks optimize the carbon footprint of some portfolios, aiming for a lower footprint than the benchmark.

**1.4.3 Voice channel and ESG shareholder proposals.** Investors can voice their preferences, either actively through individual meetings with a firm's management or more passively through voting on shareholder proposals at annual general meetings (AGMs). A subset of large shareholders, so-called "activist investors," go further and attempt to replace the board or management if the company does not respond to their demands.

Passive investors tend to use the AGM voice channel at scale; that is, they voice general preferences for certain corporate and governance aspects in published guidelines rather than use a case-by-case approach that would require in-depth analysis of firm-specific data to engage individual firms. Researchers have shown that these guidelines can have an indirect effect on corporate governance because corporations monitor what their largest institutional investors want, and because other, more active investors can engage with companies, knowing that institutional investors will support certain of their initiatives (Appel, Gormley, and Keim 2016; Couvert 2020; Gormley et al. 2021).<sup>17</sup>

Central banks as quasi-public institutions will not be able to actively voice their opinions, let alone be activist investors. A passive strategy based on proxy voting guidelines could be possible, however, and could be actually quite appealing for central banks, because they do not have to engage with individual companies directly but rather publish high-level guidelines. NGFS (2020a) reports that such guidelines, together with the outsourcing of the actual voting to a third-party specialist, is considered by several central banks a viable strategy. The SNB follows such a strategy, but only for the European equity securities in its portfolio.<sup>18</sup>

The last several years have witnessed an increase in shareholder proposals regarding environmental issues. Most of the proposals however only ask

<sup>&</sup>lt;sup>17</sup> For example, Gormley et al. (2021) describe how, in 2017, the "Big Three" institutional investors (BlackRock, State Street, and Vanguard) launched campaigns to increase gender diversity on corporate boards threatening to vote against directors at AGMs if the slate of director candidates was all male.

<sup>&</sup>lt;sup>18</sup> In its 2020 annual report, the SNB states: "In exercising its voting rights, the SNB focuses on mid-cap and large-cap companies in Europe and also works with external service providers to this end. The voting procedure is based on the SNB's internal guidelines for exercising voting rights. The external service providers are tasked with interpreting the guidelines for exercising voting rights and applying them to the proposals being put forward at the shareholders' meetings. The SNB is in regular contact with the external service providers and monitors the correct interpretation of the guidelines for voting rights." (SNB 2021).

companies to disclose more information. For example, of the 400 environmental shareholder proposals submitted to AGMs of U.S. publicly listed companies in 2018 (as classified by Institutional Shareholder Services), the most common environmental proposals were "Report on Environmental / Sustainability / Water Impact of Operations" (41 proposals) or "Disclose Climate Change / Greenhouse Gas Emissions" (33 proposals). Proposals rarely ask for implementation of concrete goals related to environmental and social issues (e.g., reduce carbon emissions by 20%). One potential explanation for the lack of such proposals is that the U.S. Security and Exchange Commission (SEC) can grant management the right to exclude proposals from the annual general meeting if they relate to the company's ordinary business operations (Rule 14a-8(i)(7)).<sup>19</sup>

Finally, the proxy fight at Exxon in May 2021 showcased an interesting, and potentially feasible voice mechanism for passive investors. The environmental activist fund Engine 1 secured several board seats with the support of large passive investors voting in favor of Engine 1's director candidates at the AGM.<sup>20</sup>

### 2. Data and Methodology

Our data sources are Standard and Poor's (S&P) Capital IQ and Trucost databases for equity portfolio holdings and carbon emissions, respectively. The performance of individual stocks is based on the total return index (including dividend payments), available from Refinitiv.

## 2.1 Equity portfolio holdings

We obtain annual snapshots of the equity portfolios of the SNB, the Norwegian Oil Fund (GPFG) as well as BlackRock from December 2013 to December 2020. We chose December 2013 as a start date because the SNB began to build a diversified equity portfolio in 2012 and to invest significantly in U.S. equities in 2013.

The source of the S&P Capital IQ data on the U.S. equity portfolios of the above three entities is Form 13F of the U.S. Securities and Exchange Commission (SEC).<sup>21</sup> The SEC only requires institutional investment managers to report on their Section 13(f) securities, which primarily include U.S. exchange-traded stocks, shares of closed-end investment companies, and

<sup>&</sup>lt;sup>19</sup> For an example, see https://www.sec.gov/divisions/corpfin/cf-noaction/14a-8/2020/activehomeexxon030620-14a8.pdf.

<sup>&</sup>lt;sup>20</sup> See https://www.bloomberg.com/news/articles/2021-03-18/exxon-activist-reveals-high-30-million-cost-ofboardroom-battle.

<sup>&</sup>lt;sup>21</sup> Institutional investment managers that exercise investment discretion over \$100 million or more in Section 13(f) securities must file Form 13F. The SEC specifies explicitly that governments or political subdivisions, agencies, or instrumentality of government are also considered institutional investment managers under the Securities Exchange Act and have to file.

shares of exchange-traded funds (ETFs).<sup>22</sup> The SNB, for example, does not file most of its non-U.S. equity holdings.

The SNB mentions in its annual report 2020 (p. 93) that "[...] at the end of 2019, the equity portfolio comprised mostly shares of mid-cap and large-cap companies in advanced economies. Shares of small-cap companies in advanced economies and shares of companies in emerging economies were also held. This resulted in a globally well-diversified equity portfolio of around 6,700 individual shares." The 2020 annual report further specifies that the equity portfolio represented 20% of the total foreign exchange reserves, and that the foreign exchange reserves were valued at CHF 900 billion at the end of 2020. We deduce that the value of the SNB's equity portfolio was approximately CHF 180 billion at the end of 2020. Capital IQ reports SNB's holdings of 2,767 stocks for Q4 2020 with a total market value of \$150.8 billion, which at the exchange rate at the end of 2020 translates into CHF 132.8 billion. Hence, our data capture 41% of the number of stocks and 73.8% of the total equity portfolio value of the SNB's equity portfolio.

As the SNB data available in Capital IQ only include a relatively small portion of non-U.S. firms, we exclude them from the analysis. Finally, we exclude firms for which carbon data are not available. Our final sample consists of 2,064 companies (31% of the total number of stocks of the SNB) and \$126.7 billion (62% of the total equity portfolio value) in 2020.

The SNB excludes systemically important financial institutions from its portfolio. As banks have relatively low Scope 1–2 emissions, the SNB therefore has, by construction, a worse carbon profile than our benchmark portfolios.<sup>23</sup> To make the portfolios more comparable, we therefore remove banks from the benchmark portfolios as well.<sup>24</sup>

We also remove non-U.S. equity securities for BlackRock and GPFG from our analysis to facilitate comparisons with the SNB portfolio. At the end of 2020, the holdings reported in Capital IQ represent 9,030 firms with a total market value of \$961.6 billion for GPFG and 13,020 firms with a total market value of \$4,322 billion for BlackRock. Considering U.S. equity securities with carbon data only, our final sample contains 1,683 firms with a market value of \$379.2 billion for GPFG and 2,914 firms with a market value of \$2,748.7 billion for BlackRock. We also use the U.S. MSCI index, which is a marketcapitalization weighted portfolio of medium-size and large-size firms (621 U.S. firms at the end of 2020), as a benchmark in our analysis.

<sup>&</sup>lt;sup>22</sup> Investment managers do not have to report their short positions. However, the SNB does not short stock.

<sup>&</sup>lt;sup>23</sup> Table A1 in the appendix displays the number of firms and the relative weights of each sector in the SNB, GPFG, BlackRock and MSCI portfolios, based on firms for which carbon data are available.

<sup>&</sup>lt;sup>24</sup> More precisely, we exclude firms in the "Diversified Banks," "Investment Banking and Brokerage," and "Multi-Sector Holdings" primary industries.

## 2.2 Carbon emissions data

Our analysis of the portfolio carbon footprints relies on annual data from S&P Trucost. This data set covers a large number of firms globally (from 5,628 in 2013 to 17,269 in 2020) and provides information on three scopes of carbon emissions. Scope 1 refers to the GHG emissions generated from burning fossil fuels and production processes, which are owned or controlled by the company (direct emissions). Scope 2 relates to the GHG emissions from consumption of purchased electricity, heat, or steam by the company (first-tier indirect emissions). Scope 3 relates to other (upstream and downstream) indirect greenhouse gas emissions, such as from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, and electricity-related activities not covered in Scope 2. Data are provided in terms of emissions (in tonnes of  $CO_2$  equivalent) and intensity (in tonnes of  $CO_2$  equivalent per million U.S. dollars of revenue).

In our analysis, we focus on the sum of Scope 1 and Scope 2 (Scope 1–2 from hereon) emissions for two reasons. First, the availability and quality of Scope 3 emissions data are not as good as for Scope 1–2 emissions. Scope 3 emissions often need to be estimated by the data provider because of the lack of information reported by firms. Usually, only Scope 3 upstream emissions are measured, while downstream emission estimates are very scarce.<sup>25</sup> Second, Scope 3 emissions of some industries are often Scope 3 emissions of other industries. As a well-diversified portfolio includes firms from all industries, including Scope 3 emissions would overestimate the actual portfolio carbon footprint.

**2.2.1 Total carbon emissions.** We assign the total reported carbon emissions to the equity owners of the respective company. If a fund owns 2% of the equity of a corporation, it "owns" 2% of its emissions. The advantage of the total carbon emissions approach is that we gain an idea of the magnitude of the financed carbon emissions, and do not report a relative number that allows for a comparison across portfolios but is otherwise difficult to interpret.

We compute the carbon emissions of the portfolio by multiplying the emissions of each firm in the portfolio by the fraction of the market capitalization of the firm held by the SNB.

The total market values of the portfolios of our benchmarks, BlackRock and GPFG, are larger than that of the SNB, and are therefore mechanically assigned more carbon emissions. Whenever we compare the total carbon emissions of those three entities, we rescale the value of the portfolios of GPFG and BlackRock to the size of the SNB's portfolio, at the end of each year.

<sup>&</sup>lt;sup>25</sup> Trucost provides information regarding Scope 3 downstream emissions, but not before 2017.

**2.2.2 Portfolio carbon metrics.** We follow the recommendation of the Task Force on Climate-related Financial Disclosures to evaluate the carbon exposure of a portfolio (TCFD 2017).<sup>26</sup> The metric recommended by the TCFD is the (weighted-average) *carbon intensity*, which measures the portfolio's exposure to carbon-intensive companies, expressed in tonnes of  $CO_2$  equivalent per million U.S. dollars of revenue. It is defined as

$$CI_t^{(p)} = \sum_{i=1}^{N_t} w_{i,t}^{(p)} \frac{E_{i,t}}{Rev_{i,t}},$$
(1)

where  $E_{i,t}$  represents the carbon emitted by firm *i* in year *t*,  $Rev_{i,t}$  represents the revenue generated by the firm *i* in year *t*, and  $w_{i,t}^{(p)}$  is the weight of firm *i* in the portfolio. The portfolio weight is defined as  $w_{i,t}^{(p)} = V_{i,t}^{(p)} / V_t^{(p)}$ , where  $V_{i,t}^{(p)}$  is the dollar value invested in firm *i* and  $V_t^{(p)} = \sum_{i=1}^{N_t} V_{i,t}^{(p)}$  is the dollar value of the portfolio.  $N_t$  denotes the number of firms in the portfolio.

The carbon footprint of a portfolio (also called "financed emissions") measures the amount of annual carbon emissions that can be allocated to the investor per million U.S. dollars invested in the portfolio. It is measured as

$$CF_t^{(p)} = \frac{1}{V_t^{(p)}} \sum_{i=1}^{N_t} o_{i,t}^{(p)} E_{i,t}.$$
(2)

where  $o_{i,t}^{(p)} = V_{i,t}^{(p)} / Cap_{i,t}$  represents the equity ownership in firm *i* in year *t*, with  $Cap_{i,t}$  being the market capitalization of firm *i* in year *t*.

#### 2.3 Caveats

First, companies are financed with debt and equity, yet our main approach assigns carbon emissions to the equity owners only. An alternative is to distribute the carbon emissions to all financiers of the corporation, that is, to lending banks, holders of corporate debt, and equity holders, in proportions corresponding to the market value of their claims as a fraction of total firm value. These calculations would require details on the owners of corporate debt and the providers of bank financing, to which we do not have access.

Second, the Scope 2 emissions of one company may be the Scope 1 emissions of another company in a well-diversified portfolio, and our analysis double-counts them. Hence the total carbon emissions we attribute to the SNB's portfolio may be overstated. Such double-counting is particularly challenging for the energy sector. For example, an industrial company may report Scope 2 emissions that are released at the facility where the electricity is generated (i.e., the power plant). The power plant itself would report these emissions as Scope 1. If the SNB owns both the industrial company that

<sup>&</sup>lt;sup>26</sup> Some research suggests going even further by assessing the alignment of a portfolio with a temperature trajectory as described by the Paris Agreement. See, among others, Germanwatch and NewClimate Institute (2018) and Institut Louis Bachelier et al. (2020).

purchases and consumes the energy and the power plant that generates it, we count the emissions caused by the energy generation twice. In a robustness test, we assess the severity of the problem, and redo all of our analysis using Scope 1 emissions only. In general, we find that Scope 1 emissions represent approximately 85% of Scope 1–2 emissions. All the main results of our analysis remain valid if we focus on Scope 1 emissions only.

#### 3. Analysis

#### 3.1 Evolution of carbon metrics across time

We start with the evolution of the carbon intensity and the carbon footprint of the benchmark portfolio (U.S. MSCI index, excluding large banks). For this portfolio, weights in the index are proportional to the market capitalization, so that the carbon footprint simplifies to  $CF_t^{(b)} = \sum_{i=1}^{N_t} E_{i,t} / \sum_{i=1}^{N_t} Cap_{i,t}$ .

Figure 1 reveals that the carbon metrics of the MSCI benchmark index substantially improved over the sample period. The carbon intensity (solid line) decreased from 205.7 tonnes of  $CO_2e$  per million U.S. dollars of revenue in 2013 to 145.7 tonnes in 2020, a 29.2% reduction. The carbon footprint decreased from 128 tonnes of carbon per million U.S. dollars invested in 2013 to 56.4 tonnes in 2020, a 56% reduction. These trends reflect the improvement in the energy efficiency of production processes as well as the growing importance of the low-emissions tech sector. The fact that the carbon footprint decreased more than the carbon intensity can be explained by the larger increase in the market capitalization of U.S. firms relative to the increase in their revenues.

In Figure 2 (panel A), we display the carbon footprint of the portfolios of the SNB, BlackRock, and GPFG and compare them to the carbon footprint of the benchmark index. As we consider entities with the same investment opportunity set (U.S. firms, excluding banks), the measures are comparable across entities. The figure reveals that the carbon footprint of the SNB's and BlackRock's portfolios are larger than the footprint of the GPFG's portfolio and the MSCI index.

Panel B of Figure 2 displays the level of carbon emissions that can be attributed to each of the portfolios. The total emissions of the SNB's portfolio have considerably increased during the period, mainly driven by the increase in the size of its portfolio: The market value of the U.S. equity portfolio has increased by 533% over the sample, while carbon emissions have increased by 137%. Hence, although the carbon footprint of the portfolio improves through time, the SNB "owns" more and more carbon emissions, equal to 7.9 million tonnes in 2020. This number can be compared to the total CO<sub>2</sub> emissions of Switzerland in 2020 of 34.4 million tonnes.<sup>27</sup> The carbon

<sup>&</sup>lt;sup>27</sup> Data are from the Federal Office for the Environment.



Figure 1

#### Carbon metrics for the U.S. MSCI index

The figure displays the Scope 1–2 carbon intensity (in tonnes of  $CO_2e$  per million U.S. dollars of revenue) and carbon footprint (in tonnes of  $CO_2e$  per million U.S. dollars invested) for the U.S. MSCI index (excluding banks). The sample covers the period from 2013 to 2020.

emissions generated by the U.S. portion of the SNB's equity portfolio correspond to approximately 23% of what all of Switzerland has emitted in 2020.

Once rescaled to the same market value of the portfolio, total emissions by BlackRock (8.3 million tonnes in 2020) are slightly above the emissions owned by the SNB. Numbers for GPFG are more favorable, as its total carbon emissions are equal to 5.5 million tonnes in 2020 for the same market value of the portfolio. In other words, for the same portfolio size, the GPFG's portfolio is responsible for 30% less carbon emissions than the SNB's portfolio.

To evaluate the financial performance of the three portfolios during the sample period, we use the portfolio weights at the end of a given year to compute the portfolio return over the subsequent year. Our approach does not calculate the actual portfolio performance because there may be intra-annual rebalancing, which we do not observe. Instead, we obtain the performance, assuming that the number of shares held is constant during the year. Table 2 reports the financial performance of the three portfolios over the 2014–2021 period. We observe that the SNB's portfolio performs slightly better than the other portfolios. Over the sample period, the average return (including dividends) is equal to 15.5% for SNB (with a Sharpe ratio of 0.96), 14.8% for BlackRock (Sharpe ratio of 0.89) and 15.1% for GPFG (Sharpe ratio of 0.88), while the MSCI index return is equal to 15.2% (Sharpe ratio of 0.93).



Figure 2

Carbon metrics for the SNB portfolio versus benchmarks

The figure displays the Scope 1–2 carbon footprint (panel A) and carbon emissions (panel B) for the U.S. equity portfolios of the SNB, GPFG, and BlackRock, as well as the U.S. MSCI index (excluding banks). The footprint is measured in tonnes of  $CO_2$  per million U.S. dollars invested, and emissions are measured in million tonnes of  $CO_2$ . The sample covers the period from 2013 to 2020.

Table 2							
<b>Financial Performance and</b>	Carbon	Emissions	of	SNB's	and	Benchmarks'	Portfolios

	SNB	GPFG	BlackRock	MSCI
Annualized return (in %)	15.5	15.1	14.8	15.2
Annualized volatility (in %)	15.4	16.5	16.1	15.7
Sharpe ratio	0.96	0.88	0.89	0.93
Tracking error (in %)	1.22	1.25	1.30	0.00
Carbon emissions (mln tonnes CO <sub>2</sub> e)	6.18	4.50	6.41	5.47
Carbon footprint (tonnes CO2e/mln \$ invested)	120.1	89.4	121.9	98.3
Carbon intensity (tonnes CO2e/mln \$ revenue)	230.3	154.3	210.7	192.2

The table reports the financial performance and the carbon characteristics (carbon footprint, carbon intensity, and total emissions) of the three sample portfolios and the MSCI index. Carbon footprint is in tonnes of  $CO_2$  equivalents per million U.S. dollars invested. Carbon intensity is in tonnes of  $CO_2$  equivalents per million U.S. dollars invested. Carbon intensity is in tonnes of  $CO_2$  equivalents per million U.S. dollars invested. Carbon footprint, and total emissions are in million tonnes of  $CO_2$  equivalents. SNB is the Swiss National Bank. GPFG is the Norwegian Government Pension Fund Global. All portfolios have been rescaled to the same assets under management as the SNB's portfolio of U.S. equity holdings. Statistics are calculated based on actual U.S. equity portfolio holdings with available carbon data between 2013 and 2020. *Sources*: S&P Trucost, S&P Capital IQ, and Refinitiv.

In summary, the carbon intensity and footprint of the SNB's portfolio is higher than those of GPFG and similar to those of BlackRock, whereas its financial performance is slightly higher than the performance of the other portfolios. As argued by Hong and Kacperczyk (2009) for sin stocks and Bolton and Kacperczyk (2021) for carbon-intensive firms, the higher performance of the SNB's portfolio relative to GPFG may be interpreted as the compensation for investing in carbon-intensive firms, as investors may be already demanding a premium for their exposure to carbon emission risk.

## 3.2 Cross-sectional distribution of firm-level carbon intensities

Figure 3 illustrates the empirical distribution of Scope 1–2 carbon intensities of U.S. firms in 2020. Note that we use a log scale on the *x*-axis. The distribution of carbon intensities is extremely right-skewed. A few companies have particularly large carbon intensities. The top 1% (5%) of companies ranked by carbon intensity have an average intensity of 3261 tonnes (770 tonnes) of CO<sub>2</sub> per million U.S. dollars of revenue.

Figure 4 shows box plots of carbon intensities by industry. Three industries have particularly large carbon intensities (utilities, energy, and materials). The figure also reveals large within-industry variation in these particularly carbon-intensive industries. It matters a lot for the carbon intensity of a portfolio whether it is invested in the top or bottom quartile of firms ranked by carbon intensity in the utilities sector, but it does not really matter whether it is invested in the top or bottom quartile of firms in the health care or financial sector.

The skewed distribution and large within-industry variation, which is evident from Figures 3 and 4, have important consequences for the design of strategies that aim to reduce the carbon footprint of a portfolio. It means that an investor can exclude a small subset of companies and accomplish a



Figure 3

Distribution of Scope 1-2 carbon intensities (log scale)

The figure displays the histogram of the Scope 1-2 carbon intensities of firms in the SNB's portfolio in 2020. Carbon intensity is measured in tonnes of CO<sub>2</sub> per million U.S. dollars of revenue. The histogram is in log scale. The figure also displays the 95%, 97.5%, and 99% thresholds.

significant reduction in the portfolio footprint. Focusing on a small subset will also reduce trading costs for the exit strategy and engagement costs for an engagement strategy. It also hints at the promise of a best-in-class approach.

### 3.3 Negative screening and best-in-class strategies

We now consider strategies that would improve the carbon footprint of the SNB's portfolio by excluding subsets of firms.

**3.3.1 Global exclusion strategy.** We start with a global exclusion strategy, which consists of excluding the firms with the highest carbon intensities and reinvesting the proceeds in the firms with the lowest carbon intensities. We sort all companies in the U.S. equity portfolio of the SNB by their carbon intensity, in descending order. Then, we identify the companies with the highest carbon intensities until the total dollar value excluded from the portfolio reaches 1%, 2.5%, or 5% of the total market value of the portfolio. These firms are excluded from the "decarbonized" portfolio. The proceeds are reinvested in the companies with the lowest carbon intensities. We rebalance the portfolio once a year.

In 2020, the global exclusion strategy based on 1%, 2.5%, or 5% of the total market value would have led to 20, 36, and 118 firms being excluded from the



Figure 4 Distribution of Scope 1–2 carbon intensities by sector The figure displays the cross-sectional distribution of the Scope 1–2 carbon intensities by sector for 2020. The intensity is measured in tonnes of  $CO_2$  per million U.S. dollars of revenue.

SNB's portfolio, respectively. Table 3 provides summary statistics on the 20 firms excluded with the 1% exclusion strategy in 2020. The 20 excluded firms have an average carbon intensity (weighted by their weight in the SNB's portfolio) equal to 3,974 tonnes per million U.S. dollars of revenue. Their average carbon footprint is equal to 1,739 tonnes per million U.S. dollars invested. Excluding these firms would therefore reduce the carbon footprint of the portfolio by  $0.0097 \times 1,739 = 16.94$  tonnes per million U.S. dollars invested. As the carbon footprint of the SNB's portfolio is equal to 62.01 tonnes in 2020, it would reduce to 45.07 tonnes by excluding these firms. Reinvesting the proceeds in the lowest intensity firms would increase the portfolio footprint by 0.02 tonnes, for a final footprint equal to 45.09 tonnes. The overall reduction in percentage terms is  $16.94/62.01 \times 100 = 27.3\%$  in 2020. The 2.5% and 5% exclusion strategies would lead to reductions of 42.3% and 61.7% in 2020, respectively.<sup>28</sup>

<sup>&</sup>lt;sup>28</sup> Using Scope 1 carbon data instead of Scope 1–2 data would have a limited impact on our results. On average over the sample, excluding 1% (5%) of the market capitalization would allow the SNB to reduce its carbon footprint by 23% (68%). The total emissions attributed to the SNB's portfolio would be reduced from 5 million tonnes to 3.8 million tonnes with the 1% exclusion and to 1.6 million tonnes with the 5% exclusion.

Table 3									
Summary	statistics	for	excluded	firms	(as	of	end	of	2020)

		Scope 1-2	Scope 1-2	Percent	SNB ptf	Contrib.	Contrib.
		intensity	footprint	ownership	weight	ptf	ptf
Excluded company	Sector	(tCO <sub>2</sub> e/\$mln)	(tCO <sub>2</sub> e/\$mln)	(in %)	(in %)	intensity	footprint
Vistra Corp.	Utilities	8,269.1	11,923.00	0.344	0.022	1.78	2.57
ALLETE, Inc.	Utilities	6,238.1	2,217.50	0.225	0.006	0.36	0.13
Cleveland-Cliffs Inc.	Materials	6,052.4	4,546.70	0.181	0.010	0.62	0.46
OGE Energy Corp.	Utilities	5,917.1	2,082.00	0.378	0.018	1.06	0.37
Evergy, Inc.	Utilities	4,875.2	1,964.10	0.633	0.061	2.97	1.20
Diversified Gas & Oil PLC	Energy	4769.7	1,446.60	0.215	0.002	0.11	0.03
Ameren Corporation	Utilities	4.697.7	1.445.30	0.582	0.083	3.89	1.20
CF Industries Holdings,	Materials	4,536.2	1,865.80	0.378	0.030	1.36	0.56
Inc.							
The AES Corporation	Utilities	4,473.7	2,403.70	0.376	0.053	2.39	1.28
Otter Tail Corporation	Utilities	3,727.9	1,896.10	0.200	0.003	0.10	0.05
Alliant Energy	Utilities	3,696.9	1,077.00	0.423	0.039	1.45	0.42
Corporation							
The Southern Company	Utilities	3,696.5	1,237.40	0.507	0.244	9.00	3.01
IDACORP, Inc.	Utilities	3,654.1	1,138.20	0.226	0.008	0.28	0.09
MGE Energy, Inc.	Utilities	3,570.7	817.62	0.227	0.004	0.15	0.03
Century Aluminum	Materials	3,482.5	3,430.10	0.135	0.002	0.06	0.06
Company							
Xcel Energy Inc.	Utilities	3,409.6	1,260.10	0.615	0.151	5.16	1.91
PPL Corporation	Utilities	3,375.8	1,216.40	0.396	0.066	2.23	0.80
American Electric Power	Utilities	3,330.1	1,311.90	0.455	0.136	4.53	1.78
Company, Inc							
Eagle Materials Inc.	Materials	3,324.0	917.14	0.213	0.009	0.29	0.08
NRG Energy, Inc.	Utilities	3,300.2	3,169.00	0.377	0.028	0.93	0.89
Sum					0.974	38.72	16.94

The table reports summary statistics on the 20 firms that would be excluded from the SNB's portfolio in 2020 in the global exclusion strategies. Statistics are for the Scope 1–2 intensity in tonnes of  $CO_2e$  per million U.S. dollars of revenue; the Scope 1–2 carbon footprint in tonnes of  $CO_2e$  per million U.S. dollars invested; the percent ownership, that is, the fraction of the market capitalization of the firm held by the SNB; the weight of the firm in the SNB's portfolio; the contribution of the firm to the SNB's portfolio intensity; the contribution of the firm to the SNB's portfolio footprint. *Sources:* S&P Trucost, S&P Capital IQ.

Table 3 also shows that, in 2020, the U.S. firm in the SNB's portfolio with the highest carbon intensity is Vistra Corp., a utility specialized in electricity generation, with a carbon intensity of 8,269 tonnes per million U.S. dollars of revenue and a weight of 0.022% in the U.S. equity portion of the SNB's portfolio with carbon data. The firm with the largest market capitalization that would be excluded in the 1% exclusion strategy is the Southern Company, a utility specialized in natural gas power generation, with a carbon intensity of 3,697 tonnes per million U.S. dollars of revenue and a weight of 0.244%. Vistra Corp. and Southern Company contribute to 2.6 and 3 tonnes of  $CO_2$  per million U.S. dollars invested, respectively, which represents 9% of the total footprint of the SNB's portfolio. Of the 20 excluded firms, 15 are utilities, 4 are in the materials sector, and 1 is an energy firm.

Table 4, panel A, reports the reductions in the carbon intensity and carbon footprint generated by the global exclusion strategies across the entire sample period. On average over the sample, excluding 1% of the market capitalization

# Table 4 Financial performance and carbon performance of alternative strategies

	A Global exclusion and reinvestment			B Sectoral exclusion and reinvestment		
	1%	2.5%	5%	1%	2.5%	5%
Annualized return (in %)	15.6	15.6	15.8	15.5	15.5	15.6
Annualized volatility (in %)	15.5	15.6	15.7	15.4	15.4	15.4
Sharpe ratio	0.96	0.95	0.96	0.96	0.96	0.96
Tracking error wrt MSCI (in %)	1.16	1.07	1.06	1.18	1.15	1.13
Tracking error wrt SNB (in %)	0.21	0.51	0.72	0.10	0.19	0.37
Carbon emissions (mln tonnes CO2e)	4.79	3.46	2.52	5.93	5.68	5.34
(% reduction)	-22.6	-44.0	-59.2	-4.1	-8.0	-13.6
Carbon footprint (tonnes CO2e/mln \$ invested)	94.9	66.2	48.1	115.1	110.8	104.0
(% reduction)	-21.0	-44.9	-59.9	-4.1	-7.8	-13.4
Carbon intensity (tonnes CO <sub>2</sub> e/mln \$ revenue)	180.7	121.3	77.5	221.3	213.4	198.8
(% reduction)	-21.5	-47.4	-66.4	-3.9	-7.3	-13.7
	С				D	
	Global exclusion with sectoral reinvestment industry rein			clusion wit stry reinves	h primary tment	

1%	2.5%	5%	1%	2.5%	5%
15.5	15.5	15.4	15.5	15.5	15.6
15.4	15.4	15.4	15.4	15.4	15.4
0.96	0.96	0.95	0.96	0.96	0.96
1.22	1.21	1.19	1.22	1.21	1.21
0.08	0.10	0.23	0.07	0.12	0.21
4.87	3.96	2.93	5.09	4.51	4.19
-21.2	-35.9	-52.5	-17.7	-27.1	-32.2
96.2	75.4	56.0	100.0	88.4	82.3
-19.9	-37.2	-53.4	-16.7	-26.4	-31.4
183.0	141.9	89.3	189.0	163.3	154.2
-20.5	-38.4	-61.2	-17.9	-29.1	-33.1
	1%           15.5           15.4           0.96           1.22           0.08           4.87           -21.2           96.2           -19.9           183.0           -20.5	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$

The table reports financial performance and the carbon characteristics (emissions, footprint, and intensity) of four alternative exclusion strategies. Carbon emissions are in million tonnes of CO<sub>2</sub>e. Carbon footprint is in tonnes of CO<sub>2</sub>e per million U.S. dollars invested. Carbon intensity is in tonnes of CO<sub>2</sub>e per million U.S. dollars of revenue. *Sources*: S&P Trucost, S&P Capital IQ, and Refinitiv.

would allow the SNB to reduce the carbon footprint of its portfolio by 21%. Its carbon footprint would then be of the same magnitude as the one of the GPFG portfolio. Excluding 2.5% and 5% of the market capitalization would reduce the footprint by 45% and 60%, respectively.<sup>29</sup> Panel A of Figure 5 displays the carbon footprint of the SNB's portfolio based on the global

<sup>&</sup>lt;sup>29</sup> We applied the same global exclusion strategy to BlackRock and GPFG to understand the effect on their portfolios. For BlackRock, whose portfolio is quite similar to the SNB's portfolio, the strategy would result in similar carbon footprint reductions. On average, a 1% (5%) exclusion strategy would reduce the carbon footprint of BlackRock's portfolio by 21% and 60%, respectively. For GPFG, whose investment strategy already incorporates some exclusions, the carbon footprint reduction from a further divestment strategy would be attenuated. The reduction in the carbon footprint would be equal to 17.4% and 51.3% for the 1% (5%) exclusion strategies, respectively.



Figure 5



The figure displays the Scope 1–2 carbon footprint (panel A) and carbon emissions (panel B) for the SNB's portfolio with global exclusion and reinvestment with thresholds of 1%, 2.5%, and 5%. It also displays the carbon footprint and carbon emissions of the initial SNB, GPFG, and BlackRock portfolios and the U.S. MSCI index. The footprint is measured in tonnes of CO<sub>2</sub> per million U.S. dollars invested, and emissions are measured in million tonnes of CO<sub>2</sub>. The sample covers the period from 2013 to 2020.

exclusion strategy through time and compares it with the benchmarks. Panel B displays the total carbon emissions for the same exclusion portfolios.

Table 4 (panel A) also reports the financial performance generated by the global exclusion strategy. The 1% and 2.5% exclusion portfolios would have had no material impact on the financial performance of the SNB's portfolio. The average return would have been equal to 15.6% in both cases. The 5% exclusion portfolio would have even benefited from a slightly higher average return (15.8% on average, with a Sharpe ratio of 0.96). Figure 6 (panel A) displays the temporal evolution of the cumulative excess monthly return of the exclusion portfolio relative to the initial SNB's portfolio. The positive excess return obtained for the three exclusion portfolios confirms the higher annualized return reported in Table 4. The figure also demonstrates that the gain in performance is obtained at the end of the sample, between 2020 and 2021. Panel B represents the annualized tracking error (computed based on one year of data) relative to the initial SNB's portfolio. The figure illustrates, not surprisingly, that the tracking error is higher when a larger fraction of the market capitalization is excluded.

**3.3.2 Sectoral best-in-class strategy.** When investors consider building a portfolio based on the exclusion of stocks with some specific characteristics, they face the issue of changes in risk exposures. Excluding high-carbon intensity firms might severely affect sectoral exposures. Most of the excluded firms are from the utilities, energy, and materials sectors. Other sectors, such as the financial, health care, and information technology sectors, are low carbon intensive and therefore overweighted in the portfolio resulting from the global exclusion strategy. The utilities sector is the most affected sector when using the global exclusion strategy. In 2020, 27.7% of the market value of the utilities sector would be excluded from the SNB's portfolio with the 1% exclusion threshold. With the 2.5% and 5% thresholds, the excluded market value would jump to 58.4% and 74.7%, respectively. Although such an exclusion would be desirable from a carbon footprint perspective, it could affect the risk exposure of the portfolio (an oft-voiced concern of the SNB).

To address this issue, we now consider a sectoral best-in-class strategy. With the 1% threshold, we exclude in a given sector all firms with the highest carbon intensity until the total dollar value excluded reaches 1% of the market value of the sector. Then, the proceeds are reinvested proportionally in firms in the same sector with the lowest carbon intensity (representing 1% of the market value of the sector). The portfolio weights of these "green" firms with the lowest carbon intensity double.

The three sectoral exclusion strategies, based on 1%, 2.5%, and 5% of the market capitalization in each sector, have a much more limited impact on the carbon footprint. Panel B of Table 4 and Figure 7 show that on average over the sample period, the 1% exclusion results in a reduction of the carbon



Figure 6

Financial performance with global exclusion and reinvestment

The figure displays the cumulative monthly excess return (panel A) and tracking error (panel B) for the SNB's portfolio with global exclusion and reinvestment with thresholds of 1%, 2.5%, and 5%, relative to the initial SNB's portfolio. Both series are expressed as a percent per year. The sample covers the period from 2014 to 2021.



#### Figure 7



The figure displays the Scope 1–2 carbon footprint (panel A) and carbon emissions (panel B) for the SNB's portfolio with sectoral exclusion and reinvestment with thresholds of 1%, 2.5%, and 5%. It also displays the carbon footprint and carbon emissions of the initial SNB, GPFG, and BlackRock portfolios and the U.S. MSCI index. The footprint is measured in tonnes of CO<sub>2</sub> per million U.S. dollars invested, and emissions are measured in million tonnes of CO<sub>2</sub>. The sample covers the period from 2013 to 2020.

footprint of the SNB's portfolio by 4.1% only. Increasing the exclusion to 5% of the market value decreases the portfolio footprint by 13.4% and total emissions by 13.6%, that is, to a level close to the MSCI index. The carbon footprint of the 5% portfolio is still 16.3% higher than the footprint of the GPFG's portfolio.

Table 4 (panel B) also indicates that the impact of sectoral exclusion on the financial performance is minimal. This result is expected, as the exclusion process affects all sectors to the same extent and therefore has limited impact on risk exposures.

We conclude that excluding the same fraction of the portfolio within each sector would not be able to significantly reduce the carbon footprint of the SNB's portfolio: in  $CO_2$ -intensive sectors, too few highly polluting firms would be excluded; in low-intensity sectors, too many very low-carbon-intensity firms would be excluded.

3.3.3 Global exclusion with sectoral reinvestment. An alternative strategy to keep the same sectoral exposure as in the initial portfolio consists of excluding the highest intensity firms globally but reinvesting the proceeds in the same sector as the excluded firms. We proceed as follows. We exclude the firms with the highest carbon intensities globally, until the total dollar value excluded from the portfolio reaches 1%, 2.5%, or 5% of the total market value of the SNB's portfolio. Then, we measure how much of the market value of each sector is excluded with this process and we reinvest the proceeds in the firms with the lowest carbon intensity in this sector. For instance, assume that in the exclusion process, 20% of the market value of the utilities sector is lost by excluding high carbon-intensity firms. We identify the utilities with the lowest carbon intensities until the total dollar value reaches 20% of the market value of the utilities sector in the initial portfolio. For each of these low carbon-intensity utilities, we double their weight, so that the utilities sector represents exactly the same proportion as in the initial SNB's portfolio. Note that there is a trade-off regarding the weights when reinvesting. The larger the overweighting of lowest carbon firms, the larger the reduction in the footprint, but the higher the danger of undesirably large individual positions.

Table 5 shows the 34 firms that would be overweighted with our strategy. CenterPoint Energy, Inc., is the last firm overweighted in the portfolio, with a Scope 1-2 intensity of 713.9. It can be compared to the last excluded firm of Table 3, NRG Energy, with a Scope 1–2 intensity of 3,300.2. The comparison suggests that even in the utilities sector, the presence of enough lower-intensity firms reduces emissions significantly. However, one can also see some limitations. The name of many of the included utilities contains "Water," indicating that we replace electricity utilities with water utilities. Finally, we overweight 34 firms, while only excluding 20, which shows that overweighted firms with low intensities are relatively smaller.

Table 5									
Summary	statistics	on	overweighted	firms	(as	of	end	of	2020)

		Scope 1-2	Scope 1-2				
		intensity	footprint	Percent	SNB ptf	Contrib.	Contrib.
		(tCO <sub>2</sub> e/	(tCO <sub>2</sub> e/	ownership	weight	ptf	ptf
Excluded company	Sector	\$mln)	\$mln)	(in %)	(in %)	intensity	footprint
World Fuel Services Corp	Energy	23	22.36	0 227	0.002	0.00	0.00
AptarGroup Inc	Materials	18.7	6.41	0.224	0.033	0.00	0.00
Valvoline Inc	Materials	10.7	10.31	0.224	0.033	0.01	0.00
Suppose Energy	Utilition	19.9	1 26	0.251	0.018	0.00	0.00
International Inc.	Ounties	52.4	1.20	0.102	0.004	0.00	0.00
Codia Inc.	Litilities.	15 5	0.06	0.219	0.001	0.00	0.00
Caulz IIIC.	Utilities	43.3	0.00	0.216	0.001	0.00	0.00
NextEre Engineer Destroyer LD	Unintes	55.5 70.4	30.19	0.226	0.001	0.00	0.00
Nextera Energy Partners, LP	Unintes	70.4	11.85	0.185	0.008	0.01	0.00
Eversource Energy	Unintes	//.0	25.69	0.508	0.113	0.09	0.03
SJW Group	Utilities	108.3	34.48	0.203	0.003	0.00	0.00
Southwest Gas Holdings, Inc.	Utilities	108.6	97.75	0.221	0.007	0.01	0.01
The York Water Company	Utilities	108.7	11.03	0.226	0.001	0.00	0.00
American States Water	Utilities	112.7	21.08	0.226	0.005	0.01	0.00
Company							
California Water Service	Utilities	114.1	34.10	0.222	0.005	0.01	0.00
Group							
Middlesex Water Company	Utilities	132.6	15.72	0.226	0.002	0.00	0.00
American Water Works	Utilities	144.3	22.76	0.412	0.083	0.12	0.02
Company Inc	eunues	11110	22.70	02	0.000	0.12	0.02
Ormat Technologies, Inc.	Utilities	154.0	23.89	0.165	0.006	0.01	0.00
Edison International	Utilities	162.0	104.01	0 391	0.069	0.11	0.07
New Jersey Resources Corp	Utilities	163.3	83.48	0.225	0.007	0.01	0.01
South Jersey Industries Inc.	Utilities	190.4	111.05	0.227	0.005	0.01	0.01
UGL Corporation	Utilities	193.7	155.90	0.378	0.026	0.05	0.04
ONE Gas Inc	Utilities	207.9	87.28	0.225	0.007	0.01	0.01
Northwest Natural Holding	Utilities	211.3	111.05	0.225	0.003	0.01	0.00
Company	Oundes	211.5	111.95	0.220	0.005	0.01	0.00
Spire Inc	Utilities	213.4	114 22	0.225	0.007	0.01	0.01
Brookfield Infrastructure	Utilities	213.4	00.83	0.103	0.007	0.01	0.01
Corp	Ounties	213.4	99.05	0.195	0.005	0.01	0.00
PG&E Corporation	Utilities	278.2	240 79	0.277	0.049	0.14	0.12
Consolidated Edison Inc.	Utilities	200.0	158.62	0.277	0.142	0.14	0.12
Chasapaska Utilitias Corp	Utilities	299.0	82 77	0.737	0.142	0.45	0.23
Atmos Energy Corporation	Utilities	341.5	85.03	0.215	0.005	0.01	0.00
Runos Energy Corporation	Utilities	202.0	150.21	0.384	0.030	0.12	0.03
Evalar Corporation	Utilities	392.9	139.51	0.280	0.018	0.07	0.05
Exclore Corporation	Utilities	415.5	50.80	0.377	0.122	0.51	0.43
Essential Utilities, Inc.	Utilities	413.7	39.80	0.339	0.051	0.15	0.02
Sample English	Utilities	4/1.0	440.75	0.220	0.011	0.05	0.05
Sempra Energy	Unines	004.1	194.01	0.301	0.107	0.05	0.21
CenterPoint Energy, Inc.	Ounnes	/13.9	493.84	0.373	0.033	0.24	0.17
Sum					0.974	2.83	1.49

The table reports summary statistics on the 34 firms that would be overweighted in the SNB's portfolio in 2020 in the global exclusion strategy with sectoral reinvestment. Statistics are for the Scope 1–2 intensity in tonnes of  $CO_2e$  per million U.S. dollars of revenue; the Scope 1–2 footprint in tonnes of  $CO_2e$  per million U.S. dollars invested; the percent ownership, that is, the fraction of the market capitalization of the firm held by the SNB's portfolio; the contribution of the firm to the SNB's portfolio; the contribution of the firm to the SNB's portfolio intensity; and the contribution of the firm to the SNB's portfolio footprint. *Sources*: S&P Trucost, S&P Capital IQ.

Figure 8 (panel A) displays the carbon footprint of the three best-in-class portfolios, based on 1%, 2.5%, and 5% of the market value, and panel C of Table 4 shows the average reductions over the entire sample period. We find that with the 1% exclusion the carbon footprint of the SNB's portfolio is



#### Figure 8



The figure displays the Scope 1–2 carbon footprint (panel A) and carbon emissions (panel B) for the SNB's portfolio with global exclusion and sectoral reinvestment with thresholds of 1%, 2.5%, and 5%. It also displays the carbon footprint and carbon emissions of the initial SNB, GPFG, and BlackRock portfolios and the U.S. MSCI index. The footprint is measured in tonnes of CO<sub>2</sub> per million U.S. dollars invested, and emissions are measured in million tonnes of CO<sub>2</sub>. The sample covers the period from 2013 to 2020.

reduced by 19.9% on average over the sample period. The resultant carbon footprint is slightly above that of the GPFG's portfolio (7.6% higher on average over the sample period). Increasing the exclusion threshold to 5% of the market value decreases the portfolio footprint by 53.4%. However, the strategy that excludes 5% of the market value of the portfolio would exclude utilities (with the highest intensity) representing 74.7% of the market value of the utilities sector. With the sectoral reinvestment strategy, the proceeds would be reinvested proportionately in the remaining utilities (with the lowest intensity) representing 25.3% of the utilities sector. Thus, we would have to increase position limits for those relatively clean utilities significantly beyond 200% of the initial investment.

When we consider the total emissions of the portfolios in panel B of Figure 8, we note that the 1% exclusion would allow the SNB to reduce the carbon emissions of its portfolio to a level slightly above the emissions generated by the GPFG's portfolio (with the same portfolio market value). In 2020, total emissions would have been reduced from 7.9 million tonnes to 5.9 million tonnes, that is, 7.5% above the GPFG's emissions.

Table 4 (panel C) also shows that the ex post financial performance of the portfolio would be barely affected by the exclusion. The cumulative return and the Sharpe ratio for all thresholds are only slightly reduced relative to those of the initial SNB's portfolio. Figure 9 (panel A) reveals that the cumulative excess monthly return of the best-in-class portfolios for 1% and 2.5% are essentially unaffected relative to the initial SNB's portfolio. When the exclusion process is increased to 5% of the market value of the portfolio, the excess performance is negative relative to the initial SNB's portfolio, although to a limited extent, as reported in Table 4. The loss for this portfolio accumulates over the second half of the sample. As panel B of the figure indicates, the annualized tracking error is usually below 0.1% for the 1% and 2.5% exclusion thresholds but increases to 0.25% on average for the 5% threshold.

**3.3.4 Implementability of the exclusion and best-in-class strategies.** The global exclusion strategy leads to the largest reduction in emissions. However, the strategy shifts sectoral risk exposures in a way that the SNB, among other entities, may not find desirable. The sectoral exclusion, which implements a best-in-class approach, leads to the least deviation from the original portfolio, but it also leads to the lowest carbon reduction. The global exclusion with sectoral reinvestment strategy combines the advantages of the two other approaches. Using the global exclusion criterion excludes the companies with the highest carbon footprint overall, while the sectoral reinvestment maintains portfolio diversification. The 1% and 2.5% exclusion thresholds would be implementable in that they would not lead to too concentrated positions in "green" utilities.



Figure 9



The figure displays the cumulative excess monthly return (panel A) and tracking error (panel B) for the SNB's portfolio with global exclusion and subsectoral reinvestment with thresholds of 1%, 2.5%, and 5%, relative to the initial SNB's portfolio. Both series are expressed in % per year. The sample covers the period from 2014 to 2021.

How expensive would it be to implement that strategy? Potential issues are the increase in trading costs through portfolio turnover, monitoring fees, increase in tracking error, and purchase cost of carbon emission data.

Trading cost and monitoring fees are low if the carbon intensity rankings are relatively stable. The more stable the ranking, the less turnover and the less monitoring is required. We have evaluated the stability of the carbon intensity ranking as follows. For a given threshold (1%, 2.5%, or 5% quantiles), we store the list of firms with a carbon intensity above this threshold. Then, we compute the correlation of the list from one year to the other. The average correlation is equal to 57% for the 1% threshold and 64% for the 2.5% and 5% thresholds. The high correlations suggest that the list of excluded firms is quite stable over time, thus limiting the cost of rebalancing the portfolio.

We also calculate two measures of tracking error, defined as the annualized volatility of the difference between the SNB's portfolio return and the return of a reference portfolio. The first reference portfolio we consider is the initial SNB's portfolio. For our preferred strategy with global exclusion and sectoral reinvestment, the tracking error is low because proceeds from excluded firms are reinvested in firms in the same sector. Even with a 5% threshold, the tracking error is only 0.28% per year.

The second reference portfolio we use is the U.S. MSCI index. The tracking error between the U.S. MSCI index and the original SNB's portfolio is equal to 1.1%, reflecting the investment strategy of the SNB. For any exclusion threshold in the global exclusion and sectoral reinvestment case, the tracking error does not exceed 1.2% per year. Hence, concerns about increases in tracking error due to exclusion are unwarranted.

Finally, the cost for carbon data is minimal given the size of the SNB's equity portfolio. In addition, corporate carbon disclosure will become more prevalent and the cost for carbon data will decrease over time, as an increasing number of investors will share the cost of the data collection.

## 4. Discussion of Results and Alternative Strategies

The exclusion strategies we presented in the prior section are very effective at reducing the carbon footprint of the SNB's portfolio, without a significant impact on its financial performance during our sample period. The strategies are consistent with value-based and risk-management-based preferences, but they do not lead, at least directly, to additionality.

The SNB would implement the different exclusion strategies we discussed by selling shares in secondary markets; that is, it would sell its holdings of high carbon intensity companies on the stock exchange to different investors. Such a strategy *per se* would not affect the targeted company, in the sense that the company would not have less capital to carry out its investments. It merely reallocates the financed carbon emissions to a different investor. The effect on global carbon emissions is at best indirect: fewer investors could be participating in a future equity or debt financing round for the excluded companies and therefore the company's cost of capital could increase in the future. Or the management of excluded companies worries that more investors become dissatisfied with them and therefore implement environmentally friendly changes.

In our preferred strategy (global exclusion with sectoral reinvestment), we sell companies in a specific sector and reinvest the proceeds in the same sector, which may increase pressure on companies to improve their carbon footprint. Still, the sectors are very broadly defined and the excluded companies may argue that the chosen replacement companies have little in common with themselves (e.g., a utility producing electricity with coal is sold and the proceeds are reinvested in a utility providing water services (see, e.g., Table 5). In such a scenario, they would not feel much pressure to change. What if we implemented a strategy in which we followed a stricter best-inclass reinvestment approach, where we sell one utility company producing electricity with coal and invest in the least polluting publicly listed utility producing electricity with coal available in the U.S. market? If enough investors carried out such a reallocation to truly *comparable* companies, the strategy could be more effective at increasing the pressure on polluting companies to reduce their carbon footprint.

With such an exclusion strategy at the primary industry level, the SNB would see, as before, an immediate reduction in its own carbon footprint. As Figure 10 reveals, in 2020, with the 1% exclusion, total carbon emissions attributed to the SNB's portfolio would be reduced from 7.9 million tonnes to 6.2 million tonnes, corresponding to a 21.3% reduction. Increasing the exclusion to 5% of the market value would cut total emissions by 33.6%. As indicated in Table 4 (panel D), financial performance would not be affected in a significant way. If this strategy forced the most polluting companies to reconsider their carbon intensity, it would have in addition a long-term effect of reducing global carbon emissions. To estimate the global reduction in carbon emissions, one has to make assumptions on how the excluded companies would react. Suppose that each of the excluded companies would strive to improve its carbon intensity to become like the average of the nonexcluded companies in its primary industry. For instance, in 2020 the 1% exclusion strategy would lead to 14 electric utilities getting from an average carbon intensity of 3,654 tonnes per million U.S. dollars revenue to a carbon intensity of 1,950 tonnes per million U.S. dollars of revenue. Assuming that revenues of these companies would not change, total emissions by these 14 firms would decrease from 326 million tonnes to 176 million tonnes in 2020, a 46% reduction. With this strategy, the impact on the SNB's own portfolio footprint would be lower than in the global exclusion with sectoral reinvestment strategy because the SNB would continue to hold some shares in the "best of the



Figure 10



The figure displays the Scope 1–2 carbon footprint (panel A) and carbon emissions (panel B) for the SNB's portfolio with global exclusion and subsectoral reinvestment with thresholds of 1%, 2.5%, and 5%. It also displays the carbon footprint and carbon emissions of the initial SNB, GPFG, and BlackRock portfolios and the U.S. MSCI index. The footprint is measured in tonnes of CO<sub>2</sub> per million U.S. dollars invested, and emissions are measured in million tonnes of CO<sub>2</sub>. The sample covers the period from 2013 to 2020.

worst" companies, but it would have contributed to a reduction in global carbon emissions.

An alternative strategy to reduce global emissions follows a "voice" approach that aims at putting more pressure on the most-carbon-intensive companies to reduce their carbon emissions. The SNB would sell no shares and remain shareholder in all portfolio companies. However, it would publicly disclose that it will vote from now on at AGMs in favor of, say, activist strategies similar to the one successfully carried out by Engine 1 at Exxon. The effectiveness of such a strategy to reduce global emissions depends on the frequency of activism campaigns, the success of those campaigns, and the post-campaign impact of the activist on carbon emissions. For example, if every other of the 20 highest carbon intensity firms was targeted, and if the campaign was successful in half of the cases, and if the activist managed to reduce carbon emissions at targeted companies by 25%, the carbon footprint of the SNB's portfolio would be reduced by  $0.5 \times 0.5 \times 0.25 \times 27.3\% =$ 1.7%, where 27.3% corresponds to the reduction in the carbon footprint in the 1% exclusion strategy in 2020. This reduction in the portfolio's footprint would translate one-to-one in a reduction of global carbon emissions. There would, however, be only a limited reduction in the carbon footprint of the SNB's portfolio. For a central bank, such a more active approach would most likely require a substantially revised mandate, as Thomas Jordan, chairman of the governing board of the SNB, has frequently pointed out. In addition, even with such an expanded mandate, the SNB is a sufficiently large investor that its declared support of activist campaigns could lead to reputation and headline risks. Central banks most likely do not want to be exposed to these risks.

#### 5. Conclusion

Central banks have placed themselves at the head of a movement toward a more sustainable financial sector. In this paper, we analyze how they could lead by example in the management of their own portfolios. We examine the motives for a carbon-conscious asset management approach and discuss which strategies for a more carbon-conscious policy portfolio management could be politically feasible for central banks and consistent with their policy mandate of price stability.

Survey results suggest that central banks would like to reduce exposure to companies whose values do not correspond to those of the central banks' countries. Central banks are also concerned about the impact of transition risks on their portfolio's performance. Central banks' primary objective for their policy portfolios is price stability, and any other objective, for example, sustainable and responsible investment criteria, will remain a subsidiary goal. Central banks as public institutions are subject to national and international scrutiny and are unlikely to be able to engage with individual portfolio firms, and any carbon-conscious investment approach needs to follow objective criteria that can be implemented, ideally, by third parties following broad guidelines. We argue that best-in-class exclusion strategies are particularly well suited for central banks to implement carbon conscious investment policies.

We demonstrate that the SNB could implement a simple strategy that would significantly and immediately reduce its portfolio's carbon footprint, without much of an impact on portfolio's financial performance and with negligible costs. Because there is a small subset of particularly carbon-intensive firms, the exclusion in 2020 of 20 firms in a portfolio of 2,064 firms (representing 1% of the portfolio market value) would reduce total financed carbon emissions by 27.3%. The strategy does not privilege economic sectors over others, maintains diversification, and does not expose the SNB politically, and is thus likely consistent with its current mandate.

## Appendix

# Table A1Sectoral composition of portfolios

	SNB		GPF	FG	BlackI	Rock	MSCI							
A. Average values	A. Average values													
Sectors	No. firms	Weight	No. firms	Weight	No. firms	Weight	No. firms	Weight						
Information tech.	70	10.3	48	8.9	73	7.6	14	5.2						
Health care	201	11.3	152	11.1	238	10.4	73	13.1						
Consumer discr.	73	10.3	55	5.7	75	6.9	33	8.8						
Comm. services	72	6.8	30	5.3	87	5.9	27	6.8						
Industrials	203	3.3	183	16.7	324	14.5	55	7.8						
Consumer staples	207	15.7	139	14.3	273	14.4	58	14.9						
Real estate	241	9.4	192	8.1	282	9.8	67	9.5						
Utilities	217	21.2	173	19.9	242	18.6	79	24.2						
Financials	82	2.9	69	2.7	95	3.1	28	2.9						
Energy	118	4.4	98	5.1	125	5.1	33	3.4						
Materials	58	4.4	35	2.3	58	3.8	28	3.5						
Sum	1,542	100.0	1,172	100.0	1,872	100.0	494	100.0						
B. Values in 2020														
Sectors	No. firms	Weight	No. firms	Weight	No. firms	Weight	No. firms	Weight						
Information tech.	304	29.8	269	26.2	389	26.5	100	30.8						
Health care	342	14.8	244	13.3	515	14.7	77	14.6						
Consumer discr.	252	13.1	206	12.4	356	12.1	55	13.2						
Comm. services	86	11.8	71	11.5	116	9.3	31	10.3						
Industrials	302	8.2	258	7.5	399	8.9	70	8.0						

Sum	2,064	100.0	1,683	100.0	2,914
Materials	101	2.6	88	2.4	129
Energy	69	2.9	39	2.2	134
Financials	297	3.0	253	12.1	514
Utilities	63	3.3	42	1.7	70
Real estate	156	3.5	137	5.4	181

7.0

76

5.3

111

5.8

4.3

3.0

10.5

2.2

2.8

100.0

34

36

32

58

18

30

541

7.0

2.8

3.0

5.6

2.3

2.4

100.0

92

#### C. Largest positions in 2020

Consumer staples

Company	Ownership	Weight	Ownership	Weight	Ownership	Weight	Ownership	Weight
Apple	0.39	5.34	1.00	2.12	6.21	3.24	_	6.69
Microsoft	0.36	4.21	1.06	1.92	6.82	2.65	_	4.71
Amazon.com	0.32	3.26	0.91	1.43	5.49	2.07	_	4.09
Facebook	0.38	1.56	1.22	0.81	6.64	1.01	_	1.94
Alphabet	0.35	1.55	1.81	1.19	6.76	0.82	-	1.55

The table reports the sectoral composition (number of firms and relative weights) of the U.S. equity portion of the SNB, GPFG, BlackRock, and MSCI portfolios, based on firms for which carbon data are available, on average between 2013 and 2020 (panel A) and at the end of 2020 (panel B). Panel C reports the ownership (in %) and the weight (in %) of the five largest positions for the four portfolios. *Source*: S&P Capital IQ.

#### References

Amel-Zadeh, A., and G. Serafeim. 2018. Why and how investors use ESG information: Evidence from a global survey. *Financial Analysts Journal* 74:87–103.

Appel, I. R., T. R. Gormley, and D. B. Keim. 2016. Passive investors, not passive owners. *Journal of Financial Economics* 121:111–41.

Berk, J. B., and J. H. van Binsbergen. 2022. The impact of impact investing. Research Paper, Stanford University Graduate School of Business.

Bolton, P., M. Despres, L. A. Pereira Da Silva, F. Samama, and R. Svartzman. 2020. The green swan: Central banking and financial stability in the age of climate change. Working Paper, Bank for International Settlements.

Bolton, P., and M. Kacperczyk. 2021. Do investors care about carbon risk? *Journal of Financial Economics* 142:517–49.

Boneva, L., G. Ferrucci, and F. P. Mongelli. 2021. To be or not to be "green": How can monetary policy react to climate change? Working Paper, ECB.

Bonnefon, J.-F., A. Landier, P. Sastry, and D. Thesmar. 2022. The moral preferences of investors: Experimental evidence. Working Paper, TSE and IAST.

Bremus, F., F. Schuetze, and A. Zaklan. 2021. The impact of ECB corporate sector purchases on European green bonds. Discussion Paper, DIW Berlin.

Broccardo, E., O. D. Hart, and L. Zingales. 2021. Exit vs. voice. Working Paper, European Corporate Governance Institute.

Couvert, M. 2020. What is the impact of mutual funds' ESG preferences on portfolio firms? Working Paper, Swiss Finance Institute.

Eliet-Doillet, A., and A. Maino. 2022. Can unconventional monetary policy contribute to climate action? Working Paper, Swiss Finance Institute.

Fabozzi, F. J., K. C. Ma, and B. J. Oliphant. 2008. Sin stock returns. Journal of Portfolio Management 35:82-94.

Germanwatch and NewClimate Institute. 2018. Aligning investments with the Paris Agreement temperature goal – Challenges and opportunities for multilateral development banks. Working Paper, Cologne/Bonn/Berlin.

Gibson, R., S. Glossner, P. Krueger, P. Matos, and T. Steffen. 2020. Responsible institutional investing around the world. Working Paper, Swiss Finance Institute.

Global Sustainable Investment Alliance. 2018. 2018 Global Sustainable Investment Review.

Gormley, T. A., V. K. Gupta, D. A. Matsa, S. C. Mortal, and L. Yang. 2021. The Big Three and board gender diversity: The effectiveness of shareholder voice. Working Paper, Washington University in St. Louis.

Greenhouse Gas Protocol. 2004. A corporate accounting and reporting standard – revised edition. https://ghgpro-tocol.org/sites/default/files/standards/ghg-protocol-revised.pdf.

Heinkel, R., A. Kraus, and J. Zechner. 2001. The effect of green investment on corporate behavior. *Journal of Financial and Quantitative Analysis* 36:431–49.

Hong, H., and M. Kacperczyk. 2009. The price of sin: The effects of social norms on markets. *Journal of Financial Economics* 93:15–36.

Institut Louis Bachelier et al. 2020. The alignment cookbook – A technical review of methodologies assessing a portfolio's alignment with low-carbon trajectories or temperature goal. Paris. https://www.louisbachelier.org/wp-content/uploads/2020/10/cookbook.pdf.

Landier, A., and S. Lovo. 2020. ESG investing: How to optimize impact? Research Paper, HEC Paris.

McCahery, J. A., Z. Sautner, and L. T. Starks. 2016. Behind the scenes: The corporate governance preferences of institutional investors. *Journal of Finance* 71:2905–32.

NGFS, Network for Greening the Financial System. 2019a. First comprehensive report. Technical Report.

------. 2019b. A sustainable and responsible investment guide for central banks' portfolio management. Technical Report.

\_\_\_\_\_. 2020a. Guide to climate scenario analysis for central banks and supervisors. Technical Document.

------. 2020b. Progress report on the implementation of sustainable and responsible investment practices in central banks' portfolio management. Technical Report.

Oehmke, M., and M. M. Opp. 2022. A theory of socially responsible investment. Working Paper, CEPR.

Papoutsi, M., M. Piazzesi, and M. Schneider. 2022. How unconventional is green monetary policy? Working Paper, IMF.

Pastor, L., R. F. Stambaugh, and L. A. Taylor. 2021. Sustainable investing in equilibrium. *Journal of Financial Economics* 142(2):550–71.

Pedersen, L. H., S. Fitzgibbons, and L. Pomorski. 2021. Responsible investing: The ESG-efficient frontier. Journal of Financial Economics 142(2):572–97.

Schnabel, I. 2021a. From green neglect to green dominance? Speech at "Greening Monetary Policy – Central Banking and Climate Change, March 3". https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210303\_1~f3df48854e.en.html.

— 2021b. From market neutrality to market efficiency. Speech at "Climate change, financial markets and green growth, June 14". https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210614~162bd7c253.en. html.

Schoenmaker, D. 2021. Greening monetary policy. Climate Policy 21:581-92.

SNB. 2021. 113th Annual Report. Zurich, Switzerland. https://www.snb.ch/en/iabout/pub/annrep/id/pub\_annrep\_2020.

——. 2022. 114th Annual Report. Zurich, Switzerland. https://www.snb.ch/en/iabout/pub/annrep/id/pub\_ annrep\_2021.

TCFD, Task Force on Climate-related Financial Disclosures. 2017. Implementing the recommendations of the task force on climate related financial disclosures. New York. https://www.fsb-tcfd.org/wp-content/uploads/2017/12/FINAL-TCFD-Annex-Amended-121517.pdf.

Texas Comptroller of Public Accounts. 2022. Texas Comptroller Glenn Hegar announces list of financial companies that boycott energy companies. Press Release, August 24. https://comptroller.texas.gov/about/media-center/news/20220824-texas-comptroller-glenn-hegar-announces-list-of-financial-companies-that-boy-cott-energy-companies-1661267815099.