Nachhaltige Soziale Marktwirtschaft

Focus Paper | #9

Monetary Policy at the Crossroads – How to Respond to the Climate Crisis

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About us

Sustainable Social Market Economies

Combining economic performance and social participation – that is the guiding principle behind the German “social market economy” model and the recipe for its success. Yet this economic and social concept is facing increasing pressure due to climate change, limited natural resources, a shrinking workforce, globalization and digital transformation. To ensure it remains a reliable model for future generations, we need to transform our economy into a “sustainable social market economy.”

The process of socio-ecological transformation is creating forms of interaction and conflicts between the various objectives that define a sustainable social market economy. Our “Economics of Transformation” research area focuses on the macroeconomic interrelationships between various target parameters, and generates actionable empirical knowledge about economic policy measures that may help to avoid or resolve inherent conflicts between goals, or even unleash potential synergies. This focus paper is part of a series of publications on conflicts between the economic policy objectives underlying a sustainable social market economy.

Nachhaltige Soziale Marktwirtschaft

Focus Paper | #9

Monetary Policy at the Crossroads – How to Respond to the Climate Crisis

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Contents

Figures 7

Tables 7

Text box 7

Summary 8

1. Introduction 9

2. Price stability and the need for central bank independence 10

2.1. Price stability as the primary mandate of the European Central Bank 10

2.2. Central bank independence from governments 11

3. Risks posed by climate change to macroeconomic and financial stability 11

3.1. Risks to macroeconomic and price stability 12

3.2. Climate-related risks to financial market stability 18

4. Possible central bank measures in response to climate change 20

4.1. Possible measures and instruments 21

4.2. Developments in the field 24

5. Tensions and conflicts in the pursuit of goals 26

5.1. Central banks and double materiality 26

5.2. Market neutrality: Should central banks be “neutral” with respect to climate change? Can they be neutral? 27

5.3. The ECB in the context of the climate crisis and European climate policy 28

5.4. Green monetary policy in an era of rising interest rates 29

5.5. The tension between fiscal and monetary policy 32

6. Conclusion 33

Bibliography 34

Figures

Figure 1: Sustainability risks 12
Figure 2: Influence of climate risks on monetary policy transmission channels 15
Figure 3: NIESR/UNEP scenario of a CO2 price increase by 2025: Effects on economic growth and inflation 16
Figure 4: Electricity from renewables became cheaper as we increased capacity – electricity from nuclear and coal did not 17
Figure 5: From environmental and climate risks to financial risks 19
Figure 6: Double materiality 27
Figure 7: Development of the ECB balance sheet 2010-23 31

Tables

Table 1: Impacts of climate change on key macroeconomic variables..... 14
Table 2: Examples of climate and environment-related risk drivers for banks 20
Table 3: Selected stylized options for adjusting operational frameworks to climate-related risks 22
Table 4: Micro- and macroprudential instruments 23
Table 5: Detailed ECB roadmap of climate change-related actions 25

Text box

Text box 1: The mandate of the ECB and the ESCB 28

Summary

Climate change has wide-ranging effects on society and the economy, presenting challenges for central banks. These challenges encompass both physical risks stemming from climate change and transition risks related to the shift toward a more sustainable economy. On one side, central banks need to respond to fluctuations in the general price level caused by climate-related factors like “climateflation,” “fossilflation,” “greenflation,” and “RE-disinflation.” On the other side, both physical and transition risks pose threats to financial stability.

To effectively address these challenges, central banks must adapt their monetary policies and macroprudential tools. Failing to do so could hinder their ability to achieve their core objectives, which include maintaining price stability and often promoting sustainable economic growth.

This focus paper offers specific suggestions as to what these adaptations might look like. First, it proposes the introduction of targeted green refinancing lines. Second, it argues for an adjustment of central banks’ eligible collateral frameworks. Third, the authors propose excluding bonds issued by carbon intensive companies that lack credible green transition strategies from bond purchase programs.

In addition, central banks should incorporate climate risks into their regulatory activities within financial markets. For example, this could include mandatory disclosure and reporting requirements regarding the sustainability of the portfolios held by banks, as well as the performance of regular stress tests focusing on climate risks. Moreover, in the realm of banking regulation, capital requirements should be adapted to account for climate and environmental risks.

In principle, alterations in the use of policy instruments can lead to goal conflicts for the central bank. For example, an excessively loose monetary policy aimed at encouraging sustainable investment could result in a central bank failing to achieve its objective of price stability. In addition, some observers fear that the transition to a green economy might lead central banks to take over tasks that are primarily the responsibility of national governments. This could undermine a central bank’s independence and thus its ability to guarantee stable prices.

However, this focus paper shows that with an appropriate choice of instruments, central banks need not expose themselves to goal conflicts, and that they can pursue their price stability mandate while also factoring in climate risks and impacts.

Indeed, Indeed, the adjustments to a central bank’s policy instruments proposed here would actually help, for example, the ECB pursue its primary mandate while simultaneously fulfilling its secondary mandate of supporting EU economic policies.

The authors would like to thank the participants of the March 17, 2023, Bertelsmann Stiftung workshop entitled “Inflation beats climate protection?” for their helpful comments.

1. Introduction

The global environmental crisis threatens to intensify further, jeopardizing the growth and stability of economies around the world. The effects of global warming and the destruction of natural spaces threaten both macroeconomic stability – that is, stable growth and prices – and financial stability. Central banks and financial-market oversight authorities have therefore focused increasingly on climate and other environmental risks in recent years and have started to adjust their operational frameworks.

Central banks (along with financial regulators) face a twofold task: They must improve their understanding of the macroeconomic impacts and the risks to financial stability associated with climate change and the destruction of natural environments, and they must minimize such risks within the context of their mandate. In this respect, there is no question that it is primarily the task of governments to pursue climate and environmental policies, and to achieve climate and environmental goals. However, climate change, environmental degradation and policies to counter them have direct implications for price and financial stability, and thus for the work and success of central banks.

The consequences of the climate and environmental crises affect central banks' core mandate of maintaining macroeconomic and financial stability (Volz 2017, NGFS 2019, Dikau and Volz 2021). It is now widely recognized that the physical risks of climate change and the loss of natural spaces, as well as transitional risks associated with the shift to a low-emission, more sustainable economy, create financial risks that must be minimized and controlled. Moreover, it is increasingly well documented that climate impacts can also threaten macroeconomic and price stability – including in the eurozone (Beirne et al. 2021; Dafermos, Kriwoluzky et al. 2021; Kotz et al. 2023). Central banks need to understand such relationships in order to respond appropriately. Furthermore, central banks must also consider the impact of climate- and environment-related risks on their own balance sheets (Elderson 2021). Central banks' investment strategies and collateral rules should minimize the environmental risks associated with such activities. This will serve to protect their own balance sheets, while also sending important signals to the financial markets and the real economy.

Central banks can play an important role in helping the financial and real economies align their activities with climate and sustainability goals, thereby minimizing climate and environmental risks. Finally, central bank policies and decisions play a major role in shaping markets. For example, their supervisory guidelines specify what commercial banks must take into account when making loans, issuing bonds or reporting to shareholders. Thus, financial institutions could be required to disclose climate- and nature-related risks, or to consider potential environmental impacts in their lending and investment activities. Provisions of this kind could help ensure that the financial system supports environmental change.

With regard to supporting the transition to a green economy, it is important to note that many central banks – including the European Central Bank (ECB) and the national central banks in the European System of Central Banks (ESCB) – also have a mandate to support their respective governments' economic policies. Consequently, one of their tasks is to review how they might support a sustainable transformation of the financial sector so that sustainability criteria are taken into account in lending and investment decisions.

A consensus has now emerged in the international central banking community that making provision for climate- and nature-related risks in the design of monetary policy, as well as in financial supervision that pursues traditional price and financial stability objectives, lies within the area of central banks' responsibilities and is covered by central bank mandates. Within the Network of Central Banks and Supervisors for Greening the Financial System (NGFS), which was established in 2017 and now includes 127 central banks and financial regulatory authorities as members, there is also

consensus that central banks and financial regulators should support the expansion of sustainable finance. How far this commitment should go, however, remains a controversial question.

Against this background, based on the current theoretical and empirical research literature, this focus paper discusses what central banks can and should do in response to climate change, and the extent to which potential actions conflict with the goal of price stability. After discussing the great importance of price stability for economic progress, the paper shows how central bank independence can ensure price stability. IIt additionally discusses the degree to which monetary policy that responds to aspects of climate change – even while acting within a central bank's mandate – jeopardizes this independence and thus price stability. The paper then examines the influence of physical and transition risks and impacts on inflation trends, as well as their potential repercussions on macroeconomic variables and financial stability. Based on these observations, it discusses potential central bank measures and examines several policies that have already been put into practice in the field. The focus paper proceeds to examine potential conflicts in objectives faced by central banks and the threats that may hinder the fulfillment of their mandated goals. It places special emphasis on challenges within the European context for a comprehensive analysis. The paper concludes with policy recommendations for the European Central Bank specifically.

2. Price stability and the need for central bank independence

Before addressing the challenges of climate change for central banks, this chapter discusses the importance of price stability for economic progress and explores why a high degree of central bank independence is necessary to achieve the goal of price stability.

2.1. Price stability as the primary mandate of the European Central Bank

Central banks' primary focus on price stability is based on the theoretical and empirical understanding that low and stable rates of inflation are a necessary condition for growth and development (e.g., Fischer 1991). Price stability is an essential ingredient of a functioning economy. In a market economy, prices have a steering function. The relative prices of two goods should and must hold informational content for consumers with regard to quality and scarcity. However, in an economy that lacks price stability, but where price adjustment carries costs, this informational content is sharply diminished. Due to the costs of price adjustment, firms in such an environment do not revise their prices on a continuous basis, but instead do so gradually at certain intervals, with the shifts being larger as a consequence. This can lead to situations in which the price for one good has just been adjusted, but that of another has not. The relative price difference between the goods then carries negligible informational content and leads to misallocations in purchasing decisions.

A second strong reason why price stability should be maintained in an economy is related to cold progression. Taxes and other contributions are levied based on nominal income. If nominal income rises, rates and thus tax burdens generally rise in parallel at first, disproportionately increasing tax and contribution rates for the lower- and middle-income brackets. This leads to a disproportionate burden being imposed on these income groups, and to a decline in private consumption.

Third, to the extent that inflation surprises the actors in an economy, it leads to a redistribution from lenders to borrowers. A lack of price stability thus prevents long-term loans from being concluded at fixed nominal interest rates. This in turn creates an environment that is detrimental to investment.

A fourth and final reason why ensuring stable prices in an economy is of great importance arises from the fact that in an economy, means of payment that do not offer interest (such as cash) have to be held in order to carry out transactions. Inflation devalues these means of payment. By contrast, price stability guarantees that this uncertainty associated with holding cash is minimized. This creates security for economic actors and increases the benefits of holding cash.

2.2. Central bank independence from governments

In today's central banking system, the value of money is not linked to a precious metal such as gold. Economic history shows that in such a case, monetary price stability can be achieved only with an independent central bank. In this regard, the central bank must be independent of both the government and public opinion. In the event that the central bank is not independent of the government, it can be forced to finance debt and thus government spending. However, if the central bank finances fiscal expenditures, it may not be able to tighten monetary policy sufficiently to counter rising inflation. This fact can be used to justify arguments against central bank action to curb global warming. A central bank that proactively contributes to climate change mitigation could run the risk of assuming tasks that are the responsibility of fiscal policymakers, or of financing these tasks. If the government assigns the central bank responsibility for combating climate change, or if it even speculates on the prospect of the central bank taking over tasks that are in fact fiscal policymakers' responsibility, then the independence of the central bank and thus the goal of price stability are at risk.

Moreover, in order to fulfill their mandate of price stability, central banks must be independent of public opinion as well as of the government. A central bank can continue to raise interest rates in difficult economic environments only if its decisions are independent of public opinion. If it is unable to do so, and instead has to give way to pressures exerted by a public fearful of further negative economic consequences, it will not be able to put a stop to rising inflation. A central bank that proactively seeks to mitigate the effects of climate change could lose its independence from public opinion, and face calls for further monetary easing in response to climate change. This would make it much more difficult to achieve the goal of price stability.

These two arguments identify potential risks of a monetary policy that seeks to respond directly to climate change. In the following sections, this focus paper highlights the risks to price stability that would arise if monetary policy were to ignore climate change.

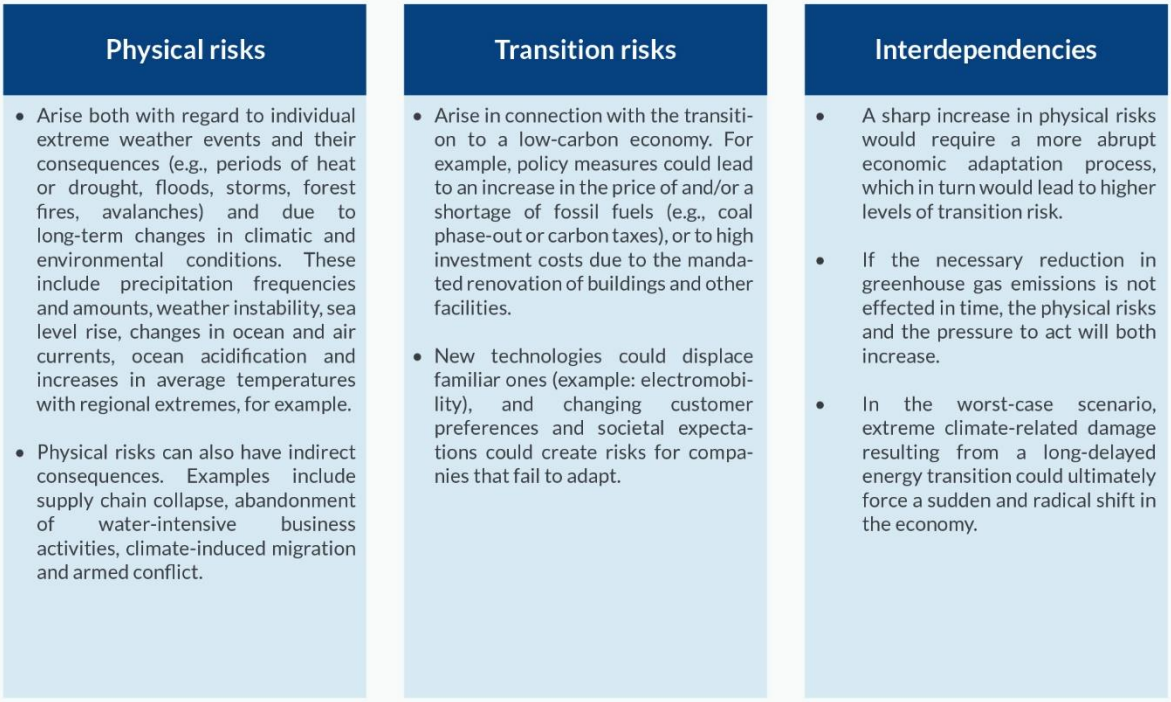
3. Risks posed by climate change to macroeconomic and financial stability

Both climate change and the loss of natural capital and related ecosystem services can have devastating consequences for the macroeconomy and price stability, while also threatening financial stability. Observers typically distinguish between two types of risks.

Physical risks relate to the physical impacts of a changing climate and ecosystem loss. These include an increase in the number and intensity of extreme weather events such as floods, storms or droughts. These are referred to in the literature as acute physical risks of climate change. In addition,

there are so-called chronic risks. This refers to gradual effects of climate change such as rising temperatures, rising sea levels, water stress or biodiversity loss. In addition, the scientific literature talks about so-called transition risks (also referred to as transition risks). These risks may arise in the course of adaptation to a lower-carbon and more sustainable economy. There are a number of drivers of transition risks. In addition to the consequences of policy and regulatory measures intended to protect the climate and the environment, these also include the impact of technological progress, changing consumer preferences and changes in market sentiment.

Figure 1: **Sustainability risks**



Source: Adapted from BaFin (2019).

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3.1. Risks to macroeconomic and price stability

Climate change and environmental degradation – as well as measures intended to combat them – can trigger both temporary shocks and structural changes, each of which can have significant consequences for economic activity and the financial system (Batten et al. 2020). This is particularly true with regard to inflation and future inflation expectations. Given this fact, a closer look at key macroeconomic variables is essential. Table 1 provides an overview of potential climate change impacts on key macroeconomic variables including output, consumption, investment, productivity, employment, wages, international trade, exchange rates, inflation and inflation expectations.

Both temporary and structural effects on key macroeconomic variables can be expected to have an influence on the conduct of monetary policy that increases over time and varies over different time horizons. They should thus also be deemed capable of reducing the central bank's freedom of policy action (NGFS 2020). One particular challenge lies in distinguishing between transitory and permanent shocks, and in understanding changes in inflation developments and dynamics. Equally important is to gain a better understanding of what factors can influence monetary policy transmission channels, and how (Figure 2).

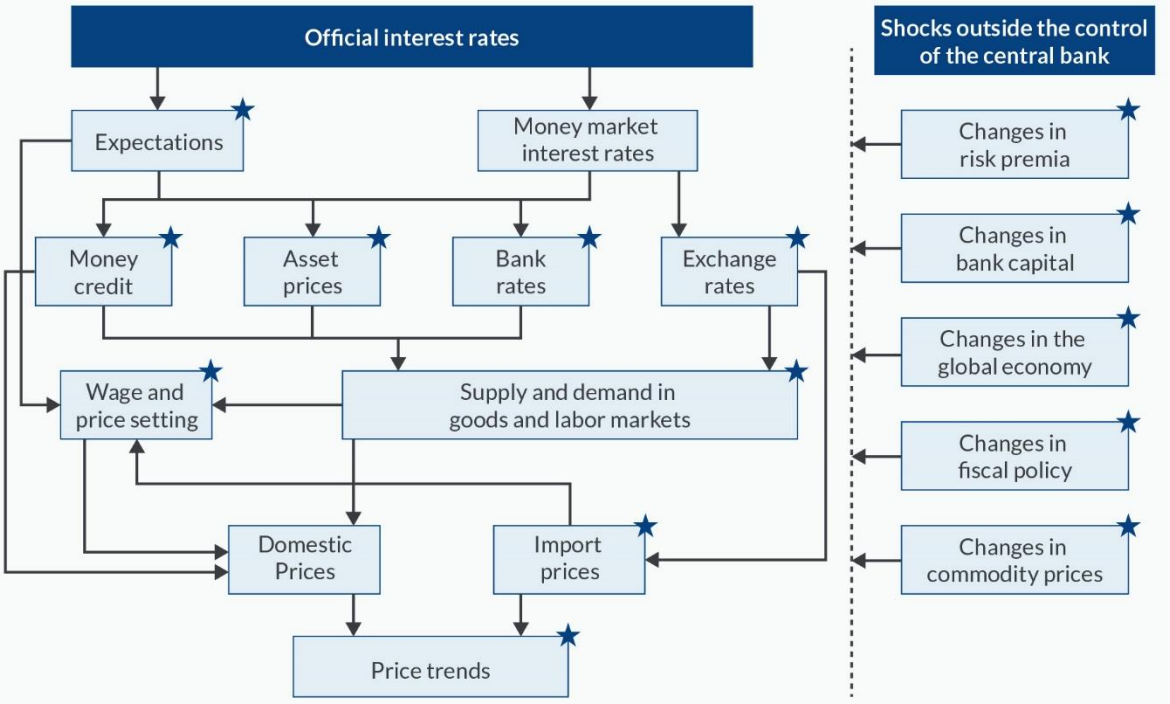
Central banks need to enhance their analytical toolkits by incorporating climate risks and their impacts into their macroeconomic models and forecasting tools. Climate change will also present monetary authorities with new challenges in terms of communication and credibility. Finally, shocks will in all likelihood become significantly more unpredictable. In the following section, we briefly discuss how climate change and climate-induced shocks could affect inflation as well as the natural rate of interest.

Table 1: Impacts of climate change on key macroeconomic variables

Variables	Extreme weather events Short to medium term	Gradual warming, with increasingly volatile temperatures and precipitation patterns Medium to long term	Transition to low-carbon economies Short to long term
Output	Lower due to physical damage (crop failures, destruction of production facilities and infrastructure, disruption of supply chains and tourism).	Lower due to reduced labor productivity, diversion of investment to climate-protection activities, and loss of arable land.	Redistribution of capital and labor could lead to tensions between sectors due to distortion-inducing (fiscal) transition policies and/or uncertainties introduced by (fiscal) transition policies, leading to insufficient/inefficient investments. Mitigating the impacts will depend on the use of (fiscal) transition policy budget allocations.
Consumption	Lower due to increased uncertainty, for instance around housing assets and future incomes. Higher due to increased household demand to replace destroyed goods, or due to hoarding.	Higher volatility due to shifts in sectoral demand.	Probably lower due to increased sustainability concerns. The transition to more environmentally friendly goods and/or services could also spur sectoral shifts. However, the impact on overall consumption is uncertain.
Investment	Lower due to increased uncertainty and volatility, as well as direct destruction of capital stock. May pick up after extreme events, but the effective or usable capital stock may well be reduced. Redirection of investment away from productivity-enhancing investments, and toward mitigation.	Shifts in investment toward climate adaptation technologies.	Higher if investments are shifted toward climate protection technologies. Lower due to greater uncertainty about future policies, an increase in sunken assets, and lower productivity gains associated with the international division of labor.
Productivity	Lower labor and capital productivity due to (possibly permanent) capital and infrastructure destruction.	Lower labor productivity due to lower levels of human capital accumulation (as a result of increased health problems and mortality).	Impacts on productivity uncertain, as technological advances could offset underinvestment likely to occur due to transition policies and the rise in stranded assets.
Employment	Lower due to property destruction and displacement of populations from the immediate vicinity of disaster areas. Potential frictional unemployment that could be reduced with sufficient labor mobility.	Reduction in labor supply in exposed industries such as construction and agriculture, in which it becomes less desirable to work due to higher temperatures. Increased international migration flows could increase labor supply in less affected regions.	Changes in sectoral composition of the labor market could lead to an increase in structural unemployment.
Wages	Uneven impacts across sectors and economies (agriculture, tourism and construction are most affected in developing countries). Labor reallocation may lead to labor shortages in some sectors, in which wages may temporarily increase. Wage patterns depend on duration of disaster impacts (e.g., floods).	Lower productivity levels caused by gradual warming could lead to lower wages.	Potential shift of workers from one sector to another, with retraining necessary.
Internationaltrade	Disruption of import/export flows due to disasters could result in lower revenues due to loss of export markets or higher import costs. Supply chain interruptions could lead to supply disruptions. Tourism may suffer due to the destruction of infrastructure.	Disruption of trade routes due to geophysical changes (e.g., rising sea levels). Increases in average temperatures could reduce export values.	Taxes, regulations and restrictions could disrupt import and export routes. Changing international demand for different types of energy products could affect energy exporters and importers differently. Market distortion risks due to asymmetric or unilateral climate policies. A robust, open international trade infrastructure could serve as a buffer that absorbs some of the negative impacts of climate shocks.
Exchange rate	Devaluation pressure on currencies of economies affected by climate disasters due to negative terms-of-trade shocks and lower labor productivity.	Downward pressure on currencies of economies frequently affected by climate disasters and/or loss of arable land due to extreme temperatures.	A floating exchange rate could serve to absorb shocks somewhat, especially for economies assumed to be further away from a low-CO2 emissions standard.
Inflation	Increased inflation volatility, especially with regard to food, housing and energy prices. Heterogeneous effects on headline inflation, with stronger and more persistent effects in developing countries. Impact on inflation expectations.	Relative price changes due to changes in consumer demand or preferences and changes in comparative cost advantages.	Energy prices most strongly affected by climate-related transition measures such as carbon credits and carbon taxes. Political uncertainty could boost inflation through its impact on investment, demand and inflation expectations. Inflationary pressures could be mitigated by technological changes that improve productivity or resilience, or by a shift in consumer preferences toward climate-friendly products and services, which are likely to be gradually added to the consumer basket as the weights of this basket are updated.
Inflation expectations	More homogeneous, sudden and frequent revisions of expectations are induced. Possible decline in the overall dispersion of inflation expectations (due to the synchronized responses of professional forecasters). Information rigidities typically disappear after (large scale) natural disasters.	The longer-term effects of climate-related shocks on the true inflation rate – for instance, on food and energy prices – may affect inflation expectations (due to the mutual causality between these two variables).	The formation of inflation expectations is influenced by factors such as changes in fiscal policies. The impact of transition policies on the true inflation rate could also affect inflation expectations.

Note: The short- to medium-term impacts of extreme weather events and gradual warming need to be assessed differently from those related to transition risks, which are subject to political uncertainty and therefore depend on other factors.
Source: NGFS (2020, Table 1).

Figure 2: **Influence of climate risks on monetary policy transmission channels**



Source: NGFS (2020, Figure 1).

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3.1.1. Climateflation, fossilflation, greenflation and RE-disinflation

The impact of physical and transition effects on inflation can vary. Schnabel (2022) has identified three new types of inflation: climateflation, fossilflation and greenflation. To this list, we add an additional type that we have termed RE-disinflation.

Climateflation refers to the price pressures resulting from global warming on production costs, shipping costs, agricultural yields and food prices. Moreover, climate-related events such as hurricanes, droughts, heat waves (heatflation) and floods can cause supply disruptions, which can in turn increase inflationary pressures.

Physical supply-side impacts of climate change include declining labor and capital productivity, the destruction of investment goods, declines in agricultural productivity and increases in the frequency of crop failures.

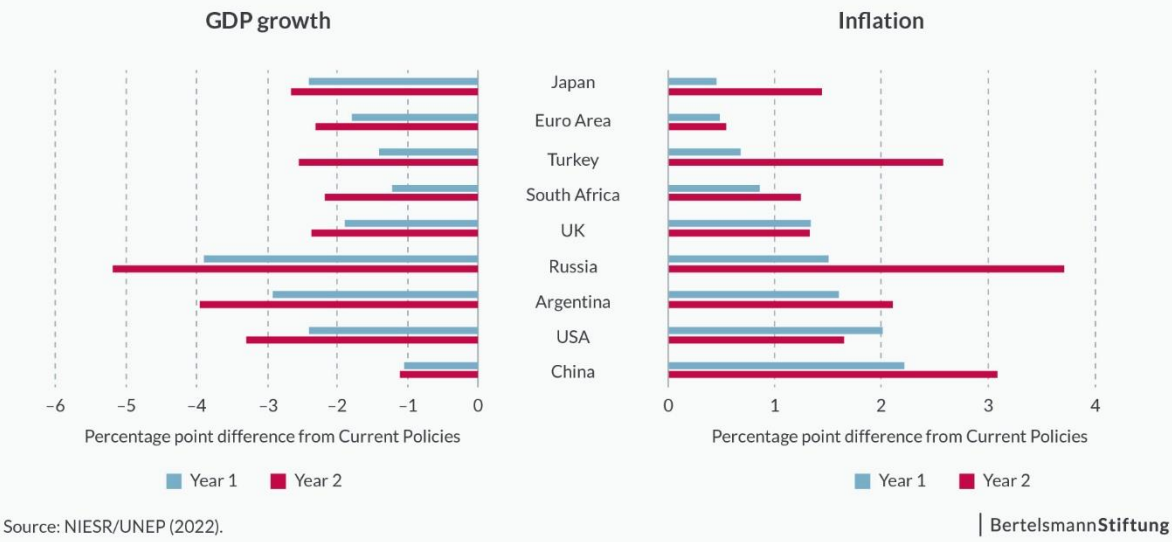
However, the physical risks of global warming can also affect the demand side of the economy by dampening consumption and investment. This can result from the increased uncertainty associated with extreme weather events, among other factors. Thus, from a theoretical perspective, it is unclear whether the physical effects of climate change will lead to a reduction or an increase in inflation.

Climate change is already having a direct impact on price stability in both developed and developing countries (Parker 2018, Heinen et al. 2018, Mukherjee and Ouatarra 2021, Dafermos et al. 2021, Beirne et al. 2021, Kotz et al. 2023). Disasters have already been demonstrated to have a significant effect on inflation within the eurozone as well (Dafermos et al. 2021, Kotz et al. 2023).

Fossilflation refers to a type of inflation that originates in the rise in the price of fossil fuels and is therefore directly related to an economy's dependence on such fuels. For example, policies aimed at supporting the transition to a net-zero economy (e.g., carbon pricing and environmental regulations) can drive up firms' production costs. The increased operating costs of facilities that remain embedded in a fossil-fuel-based energy system might then have an influence on prices, with these costs passed on to customers.

To be sure, fossilflation is likely to be a temporary phenomenon that will diminish as emissions fall. However, the transition period is likely to extend well beyond the short term, and is thus likely to have an appreciable influence on central banks' monetary policy. Figure 3 shows the estimated impact on economic growth and inflation for a scenario in which carbon prices increase by $130 and $700 per metric ton of CO2 by 2025 (NIESR/UNEP 2022).[1]

Figure 3: **NIESR/UNEP scenario of a CO2 price increase by 2025: Effects on economic growth and inflation**



Source: NIESR/UNEP (2022). | BertelsmannStiftung

Schnabel (2022) notes that fossilflation has been responsible for much of the recent sharp rise in eurozone inflation rates. In February 2022, energy accounted for more than 50% of overall inflation in the eurozone, mainly due to the sharp increases in oil and gas prices. Moreover, Schnabel (2022) observes that fossilflation reflects the legacy of dependence on fossil-fuel-based energy sources, which has not been reduced strongly enough in recent decades. In 2019, petroleum products and natural gas still accounted for 85% of total energy consumption in the eurozone.

In contrast, greenflation describes market-driven price increases in raw materials and other items, as well as policy-driven price increases, especially through carbon pricing or the elimination of climate-damaging subsidies. Green technologies such as electric vehicles, solar panels, wind turbines and batteries rely strongly on minerals such as copper, lithium and nickel. If the transition to carbon-neutral production occurs within a short period of time, there may be excessive demand for some of these minerals (Miller at al. 2023). This may lead to increased inflationary pressure.

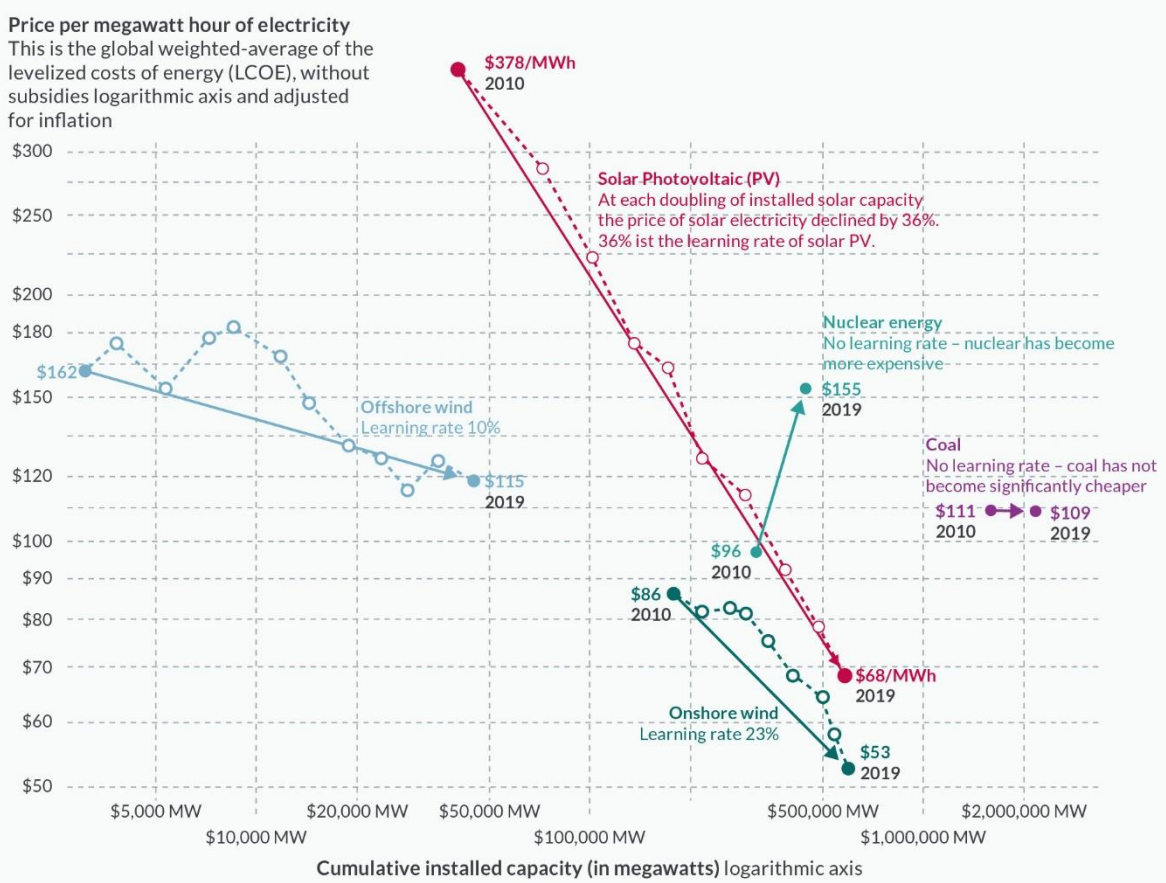
[1] For developed countries, the average CO2 price is assumed to be $550/ metric ton, and for other countries, the price is assumed to be less than $300/metric ton.

However, investments in green technologies could also lead to productivity gains in the associated technology fields or sectors, which would in turn serve as a constraint on greenflation.

That said, if central banks were to raise interest rates before this happens, this could undermine green investments, as these typically have high upfront costs. RE-disinflation results from a drop in energy prices due to the energy transition and its shift to lower-cost renewable energy (RE) sources. Figure 4 shows that producer prices for renewable energy have fallen rapidly over the past decade.

A continued decline in the cost of generating renewable energy, along with a simultaneous increase in the share of renewables in the energy mix, will have a disinflationary effect. Furthermore, the economy's decreasing reliance on fossil fuels and the lower price volatility for renewable energy may also help reduce overall inflation volatility (Beirne et al. 2023).

Figure 4: **Electricity from renewables became cheaper as we increased capacity – electricity from nuclear and coal did not**



Source: IRENA 2020 for all data on renewable sources; Lazard for the price of electricity from nuclear and coal – IAEA for nuclear capacity an Global Energy Monitor for coal capacity. Gas is noct shown because the price between gas peaker and combined cycles differs signficantly, and global data on the capacity of each of these surces is noct available. The price of electricity from gas has fallen over this decade, but over the longer run it is not following a learning curve.
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3.1.2. Impact of climate change on the natural rate of interest

The natural rate of interest is generally defined as the real interest rate that keeps the actual output of the economy at a level consistent with potential output and keeps inflation at its target value. It is usually regarded as a medium- to long-term benchmark for monetary policy, although it is not directly measurable, and its estimation is subject to considerable uncertainty.

From a model-theoretical perspective, the natural rate of interest refers to the price that brings the supply and demand for capital into equilibrium. If the demand for capital falls (↓) or the supply of capital rises permanently (↑), the natural rate of interest (↓) falls. The demand for capital comes from firms that want to invest for the purpose of production. This capital is provided by households that accumulate wealth. They convert this wealth into capital by (directly or indirectly) holding corporate shares or bonds, as well as government bonds.

The physical effects of climate change tend to lower the natural rate of interest. This can be illustrated with the help of a few examples. Increased macroeconomic volatility (↑) leads to an increase in the risk premium (↑), which in turn increases the cost of debt (↑) and reduces the demand for capital (↓). This leads to a decline in the natural rate of interest (↓). The increased uncertainty caused by climate change may also lead to higher levels of precautionary saving (↑), triggering an expansion of the supply of capital (↑) and thus also resulting in a drop in the natural rate of interest (↓). Similarly, climate change's negative effects on productivity (↓) – for example, due to increased temperatures – and its tendency to increase the rate of capital destruction (↑) – for instance, due to more frequent disasters – can reduce the marginal product of capital (↓). This in turn decreases the demand for capital (↓), and the natural rate of interest consequently falls as well (↓).

By contrast, the transition to a net-zero economy has ambiguous implications for the natural rate of interest. For example, the comparatively risky nature of green investment leads to a relatively high risk premium (↑), thus making debt financing more expensive (↑). This in turn reduces the demand for capital (↓) as well as the natural rate of interest (↓). In contrast, the high level of productivity associated with green technologies can increase the marginal product of capital (↑), which increases the demand for capital (↑) and the natural rate of interest (↑). Moreover, increased government debt (↑) due to green investment can push up the natural rate of interest (↑) by tightening the supply of capital (↓). These examples illustrate that careful analysis is needed to adequately model impacts on the natural rate of interest.[2]

Although the concept of the natural rate of interest is present in the research literature and plays a role in monetary policy practice, it is important to note that this framework ignores the endogenous nature of money: Banks can also expand their balance sheets without previously having accepted new deposits from savers (McLeay et al. 2014).

3.2. Climate-related risks to financial market stability

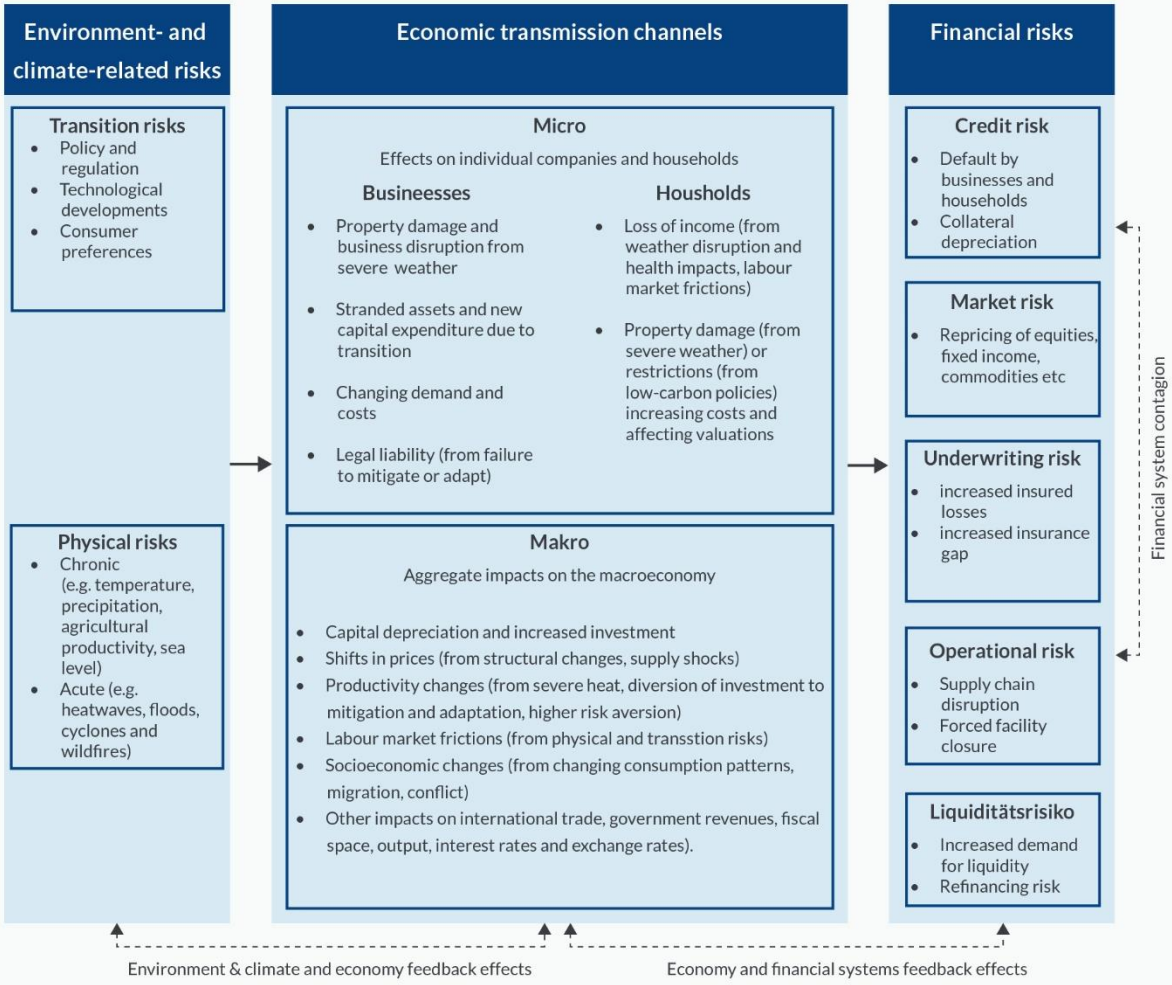
Climate and environmental risks pose significant systemic risk to the financial sector and can create "green swan" risks: potentially financially extremely disruptive events that could lead to the next systemic financial crisis (Bolton et al. 2020).[3]

Climate and environmental risks can have effects on individual households and businesses. These in turn can have aggregate macroeconomic effects. Both the microeconomic and macroeconomic effects can manifest as financial risks, which in turn can have an adverse impact on the central bank's ability to maintain price stability. For example, the central bank may find itself in the position of having to guarantee the stability of the financial system and prevent the collapse of the real economy by creating liquidity, even though this may entail considerable risks with respect to monetary stability. Figure 5 provides an overview of the transmission channels through which climate and environmental

[2] For a review of the analysis of the impact of climate change on the natural rate of interest using different macro models, see Mongelli et al. (2022).
[3] See also NGFS (2019), Basel Committee on Banking Supervision (2021).

risks can generate financial risks. In addition, Table 2 illustrates examples of climate- and environment-related risk drivers experienced by banks, along with the different types of financial risks.

Figure 5: **From environmental and climate risks to financial risks**



Source: NGFS (2022).

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Table 2: Examples of climate and environment-related risk drivers for banks

Affected risk types	Physical risks		Transition risks	
	Climate risks	Environmental risks	Climate risks	Environmental risks
	Extreme weather events Chronic weather patterns	Water stress Resource scarcity Biodiversity loss Pollution Other	Policy and regulations Technology Market sentiment	Policy and regulations Technology Market sentiment
Credit risk	The probability of default (PD) and the loss given default (LGD) associated with risk positions in sectors or geographical areas susceptible to physical risks could be affected by factors such as lower collateral valuations in real estate portfolios due to increasing flood risk, for example.		Energy efficiency standards could result in significant adaptation costs and reduced firm profitability, which could result in a higher probability of failure and lower collateral values.	
Market risk	Serious physical events could alter market expectations and lead to sudden revaluations, higher levels of volatility and declines in asset values in some markets.		Determinants of transition risk could lead to a sudden revaluation of securities and derivatives, for example in products related to industries subject to asset stranding – that is, a sudden and drastic decline in the value of assets.	
Operational risk	A bank's business operations could be disrupted by damage to its property, branch offices or data centers due to extreme weather events.		If consumer attitudes toward climate issues change, this could lead to reputational and liability risks for banks as a result of scandals stemming from the financing of activities deemed controversial from an environmental perspective.	
Other risk types (liquidity risk, business model risk))	Liquidity risk can come into play as customers withdraw funds from their accounts to finance the repair of damaged properties.		Transition risk factors can affect the viability of some business sectors, and for some business models, can lead to strategic risks in the absence of necessary adaptation or diversification measures. The sudden revaluation of securities may reduce the value of a bank's high-quality liquid assets, and thus have a negative impact on liquidity buffers.	

Source: ECB Banking Supervision (2020).

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Integrating climate-related risks into financial stability monitoring frameworks is an enormous challenge due to the complex dynamics and chain reactions involved, as well as the radical uncertainty associated with physical, social and economic processes (Bolton et al. 2020). Traditional backward-looking risk assessments and existing climate economic models cannot anticipate climate-related risks with sufficient precision.

4. Possible central bank measures in response to climate change

Today, central banks are increasingly in agreement that both monetary policy and financial supervision must account for climate and environmental risks and their impacts. This stems from the core mandate of central banks to stabilize both the macroeconomy and financial markets. Central banks as well as other supervisory authorities have a wide array of measures and instruments at their disposal. While the use of some of these measures and instruments is now widely accepted, others remain controversial.

We will preface our discussion of the use of different instruments and measures by distinguishing between the various objectives that central banks may pursue in addressing the climate crisis. On the one hand, the objectives might involve reacting to mitigate the climate and environmental risks that interfere with central banks' traditional core responsibility of maintaining macroeconomic and financial stability. On the other, institutions might pursue the goal of "greening" the economy and the financial system, which implies that central banks would play a proactive (supporting) role in advancing socio-ecological transformation (Volz 2017).

In practice, however, these two goals of limiting climate and environmental risks and fostering greener finance are closely intertwined. Stricter regulation of climate and environmental risks will ultimately make financing sustainable projects comparatively more appealing. The expansion of sustainability-driven investments, which includes both adaptation and transformation projects, would, in turn, mitigate environmental harm and reduce the economy's vulnerability, thereby decreasing future macroeconomic and financial risks. Consequently, central banks can contribute to enhancing economic resilience by promoting a more sustainable financial sector.

4.1. Possible measures and instruments

Central banks have a potentially large toolbox with which to address the risks and effects of climate change discussed in Chapter 3 (Volz 2017, Dikau et al. 2020). We will first discuss possible monetary policy measures. This will be followed by an overview of financial-market regulatory and supervisory instruments, as well as other options that can be used to promote sustainable finance.

4.1.1. Monetary policy measures

Table 1 provides an overview of possible options for adapting monetary policy instruments and operational frameworks to climate-related risks. Monetary policy instruments can either be adapted to integrate the risk perspective or adjusted to incentivize the expansion of sustainable finance and discourage unsustainable finance.

In its lending operations, for example, a central bank could adjust its pricing to reflect the sustainability of banks' lending practices. For instance, it could make the interest rate for its credit facilities dependent on the extent to which credit institutions' lending practices contribute to climate protection (relative to a relevant benchmark), and/or the extent to which they are decarbonizing their business models. Moreover, a central bank could adjust interest rates for credit institutions that pledge a higher proportion of low-carbon (or carbon-intensive) assets as collateral, or establish a credit facility, possibly at concessional rates, that is accessible only against low-carbon or otherwise sustainable assets. In addition, the central bank has the option of making access to (some) credit facilities conditional on a counterparty's disclosure of climate-related information or details about its carbon-intensive/low-carbon/green investments. A number of central banks – including those in Bangladesh, China, Japan, Lebanon, Malaysia and Hungary – have already implemented such approaches. With the exception of Hungary, however, central banks in Europe continue to express skepticism toward such measures.

A second approach that central banks could use to address the risks and effects of climate change would be to adjust the collateral framework. This defines the set of eligible collateral that financial institutions can use to obtain credit in operations with a central bank (Dafermos et al. 2021, Oustry et al. 2022).[4] For example, central banks could adjust valuation margins ("haircuts") to account for climate and natural risks, or altogether exclude asset classes that are unsustainable. Adapting the collateral framework is a highly effective instrument, as financial institutions have an incentive to hold assets that are eligible as collateral, or only those that receive small valuation haircuts. The ECB is currently in the process of integrating climate risks into its collateral framework.

Finally, central banks have the option of basing corporate asset purchase decisions on climate-related risks and/or on criteria applied at the issuer or asset level. For example, they could exclude assets or

[4] Dafermos et al. (2021) show that the collateral framework for eligible collateral in the EU context is subject to carbon bias.

issuers that did not meet certain climate-related criteria from such programs. A number of empirical studies show that the corporate bond purchase programs pursued by the ECB and the Bank of England have had a strong "carbon bias" in the recent past (Corporate Europe Observatory 2016; Matikainen et al. 2017; Jourdan and Kalinowski 2019; Cojoianu et al. 2020; Dafermos et al. 2020a, 2020b). This means that compared to the overall structure of the economy, a disproportionately large number of the bonds purchased were those of particularly carbon-intensive companies. This makes refinancing terms more favorable for these firms, while also increasing the stranded-asset risk on a central bank's balance sheet – that is, it exposes itself to the risk of a sudden and drastic decline in the value of carbon-intensive assets. Since the publication of these studies, both the ECB and the Bank of England have responded to the criticisms, and have started to decarbonize their corporate bond purchase programs.

Table 3: Selected stylized options for adjusting operational frameworks to climate-related risks

Credit operations[a]	
(1) Adjust pricing to reflect counterparties' climate-related lending	Make the interest rate for central bank lending facilities conditional on the extent to which a counterparty's lending (relative to a relevant benchmark) is contributing to climate change mitigation and/or the extent to which they are decarbonizing their business model.
(2) Adjust pricing to reflect the composition of pledged collateral	Charge a lower (or higher) interest rate to counterparties that pledge a higher proportion of low-carbon (or carbon-intensive) assets as collateral. Or: Set up a credit facility (potentially at concessional rates) accessible only against low-carbon assets.
(3) Adjust counterparties' eligibility	Make access to (some) lending facilities conditional on a counterparty's disclosure of climate-related information or on its carbon-intensive/low-carbon/green investments.
Eligible collateral[b]	
(4) Adjust haircuts	Adjust haircuts to better account for climate-related risks. Haircuts could also be calibrated such that they go beyond what might be required from a purely risk mitigation perspective. This could provide market incentives for sustainable assets.
(5) Negative screening	Exclude otherwise eligible collateral assets, based on their issuer-level climate-related risk profile for debt securities or on the analysis of the carbon performance of underlying assets for pledged pools of loans or securitized products. This could be done in different ways, including adjusting eligibility requirements, tightening risk tolerance, introducing tighter or specific mobilization rules, etc.
(6) Positive screening	Accept sustainable collateral so as to incentivize banks to lend or capital markets to fund projects and assets that support environmentally friendly activities (e.g., green bonds or sustainability linked assets). This could be done in different ways, including adjusting eligibility requirements, increasing risk tolerance on a limited scale, relaxing some mobilization rules, etc.
(7) Align collateral pools with a climate-related objective	Require counterparties to pledge collateral such that it complies with a climate-related metric at an aggregate pool level.
Asset purchases[c]	
(8) Tilt purchases	Skew asset purchases according to climate-related risks and/or criteria applied at the issuer or asset level.
(9) Negative screening	Exclude some assets or issuers from purchases if they fail to meet climate-related criteria.

a Credit operations are widely used to provide aggregate liquidity, and usually take the form of collateralized lending.
b Collateral policy defines the range of assets that can be pledged to secure central bank credit operations, as well as the risk control measures that apply to them.
c Central banks may buy a variety of assets from both public and private sectors, typically in an effort to exert greater influence on longer-term interest rate levels and spreads while improving market liquidity.

Source: NGFS (2021).

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4.1.2. Financial market regulation and supervision

Climate and environmental risks and effects must also be taken into account in financial market regulation and supervision. Micro- and macroprudential instruments and frameworks can be calibrated or designed to make provision for climate- and nature-related financial risks and to

contribute to the achievement of climate and environmental objectives. Table 4 provides an overview of possibilities in this regard.

Improving the transparency and availability of data relevant to climate and environmental risks is one very important area of activity. Developing standards, taxonomies and metrics will be important. However, creating disclosure requirements will also be critical in order to improve the identification, assessment and mitigation of relevant climate and environmental risks, and to support the mobilization of sustainable finance and investments. One vital step in making transition risks transparent is the implementation of prudential transition plans, which allow financial institutions to describe how they will align their portfolios with climate goals (Dikau et al. 2022).

With regard to the microprudential regulation of financial institutions, central banks can define clear regulatory expectations for the management of climate and environmental risks (Basel Committee on Banking Supervision 2022a, 2022b). Established tools such as stress tests can also be applied to climate and environmental risks (Baudino and Svoronos 2021). In addition, in the area of banking regulation, capital requirements can be adjusted to reflect climate and environmental risks (Berenguer et al. 2020, Chamberlin and Evain 2021, Dafermos and Nikolaidi 2021, Ford et al. 2022).

In the area of macroprudential regulation, system-wide stress tests can be conducted with the goal of identifying systemic risks arising from climate change and environmental degradation. Banks, especially systemically important financial institutions, could subsequently be required to build up additional buffers against systemic risks (e.g., countercyclical and higher capital buffers) (Philipponna 2020, Monnin 2021). The introduction of so-called exposure limits would also be a conceivable option.

Table 4: Micro- and macroprudential instruments

Microprudential instruments	Macroprudential instruments
• Mandatory disclosure requirements for climate-related financial risks or other sustainability risks.	• System-wide stress testing that analyzes and assesses systemic climate-related financial risks.
• Stress-testing frameworks that analyze climate and other sustainability risks, and help firms take into account longer-term risks.	• Cyclical instruments calibrated to account for and mitigate systemic risk implications of climate change, and restrain the build-up of risk-taking during the recovery/expansion phase (e.g., countercyclical and higher capital buffers in order to prevent carbon-intensive lending growth; LVRs and loan-to-income ratios to limit the extension of credit by banks to carbon-intensive industries and investment in non-sustainable asset classes).
• Supervisory review process that highlights management of climate-related financial risks or other sustainability risks.	
• Climate-risk-sensitive calibration of other Basel III instruments distinguishing between low-carbon and carbon-intensive/high-exposure assets, to create buffers against climate-related losses. Examples: Differential risk-based capital requirements, lower required stable funding factor for green loans.	• Cross-sectional instruments calibrated to account for and mitigate systemic risk implications of climate change and to mitigate individual institutions' contribution to systemic risk (e.g., large exposure restrictions to limit financial institutions' exposure to highly carbon-intensive assets, capital surcharges for systemically important financial institutions and institutions with high exposure to carbon-intensive assets).

Source: Dikau et al. (2020). | BertelsmannStiftung

4.1.3. Other measures

In addition to monetary policy and prudential measures, central banks can take numerous other steps to help make financial markets more sustainable. For example, working in cooperation with banking associations and other industry groups, they could conduct a dialogue on sustainability with market participants.

In addition, central banks could support the sustainability agenda by helping to craft sustainable finance roadmaps, and by taking a leading role in developing the critical elements of the financial architecture needed for sustainable finance, including standards, taxonomies and metrics, disclosure

rules, and an effective data and information infrastructure. This will be an important step in improving the identification, assessment and mitigation of relevant climate and environmental risks, as well as the framework for mobilizing sustainable finance and investment (Dikau et al. 2022). Institutions can also follow sustainability principles in the management of their own portfolios, in part by disclosing their own climate and environmental risks and explaining how they are addressing them (e.g., Banque de France 2021). This would allow central banks to lead by example, while setting new standards in the process.

4.2. Developments in the field

In recent years, central banks around the world have taken a number of measures in this field. They have given particular attention to integrating climate risks – and increasingly environmental risks – into risk management expectations and other regulatory frameworks. Some central banks and regulators have created disclosure requirements and defined regulatory expectations relating to climate and environmental risk management. The Basel Committee on Banking Supervision (2022) has already published a set of guidelines on this issue as well. By contrast, capital requirements and other instruments have not yet been adjusted.

In Europe, the ECB issued guidance on climate and environmental risks, including supervisory expectations relating to risk management and disclosure, in 2020 (ECB 2020). The following year, the European Banking Authority (2021) issued expectations relating to the management and supervision of ESG risks for credit institutions and investment firms. Similarly, the ECB Banking Supervision (2022a), which in the context of the Single Supervisory Mechanism (SSM) constitutes the central supervisory authority for the largest financial institutions in the eurozone (as well as non-euro EU countries that have joined the SSM), stated as a strategic objective in its supervisory priorities for 2023-2025 that: “Banks should adequately incorporate climate-related and environmental (C&E) risks within their business strategy and their governance and risk management frameworks in order to mitigate and disclose such risks, aligning their practices with current regulatory requirements and supervisory expectations.”

Numerous central banks and regulators, including the ECB, have started to conduct climate stress tests to assess the vulnerability of individual banks and of the financial system as a whole with regard to climate and environmental risks. Published in July 2022, the results of the ECB’s stress test on climate risks – in which the 104 “significant banks” directly supervised by the ECB participated – indicated that banks had not yet sufficiently incorporated these risks into their stress testing frameworks and internal models, despite some progress since 2020 (EZB Bankenaufsicht 2022b). About 60% of the banks tested did not yet have a robust climate-risk stress testing framework and lacked relevant data and did not yet incorporate climate risks into their credit risk models. Just 20% of the banks tested took climate risks into consideration as a variable when granting loans. The ECB will consider the results of this stress test in the course of its Supervisory Review and Evaluation Process (SREP). However, for the time being, this will not have a direct impact on the bank’s own capital through the Basel Pillar 2 recommendations.

As a result of its Strategic Review, the ECB presented a detailed “Roadmap of Climate-Related Actions” in July 2021 (ECB 2021a, 2021b). Among other elements, this included the incorporation of climate change considerations into the organization’s monetary policy instruments, the development of climate-related indicators and modeling approaches in its macroeconomic modeling, the use of climate-related disclosures, and the conduct of climate stress tests (see Table 5). In early 2021, the ECB established a climate change center to help shape and steer the climate agenda. In March 2023,

the ECB published information on the carbon footprint associated with its corporate bond portfolio for the first time (ECB 2023).

Table 5: Detailed ECB roadmap of climate change-related actions

		2021	2022	2023	2024
1	Eurosystem/ECBstaff macroeconomic projections	Introduce technical assumptions on carbon pricing for forecasting and regularly evaluate the impact of climate-related fiscal policies on the Eurosystem/ECB staff macroeconomic projections baseline.			
2	Macroeconomic modeling and scenario analyses		Integrate climate risks into the ECB's workhorse models and assess their impact on potential growth. Conduct scenario analyses regarding transition policies. Model implications of climate change for the transmission of monetary policy.		
3	Statistical data for climate-change risk analyses	Develop indicators on green financial instruments. Construct indicators on exposures of financial institutions to climate-related physical risks through their portfolios. Derive indicators on the carbon footprint of portfolios of financial institutions		Develop new statistical collections related to climate change	
4	Market neutrality and efficiency concepts in monetary policy operations	Assess potential biases in the market allocation amid market inefficiencies and the pros/cons of alternative allocations	Make concrete proposals for alternative benchmarks, in particular for the Corporate Sector Purchase Program (CSPP).		
5	Disclosures in line with EU policies as an eligibility requirement in collateral framework and asset purchases	Proposal and adoption of EU disclosure regulation.		In force	First regulatory disclosures covering 2023.
			Design adequate policies and conduct legal and operational preparations.	Adaptation period for issuers.	In force.
6	Climate stress-testing of the Eurosystem balance sheet	Prepare data and methodology.	Conduct pilot stress test based on the 2021 ECB economy-wide climate stress test and 2022 supervisory climate stress test of individual banks.	Build upon the pilot stress test and introduce regular climate stress testing.	
7	Climate change risks in credit ratings for collateral and asset purchases	Assess rating agencies' disclosures Understand how they incorporate climate change risk in ratings.	Introduce requirements into the Eurosystem Credit Assessment Framework (ECAF) targeted to climate change risk, if warranted		
		Develop minimum standards for internal credit ratings.			
8	Climate change risks in the collateral framework	Review collateral valuation and risk control framework to ensure that climate change risks are reflected. Assess financial innovation related to environmental sustainability.		Monitor the adequacy of the collateral valuation and risk control framework to ensure that climate change risks are properly reflected. Design and implement changes, if warranted.	
9	Climate change risks in the CSPP	Conduct enhanced due diligence to incorporate climate change risks.			
		Prepare climate-related disclosures of the CSPP.			
		Develop proposals to adapt the CSPP framework to include climate change considerations.	Adapt CSPP framework.		

Source: EZB (2021b).

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With respect to Germany, the Deutsche Bundesbank, as a founding member of the NGFS, has played a significant role in encouraging central banks to address the climate issue. As a central bank with a conservative reputation and a strong focus on stability, it has been instrumental in ensuring that climate risks to both financial and macroeconomic stability are taken seriously by central banks. Like

the ECB, the Bundesbank has emphasized the importance it attributes to the issue of climate change by building up expertise in the field of climate-related research. Moreover, like the other central banks in the Eurosystem, the Bundesbank published its first climate-related report in July 2022 (Deutsche Bundesbank 2022). This provided a look at how the Bundesbank makes provision for climate-related risks within its mandate and within the individual operational areas.

5. Tensions and conflicts in the pursuit of goals

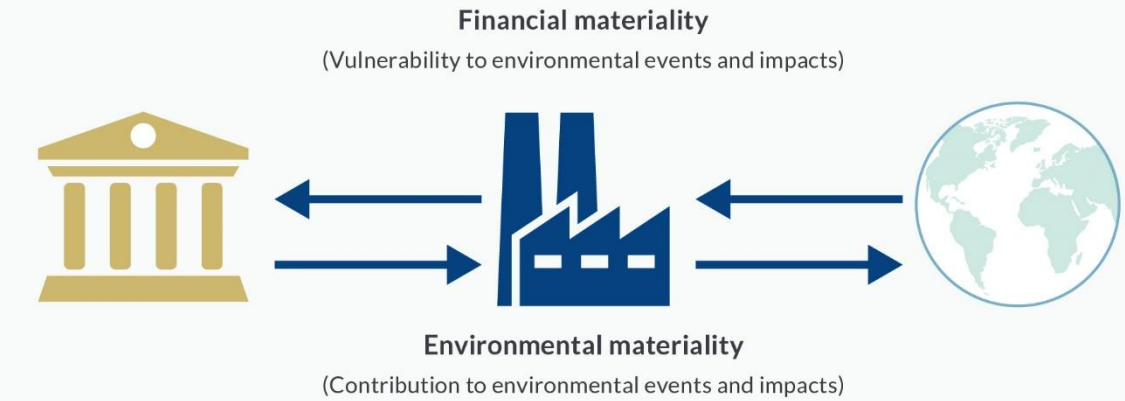
It is today widely accepted that in pursuing their core mandate, central banks must incorporate climate and environmental factors into their macroeconomic analyses and prudential frameworks, without this necessarily meaning they are pursuing a dedicated “sustainability agenda.” Similarly, central banks clearly have many instruments at their disposal to proactively address climate and environmental concerns. Nonetheless, using these tools comes with the risk of potentially overstepping their mandate or creating the perception of doing so (Volz 2017), which could expose them to criticism and entangle them in political processes, ultimately threatening their independence.

Nevertheless, relying solely on a passive response to the impacts of climate change may not be adequate, especially considering central banks' responsibility for maintaining macroeconomic and financial stability. One critical aspect to consider is the time frame within which central banks should address climate and environmental risks. This chapter explores potential conflicts between central bank objectives in responding to climate change, and the extent to which ensuring long-term macroeconomic stability requires a rethinking of how central banks employ their available tools.

5.1. Central banks and double materiality

One important debate, which is also highly relevant to central banks, has risen around the concept of double materiality. This centers on rethinking and expanding the existing accounting and auditing convention of materiality (Boissinon et al. 2022). The concept of single materiality suggests that the accounting and reporting framework used by an organization (e.g., a company) should reflect all information that could influence decisions by recipients of that organization’s financial statements, such as its investors (see, for example, IFRS 2018). With regard to climate change, this means that organizations should disclose their vulnerability to climate-related events and risks. In contrast, under the concept of dual materiality, the way the organization’s own activities affect the environment would also be deemed material, alongside the impact of negative environmental developments on the organization (e.g., European Commission 2019a, 2019b, Figure 6).

Figure 6: **Double materiality**



Source: Adapted from Oman and Svartzmann (2021). | BertelsmannStiftung

For central banks, the concept of dual materiality has relevance that extends beyond their supervisory role, as their other activities including monetary policy can amplify negative climate externalities (Boissinon et al. 2022). For example, as noted above, the ECB and Bank of England corporate asset purchase programs have had a strong "carbon bias," and have thus created favorable refinancing conditions for firms with problematic climate profiles. Both the ECB and the Bank of England announced plans to decarbonize their corporate bond purchase programs in 2022, implicitly acknowledging the concept of dual materiality.

Beyond the issue of bond purchase programs, the NGFS (2021) has discussed proposals to adjust instruments such as collateral frameworks with a focus on their climate impact (see Table 3). The NGFS report called "Adapting central bank operations to a hotter world" states: "Where it falls within their policy remit, central banks could also consider going beyond the adjustment of their operational frameworks solely from a risk management perspective by seeking to ensure that their monetary policy operations do not undermine the transition to a low-carbon economy and/or by exploring ways in which they can actively support that transition" (NGFS 2021, p. 4).

5.2. Market neutrality: Should central banks be "neutral" with respect to climate change? Can they be neutral?

One key question is the extent to which central banks should intervene in markets. The principle of market neutrality is a concept long cherished by central banks. According to this precept, central banks should not interfere with the market's free allocation of resources. The assumption is that by following this rule, they will avoid distorting interest rates or risk premiums. However, viewing this concept as a rigid criterion of behavior is problematic from two perspectives. First, the notion that central banks can be market neutral is naive and does not reflect the wealth of empirical evidence that exists on the subject. For example, every interest rate decision has allocative consequences. The ECB asset purchase programs of recent years have also failed to meet the criterion of market neutrality. Instead, they have favored "non-green" sectors relative to "green" sectors (Papoutsi et al. 2022). Second, it is problematic if the central bank wants to be neutral in the context of a clear market failure. Lord Nicholas Stern has described climate change as the result of the greatest market failure the world has ever seen. To remain neutral in the face of this market failure would mean perpetuating it. Leading central bankers have recognized this problem. For example, Isabel Schnabel (2021a), a member of the ECB Executive Board, has said, "the existence of climate externalities implies that we need to reconsider the notion of market neutrality. In the presence of market failures, adhering to the

market neutrality principle may reinforce pre-existing inefficiencies that give rise to a suboptimal allocation of resources."

5.3. The ECB in the context of the climate crisis and European climate policy

The ECB has a clear primary mandate, which is to maintain price stability within the eurozone. However, it also has a secondary mandate, which is to support EU economic policies to the extent this does not jeopardize the achievement of the primary mandate (see box). According to Frank Elderson (2021), member of the ECB Executive Board, the "secondary objective" of the ECB represents "a duty, not an option, for the ECB to provide its support."

Text box 1: The mandate of the ECB and the ESCB

Article 127	Article 3
• of the Treaty on the Functioning of the European Union sets out the objectives of the single monetary policy: "The primary objective of the European System of Central Banks (hereinafter referred to as 'the ESCB') shall be to maintain price stability. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union as laid down in Article 3 of the Treaty on European Union."	• **of the Treaty on European Union, in turn, defines as the Union's objective as the** "sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment." This means that the ESCB's mandate actually includes support for the European Union's environmental objectives, as long as this does not interfere with the goal of price stability

Source: Volz (2017). | BertelsmannStiftung

In addition, both the ECB and the national central banks within the eurozone are subject to the currently valid legislation of the European Union (EU). As part of the Green Deal, the European Commission proposed the first European-level climate law, which, once adopted by the European Parliament and Council in June 2021, made the goal of climate neutrality legally binding (European Commission 2021). The EU Climate Law requires the community of states to reduce greenhouse gas emissions by at least 55% below 1990 levels by 2030. Furthermore, climate neutrality is to be achieved in the EU by 2050.

Under the law, the EU institutions – a list that includes the ECB – and the member states are required to take the steps necessary to achieve this objective at the EU and national levels, respectively. The aim is to ensure that all EU policies, as well as all sectors, are aligned with this objective.[5] This also means that the ECB and the national central banks will have to review their activities to determine whether they are consistent with or contradict the objective of climate neutrality. In this regard, monetary policy measures cannot be seen as having necessarily positive climate effects. However, central banks are expected to prevent negative climate effects (as have been produced by past corporate bond/asset acquisitions) in order to ensure the coherence between EU policies required by the EU treaties. As noted by Elderson (2021), "the Treaties explicitly state that environmental protection requirements must be integrated into the definition and implementation of all EU policies and activities, which include actions taken by the ECB." Elderson therefore concludes that:

[5] A number of EU member states have already enshrined a net zero emissions target into law. Germany and Sweden are now required to achieve net zero emissions by 2045, and Denmark, France, Italy and Hungary by 2050 (European Parliament, 2020).

“[t]hese provisions, although not conferring a specific mandate for ECB climate change action, do require us to take into account the EU’s environmental objectives and policies when pursuing both our primary and secondary objectives.”

5.4. Green monetary policy in an era of rising interest rates

The ECB faces clear challenges in the current macroeconomic environment. For example, there is currently the appearance of conflict between efforts to fight inflation and the EU’s climate objectives. As noted by Schmidt et al. (2019), rising interest rates have a detrimental impact on the energy transition envisaged by climate policy (and enshrined in EU climate law). Investments in renewable energy and other elements of a low-carbon and climate-resilient infrastructure have high upfront costs. When central banks fight inflation by increasing interest rates, they discourage investment in renewable energies, as well as in the transition to a low-carbon economy.

ECB Executive Board member Isabel Schnabel (2023) has recognized this problem, stating in January 2023 that: “[T]he relatively large upfront costs incurred in these capital-intensive expenditures are particularly susceptible to changes in the cost of credit. Low and declining interest rates have measurably contributed to the fall in the ‘levelized cost of electricity,’ or LCOE, of renewable energies. As a result, the cost of electricity from renewable sources is now comparable to, or lower than, that of conventional power plants. These developments now risk being reversed by the marked rise in global interest rates over the past year. Since fossil fuel-based power plants have comparably low upfront costs, a persistent rise in the cost of capital may discourage efforts to decarbonize our economies rapidly.” However, Schnabel (2023) concludes that central banks cannot do much about this problem, and that a failure by central banks to reduce high inflation rates in a timely manner would represent a greater threat to the energy transition. According to Schnabel, society would benefit more in the medium to long term from a restrictive monetary policy stance and the restoration of price stability.

Yet this position ignores the fact that central banks have other options than simply changing the key interest rate. The ECB (and other central banks as well) could pursue a nuanced monetary policy, specifically by engaging in interest rate differentiation. The logic is very simple: When it appears necessary to raise interest rates in order to contain inflationary pressures and manage inflation expectations, central banks should proceed in their usual manner. However, they could also keep open a refinancing window with lower interest rates for targeted investments, for example in renewable energies and energy efficiency. The experience of the Ukraine war has underscored the fact that international fossil-fuel price shocks drive up domestic inflation rates. However, countries that are less dependent on energy imports, and which have a higher share of renewables in their energy mix, are less exposed to such shocks. Expanding investment in renewable energy and energy efficiency, and thereby reducing dependence on fossil fuels and their volatile prices, would therefore contribute to curtailing carbon emissions and to reducing inflation rates and their volatility – thus furthering the central bank’s objectives.

With the introduction of a special refinancing instrument, the ECB could facilitate investment in areas that would reduce inflationary pressures over the medium term, which would in turn help the bank achieve its price stability objective. A policy of this kind would have the positive side effect of supporting the transition to a low-carbon economy, thereby contributing to the achievement of the EU’s climate targets. This would additionally contribute to reducing long-term climate-related risks and impacts, which would help the ECB achieve its mandate over the long term.

Proposals of this nature are hardly breaking new ground, especially within the academic discourse. Even before the recent eurozone inflation shock, van 't Klooster and van Tilburg (2020) called on the

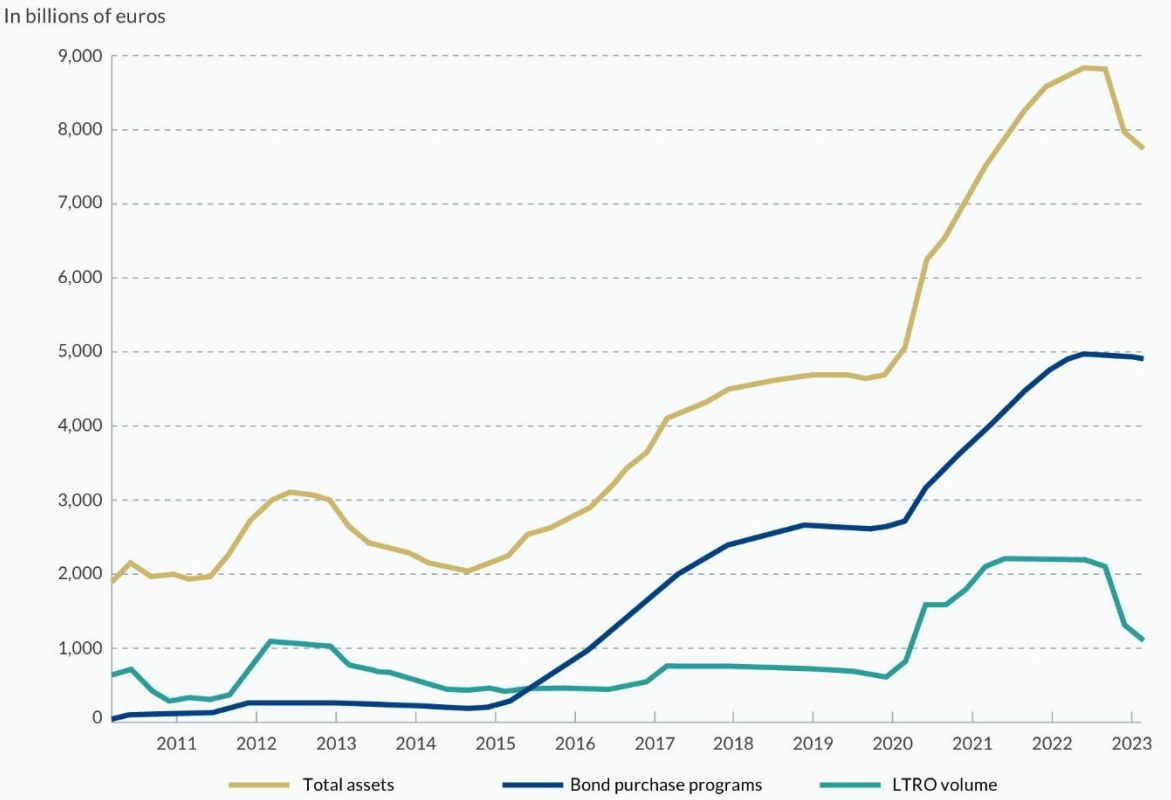
ECB to introduce green targeted longer-term refinancing operations (TLTROs) in order to boost green investment. Böser and Senni (2021) have also proposed the implementation of climate-risk-adjusted refinancing operations. Even in the current high-inflation context, van 't Klooster (2022) reiterated the case for interest rate differentiation at the ECB, while Colesanti Senni and van 't Klooster (2023) also proposed a green TLTRO program.

To some, this monetary policy approach may sound new, and very radical. However, leading central banks around the world have in fact already applied differentiated interest rates. In 2008, the Bank of Korea introduced a Bank Intermediated Lending Support Facility that provides financing at low interest rates to financial institutions that lend to SMEs. In 2010, the Bank of Japan established a program (the “Fund-Provisioning Measure to Support Strengthening the Foundations for Economic Growth”) focused on economic activities that strengthen the foundations for Japan’s economic growth. The Bank of England (in conjunction with HM Treasury) launched a program called the Funding for Lending Scheme in 2012 to encourage lending to households and businesses. The ECB has also been using TLTROs since 2014 to support the real economy.

Such refinancing lines can also be offered “in green,” as some central banks are indeed already doing. In 2016, the People's Bank of China introduced discounted green refinancing for commercial banks that use green loans or bonds as collateral. In 2021, the People’s Bank of China introduced a Carbon Emission Reduction Facility. Also in 2021, Magyar Nemzeti Bank (the Hungarian central bank) established a Green Home Program within its Funding for Growth Scheme, as well as a Green Mortgage Bond Purchase Program. The Bank of Japan also introduced its Funds-Supplying Operations to Support Financing for Climate Change Responses program in 2021. Finally, the Bank Negara Malaysia (the Malaysian national bank) created a High Tech & Green Facility and a separate Low Carbon Transition Facility in 2022.

The current high-inflation environment, which can be largely attributed to fossil-fuel price shocks, suggests that the ECB should follow these examples and establish targeted refinancing facilities that support investments in renewable energy and energy efficiency. This would be entirely within the mandate of the ECB (and other central banks as well), as a monetary policy instrument of this nature would directly help to stabilize inflation rates and reduce the risk of fossil-fuel price shocks.

Figure 7: **Development of the ECB balance sheet 2010-23**



Source: Authors, based on ECB data. | BertelsmannStiftung

Objections that the introduction of a “green” TLTRO program would counteract the ECB’s efforts to tighten monetary policy are not valid, as we argue below. Figure 7 shows the development of the ECB’s balance sheet since 2010. The beige line depicts the ECB’s total assets. The ECB’s longer-term refinancing operations (LTROs, green line) were larger in volume than its bond purchase programs (blue line) until 2015. TLTROs – a subcategory of LTROs – were introduced by the ECB in 2014. Since that time, three TLTRO programs have been established. The first program began in June 2014, while the most recent opened in September 2019.

In total, just over €2 trillion was lent through the TLTRO programs. At times, TLTROs accounted for almost 25% of the ECB’s total balance-sheet assets. However, the scope of this measure has been cut in half, and is slated for imminent further reduction. Figure 7 shows that the reduction in TLTRO programs accounts for the largest share of the reduction in the ECB's balance sheet in the recent past.

However, the scale of the TLTRO programs should be contrasted with that of the ECB’s bond purchase programs. After bonds worth more than €2.5 trillion were acquired under the first asset purchase program (APP), acquisitions on a similarly large scale followed in the course of the Pandemic Emergency Purchase Program (PEPP). The two bond-buying programs together total €5 trillion, and account for more than 50% of the ECB's balance sheet. That is why the introduction of a green TLTRO program would not counteract efforts to tighten monetary policy – if the ECB simultaneously proceeded to dismantle its bond-buying programs.

In this context, it is worth noting that while the ECB’s interest rate policy is certainly important for firms’ financing conditions, there is no consensus as to the degree of influence that the size of the balance sheet has on the level of inflation. Studies by Sargent and Surrico (2011) and by Teles et al. (2016)

show that since the 1980s, there has been no relationship between the growth of the money supply (and hence the central bank's balance sheet) and the inflation rate. The authors regard the introduction of inflation targeting as being the cause of this disjunction. Even with the introduction of a green TLTRO program, the ECB can and should continue to pursue its inflation target in order to achieve the objective of price stability. Therefore, the ECB's balance sheet does not play a prominent role as an inflation driver.

A similar instrument that could be implemented as a complement to a green TLTRO program would be a system of tiered reserve requirements (van 't Klooster 2023). Many central banks require banks to hold a portion of their assets as central bank reserves. Originally, this requirement helped ensure that banks would be able to service deposit outflows, and helped stabilize the demand for central bank cash. In the climate-crisis era, reserve requirements could be tiered on the basis of climate risks and impacts. For example, the reserve requirement for non-green assets could be increased, which would reduce the volume of inflationary lending. Similarly, a reduction in reserve requirements for green assets would encourage sustainable investment.

5.5. The tension between fiscal and monetary policy

Chapter 2 of this focus paper argued that the central bank must be independent of the government in order to carry out its mandate. In particular, this means that it should not feel obliged to perform tasks that are primarily the responsibility of national governments. Issuing concessional loans that promote sustainable investments can be numbered among such tasks. In Germany, this role can be and is performed by the Kreditanstalt für Wiederaufbau (KfW), a development bank owned by the German federal government. Lending by KfW takes place on more favorable terms than is true of commercial loans, partly because KfW can refinance itself inexpensively on the capital markets thanks to its AAA rating, and partly because it can issue publicly subsidized loans with subsidized interest rates. Thus, the government is in this case using fiscal policy to encourage investment in the green transition.

However, a number of important factors argue against leaving the financing of sustainable investments solely to fiscal policy in the era of climate crisis. Moreover, it is far from clear that the independence of the central bank would be endangered by this intervention in the market. On the one hand, the response to climate change in the eurozone, including in Germany, requires investments on a scale that significantly exceeds the financing capabilities of public development banks such as KfW (with a funding volume of €167 billion in 2022) or the European Investment Bank (with a funding volume of €72.45 billion in 2022, including financing from the European Investment Fund).[6] Even public investment packages such as NextGenerationEU, the EU's stimulus package for the 2021-2026 period that exceeds the €800 billion mark, will not be enough to make the economy climate-neutral. In Europe's energy and transport sector alone, annual investments of around €300 billion are needed (Klaassen and Steffen 2023). A significant portion of the investment in the decarbonization of the European economy must thus be financed by loans from private banks, savings banks and cooperative banks. This is where the ECB's interest rate policy with the introduction of green TLTROs can make a crucial difference.

Second, as described in chapter 3, climate change is generating changes that affect the ECB's primary mandate. Climate risks jeopardize the goal of price stability. By financing lower-interest loans for sustainable investments, the ECB could help create the maneuvering room it will need to continue achieving the objective of price stability in the future. If the ECB ignores the negative impact of its

[6] KfW's funding volume grew exceptionally strongly in 2022, by a total of 56%. This was due to large-volume transactions on behalf of the German government ("strategic mandated transactions") amounting to €58.3 billion in connection with securing the energy supply in Germany.

monetary policy on critical investments in the energy transition and the decarbonization of the economy, the EU will be increasingly unlikely to meet its climate targets. This in turn would magnify future macroeconomic and financial risks and make it more difficult for the bank to achieve its mandate. ECB inaction and a reliance instead on government fiscal policies would be counterproductive in this context – not least because the green TLTRO program we are proposing is in no way inconsistent with achieving the inflation target.

To be sure, in this often-tense relationship between the central bank and the government's fiscal policy, risks to monetary policy must be carefully weighed. Thus, finding the optimal interplay between fiscal policy and "green monetary policy," in the form of differentiated interest rates or green TLTRO programs, must be a matter of meticulous balance.

6. Conclusion

The physical risks stemming from climate change, as well as climate-related transition risks, impact both the real economy and the financial sector. This poses substantial challenges for central banks worldwide. This focus paper has outlined the specific nature of these challenges and how they could be addressed.

Central banks face the task of addressing both short-term and persistent fluctuations in the general price level brought about by climate-related factors like climateflation, fossilflation, greenflation and RE-disinflation. Additionally, physical and transition risks pose a threat to financial stability.

Central banks must tackle these risks; Failing to do so jeopardizes their ability to fulfill their mandated objectives, which encompass maintaining price stability and, often, fostering sustainable growth. Consequently, central banks must adapt their monetary and macroprudential tools to suit the evolving landscape.

This focus paper offers practical recommendations for implementing these adjustments. In addition to adjusting interest rates to reflect the sustainability of portfolios held by banks, central banks should consider revising the criteria for eligible collateral frameworks. In the case of corporatebond purchase programs, bonds issued by carbon-intensive companies lacking a credible transition strategy should be excluded.

Central banks should also incorporate climate risks into their regulatory activities within financial markets. This could involve, for example, requiring banks to disclose and report on the sustainability of their portfolios as well as conducting regular stress tests focused on climate risks. Moreover, in the realm of banking regulation, capital requirements should be recalibrated to account for climate and environmental risks.

These proposed measures do not conflict with the stability objectives of the ECB or other central banks. Rather, this focus paper provides insights into how central banks can achieve their stability objectives while addressing the manifold challenges posed by the climate crisis.

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