CENTRO STUDI SUL FEDERALISMO

research paper

OLIMPIA FONTANA

WHAT ROLE DOES THE ECB PLAY IN ADDRESSING CLIMATE CHANGE?

March 2024

ISSN: 2038-0623

ISBN: 979-12-80969-13-2

ABSTRACT

Climate change has disruptive consequences not only on our lives, but also on monetary policy. Understanding the impact of climate change requires analysing the direct link between natural events and economic activity, the indirect effects of climate risks on monetary policy, and how central banks have to take these into account when preparing their response through monetary policy in the medium term. On the one hand climate change affects monetary policy through physical and transition risks, while the two main channels through which climate change influence monetary policy are the transmission mechanisms and the natural rate of interest. On the other, central banks can take proactive measures aimed at "greening" their portfolios. The ECB has recently begun to incorporate climate change considerations into its operations, while respecting the limits of its mandate. However, other factors will contribute to the direction of monetary policy against climate change – the ambition of fiscal policies and regulators and the capacity of the supply side to accommodate the transition.

Keywords: green monetary policy, ECB, carbon price, climate-related risks, greenflation

JEL Codes: E52; E58; Q54

Olimpia Fontana is Mario Albertini Fellow at the Centro Studi sul Federalismo and Research Fellow at Università Cattolica del Sacro Cuore

Email: fontana@csfederalismo.it

This paper is forthcoming as a chapter – titled "Climate change, carbon prices and the role of the ECB's monetary policy" – in Citera E., Sau L., & Tropeano D. (Eds.), *Central Banking, Monetary Policy, and the ECB: Coping with the Challenges*, Edward Elgar, 2024.

1. Introduction

Climate change has disruptive consequences on our lives, in some cases with clear manifestations, such as heat waves, that pose risks for goods and people; in other cases with less evident effects on other variables that affect the economy, in particular monetary policy. Understanding the impact of climate change requires analysing the direct link between natural events and economic activity, the indirect effects of climate risks on monetary policy, and how central banks have to take these into account when preparing their response through monetary policy in the medium term.

The European Central Bank (ECB) has recently begun to incorporate climate change into its operations. In 2018, Benoît Cœuré, then member of the ECB executive board, when discussing global warming had cautioned that "if left unchecked, it may further complicate the correct identification of shocks relevant for the medium-term inflation outlook, it may increase the likelihood of extreme events and hence erode central banks' conventional policy space more often, and it may raise the number of occasions on which central banks face a trade-off forcing them to prioritise stable prices over output" (Cœuré, 2018). And in 2020, shortly before the launch of the ECB Strategy Review 2021, President Lagarde recalled the need to carefully study all the implications of climate change for the primary objective of inflation targeting (Lagarde, 2020). The ECB's climate orientation was officially declared in July 2021, when a detailed roadmap of climate-related actions was launched, along with the ECB Strategy Review 2021 (Drudi et al., 2021). On this occasion, the ECB explicitly acknowledged that climate change, through its impact on the structure and cyclical dynamics of the economy and the financial system, has profound implications for price stability.

According to the climate change action roadmap, the ECB and the Euro-system are required, among other things, to integrate climate risks into the ECB's workhorse models, to assess their impact on potential growth, and to conduct scenario analyses through technical hypotheses on carbon pricing to predict and regularly evaluate the impact of climate-related fiscal policy (like carbon tax) on its macroeconomic projections (ECB, 2021b). Furthermore, many central banks, including the ECB, are actively contributing to the forum of central bankers and financial supervisors, the Network for Greening the Financial System, which voluntarily shares best practices, promotes the development of climate risk management in the financial sector and mobilises mainstream finance to support the transition to a sustainable economy.

The Strategy Review coincided with the European Union's (EU) strong legislative push for a green transition, the European Climate Law, which enshrines the goal set in the European Green Deal (EGD) of making the EU climate neutral by 2050. The law also sets an intermediate target of reducing net greenhouse gas (GHG) emissions by at least 55% (compared to 1990 levels) by 2030, with the European Commission recently recommending a 90% reduction by 2040.

Many authors argue that the ECB should take a more active role in the green transition (De Grauwe, 2019; Dafermos et al., 2020). They believe that climate policies align with the ECB's secondary objective of supporting EU economic policies, which include protecting and improving the quality of the environment (Art. 3 of the Treaty of the EU). This task must balance the ECB's primary objective of price stability with broader efforts by EU institutions to actively contribute to the green transition. This creates tensions between the ECB's specific role and the EU's overall climate goals. Additionally, the unique nature of climate-related shocks can make it difficult to target both objectives, low inflation and low emissions, simultaneously.

In this chapter we focus our analysis on the relationship between climate change and monetary policy, starting with the climate-related risks to the macroeconomic variables (Section 2) and the effects of climate change on the main monetary variables (Section 3). Among climate-related risks, transition risks are relevant to both transition and monetary policy. We then consider (Section 4) the specific case of carbon prices, the flagship measure of the EU climate policy, which affects monetary policy through adverse supply-side shocks (Section 5). Section 6 concludes with thoughts on the specific challenges the ECB faces in its current context.

2. Climate-related risks and the macroeconomy

According to the established taxonomy in the climate economy literature, climate-related risks are divided into two main categories: (1) physical risks, linked to the material impact of climate change; and (2) transition risks, related to the phasing out of fossil fuels towards a low-carbon economy (Carney, 2015; TCFD, 2017).

Batten et al. (2016) define physical risks as risks that arise from the interaction between climate-related hazards and the vulnerability of human and natural systems. Consequently, two main sources of physical risks can be identified: gradual global warming and an increase in extreme weather events, which can be either a consequence of immediate acute (extreme weather events) or chronic long-term shifts in climate patterns (gradual global warming). Furthermore, the transition to a carbon-neutral economy aligned with the Paris Agreement of limiting global warming to well below 2°C of pre-industrial levels carries transition risks. These require extensive policy measures for climate change mitigation and adaptation. Importantly, extreme and gradual risks are closely linked, as global warming increases the likelihood of extreme weather events. All these risks exert effects on the macroeconomy. On the one hand, droughts, changes in precipitation patterns, rising sea levels, ocean acidification and soil erosion cause damage to various sectors of economic activity. On the other hand, transition risks may lead to further side effects, depending on the design of policy measures. In this section we provide an analysis of the channels through which these risks affect economic sectors, as they differ in terms of timing and severity, in particular on those variables relevant to monetary policy.

Impacts associated with physical effects (both extreme and gradual changes) are transmitted to the macroeconomy through channels that affect both the supply and demand sides of the economy (Angeli et al., 2022). Demand-side shocks are those that affect the components of aggregate demand, such as consumption and investment (both private and public) and international trade. Supply-side shocks concern the productive capacity of the economy through the components of potential supply, i.e., labour, physical capital and technology.

Climate risks trigger both demand and supply shocks. Natural disasters are unexpected shocks with economic consequences understood as indirect damage caused by extreme events on main variables, such as production, inflation and employment. After a major catastrophe there can be an immediate negative impact on economic growth. However, over a longer period, there could be positive effects on growth, thanks to investments in reconstruction (Batten, 2018). Furthermore, as temperatures gradually rise, the climate is becoming a new source of macroeconomic instability, affecting the productive capacity of the economy. In climate models, temperatures are usually assumed to affect the level of GDP, although climate change can cause lasting damage to capital stocks and productivity, thus affecting GDP growth (Batten, 2018). Physical, human and other forms of capital (social and organisational capital) are also exposed to gradual global warming. For example, non-productive adaptation investment will be needed to counteract the impact of high temperatures on humans and goods. Furthermore, workers' physical and cognitive performance can be impaired, and climate migration and social conflicts could undermine the social order.

There is a trade-off related to transition risks between the cost of mitigation and the effectiveness of climate policies. On the one hand, mitigation measures could have a high negative impact on growth, at least in the short term, while on the other hand ambitious enough green policies serve the imperative to preserve the planet for future generations. Policy measures to achieve a low-carbon economy are many and can be classified into three categories (Frankhauser, 2013). First, a price on carbon to internalise the externality of climate change. Second, promote low-carbon technology by addressing innovation-related externalities and market failures. Third, encourage carbon-efficient behavior and investments, to unlock existing energy efficiency potential. Therefore, although carbon pricing is considered the most efficient way to curb emissions, other policies are equally important, such as energy efficiency, investment in research and innovation, sustainable infrastructure, forest conservation and restoration, and planning low carbon urbanisation.

Above all, the timing of the effects of such policies will depend on how the transition is pursued. An orderly transition, in which climate policies are introduced early and gradually become more stringent, will require counterbalancing effects to mitigate negative physical risks. However, a disorderly transition with delayed and aggressive policy action could exacerbate the negative effects, especially on inflation (Drudi et al., 2021). Table 1 summarises the main effects of climate-related physical and transition risks on the macroeconomy.

Table 1. Impact of climate-related physical and transition risks on the macroeconomy

		Demand side	Supply side	Timing of effects
PHYSICAL RISKS	EXTREME EVENTS	Destruction causes households' wealth and private consumption to decrease	Shortage of inputs (food and energy) and volatility of their prices	Unexpected shock with short- to medium-term effects on the economy
		Damages causes private investment to decrease	Working hours lost due to natural disasters	
		EX: Disruption in transportation and distribution infrastructure cause decrease in exports	Damage to capital stock and infrastructure	
	GRADUAL WARMING	Changes to consumption preferences towards green products	Labour productivity decreases due to the impact on health	Predictable outcome on potential productive capacity and economic growth with medium- to long-term effects on the economy
		Uncertainty reduces private investment	Resources diverted from productive investment and innovation to adaptation measures	
			Agricultural productivity decreases	
TRANSITION RISKS		Investment in low carbon technologies may "crowd out" private investment and consumption	Short-term growth reduction caused by mitigation policy requirements	Demand/supply shocks with short- to medium-term effects on the economy
		Distortion to trade from asymmetric climate policy	Uncertainty about the rate of innovation and adoption of clean energy technologies	
			Resources diverted from productive investment to mitigation measures	

Source: Batten et al., 2018

3. Climate-related risks and monetary policy

In recent times, more attention has been paid to the two-way relation between monetary policy and climate change. On the one hand, climate-related risks affect economic variables relevant to monetary policy and financial sectors, and thus impact the ability of central banks to meet their price stability mandate. On the other hand, some argue that monetary policy could contribute to addressing environmental challenges while aligning with the central bank's mandate.

A fundamental point in ascertaining the effects of climate change on monetary policy is the peculiar nature of climate-related risks. In general terms, demand and supply shocks differ in terms of their response from the central bank's perspective. For example, positive demand shocks lead to an increase in both GDP and the inflation rate, thus making it easy for the inflation-targeting central bank to implement a restrictive monetary policy to curb inflationary pressure and economic overheating. Conversely, negative supply shocks cause an increase in prices and lower GDP. Consequently, a restrictive monetary policy that prioritises price stability would lead to widening the negative output gap.

Climate-related risks involve a combination of negative supply shocks and negative demand shocks, with policymakers facing the dilemma of stabilising the inflation rate while maintaining the level of economic activity (Beadry et al., 2022). This trade-off widens when it comes to climate change, since extreme weather events can be considered primarily as a negative supply shock (such as the destruction of crops, buildings and infrastructure) that mainly implies an increase in prices, which subsequently transforms into negative demand shocks, with uncertainty that puts investment and consumption decisions at risk.

Monetary policy is also affected by transition risks, particularly in the case of mitigation measures, which could lead to a persistent positive distortion of inflation during the transition. Once again, the multiple effects of climate change and climate policies exert fundamental uncertainties on the inflation process, in terms of both increased price volatility and a persistent inflationary distortion during the carbon transition.

Overall, climate change can affect prices in various ways, creating both upward and downward pressures on inflation rates, such that it is difficult to predict which of these countervailing forces will prevail (Dafermos et al., 2021). Furthermore, the inflation process and the goal of price stability will depend on the timing of implementation of climate policies, their scope, thrust and impact on growth (Boneva et al., 2022). Therefore, central banks could face difficulties in defining an appropriate stance for their monetary policy.

It is important to acknowledge the specific ways in which climate change impacts central bank monetary operations, as these will ultimately affect the proper conduct of monetary policy operations. In particular, there are two main channels through which climate change can influence monetary policy (Boneva et al., 2022; Drudi et al., 2021): the monetary policy transmission channel and the natural interest rate.

3.1 Climate change and the transmission channels of monetary policy

Monetary policy decisions affect the economy in general and the price level in particular, although in ways that are difficult to predict with precision, as it depends on different channels and variables, and is thus subject to uncertainty. For example, losses resulting from physical risks or stranded assets could weigh on the balance sheets of financial institutions, reducing the flow of credit to the real economy (Schnabel, 2021). Central banks are also exposed to potential losses, for example from securities acquired under asset purchase programmes or from the collaterals provided as counterparts in monetary policy operations. The transmission channels of monetary policy – the interest rate channel, the credit channel, the asset price channel, the exchange rate channel and the expectation channel – are all affected by climate change (Drudi et al., 2021).

1) Interest rate channel: Investments and savings are likely to become less sensitive to interest rate changes in the presence of climate risks, due to higher risk aversion and greater uncertainty. This means that households will increase their precautionary savings and businesses will reduce their investments, despite the implementation of an expansionary monetary measure.

2) Credit channel: Bank balance sheets can be affected by climate change in several ways. For example, extreme events can directly or indirectly affect the creditworthiness of households and businesses, thus increasing the risk premium on lending. Furthermore, and as a consequence, banks' stocks of non-performing loans may increase, with negative consequences on bank balance sheets.

3) Asset price channel: Extreme weather events could lead to more frequent and more severe episodes of financial market disruption, while a sudden repricing of assets, potentially triggered by transition measures, could put pressure on bank balance sheets and constrain their ability to provide credit to the economy. Sudden changes in transition policies (or changes to their credibility only) could create "stranded assets", triggering corporate re-assessments. Furthermore, the value of residential property or capital assets in areas exposed to physical risks will decrease, with losses negatively impacting household consumption and business investments.

4) Exchange rate channel. Climate change could possibly undermine the exchange rate channel of monetary policy transmission, which normally reinforces the monetary policy intentions. Physical risks are likely to affect the composition of production in some countries rather than others, thus altering the pattern of international trade more, and climate policies, such as carbon prices, can change the terms of trade of countries most exposed to climate-related risks.

5) Expectation channel: Expectations of future changes in interest rates influence medium- and long-term interest rates through the reaction of households and businesses to their own expectations, which subsequently affect output and prices. However, difficulties in distinguishing between supply and demand shocks and in understanding their ultimate effect on inflation make climate change responsible for uncertainty in the transmission mechanism of monetary policy, particularly if the transition is pursued in a disorderly way.

In summary, climate risks can compromise the proper functioning of the monetary policy transmission mechanism because they can alter the economic and financial conditions that this mechanism seeks to influence. They can impact various aspects of the financial system and the economy, including asset prices, the stability of financial markets, the ability of banks to provide credit, and the investment decisions of businesses and consumers.

3.2 Climate change and the natural interest rate

The natural rate of interest is a reference point for the direction of monetary policy, as it can be defined as the real interest rate that is neither stimulatory nor contractionary and is consistent with output at its potential and stable inflation (Woodford, 2003). Policymakers need to know the level of the natural rate to estimate the likely impact of their policies and therefore assess the stance of monetary policy.

Over the past 40 years the natural rate of interest has declined in advanced economies. This reflects the overall decline in real interest rates over the same period (by around 5 percentage points) (IMF, 2023)[1]. This is mainly due to secular trends, such as declining productivity growth and increased longevity, while other factors such as fiscal policy and financial drivers could have some effects. Eggertsson et al. (2019) estimate a 4 percentage points fall in the equilibrium real interest rate between 1970 and 2015 in the US, with longevity and productivity growth accounting for 1.8 and 1.9 percentage points, respectively. Brand et al. (2018) find that the net effect of these trends since the 1980s, is reduced real interest rates in the Euro area by around 1 percentage point. Therefore, demographic factors and productivity growth account for much of the decline in the equilibrium real interest rate, while other contingent drivers have only minor and partially offsetting effects (Cesa-Bianchi et al. 2022).

The slower trend in productivity growth has reduced the natural rate globally, as lower expected returns on investments have reduced the demand for capital. Furthermore, a profound shift in demographic patterns is underway: individuals tend to have fewer children and live longer, resulting in a dramatic increase in the relative number of elderly people. Lower availability of labour inputs and increased saving in anticipation of a longer retirement period exert a downward pressure on the natural rate (Brand et al., 2018). Fiscal policy can also affect the natural rate, as government borrowing can lead to higher interest rates because more savings are needed to meet the increased demand for funds.

Climate change can affect all these factors that influence the future development of the natural interest rate, thus making it more difficult to identify a monetary policy stance that is considered "neutral". However, the magnitude, timing and even direction of this impact are highly uncertain (Drudi et al., 2021). Regarding demography, the impact of climate change on the natural rate is two-fold. On the one hand, it could reduce labour supply and productivity, for example, extreme heat could lead to diseases, thus exacerbating the negative effect on the natural rate; on the other hand, it could also have a positive effect, as climate change could reduce life expectancy and re-balance the age composition of the population in favour of younger people. The effect on productivity is

[1] Since the natural rate is an anchor for real interest rates, long-term trends in real interest rates are potentially informative signals about the natural rate itself.

also unclear. Following a natural disaster, businesses may replace damaged machinery with more productive technology, thus improving productivity; but if the physical damage increases, they could deploy more capital for replacement and repairs, leaving companies with less funding to be invested in R&D, thus reducing productivity growth. Furthermore, in a world dominated by climate-related risks, uncertainty increases risk aversion as well as risk premia, implying a reduced willingness to invest and a greater propensity to save, both of which could lower the natural rate of interest. Finally, climate change also affects the natural rate of interest through fiscal policy, but in positive way, as higher sovereign debt due to financing green public investment increases the risk premium on bonds and therefore the interest rate. These complex variables make it difficult to predict the net effect of climate change on the natural rate. However, climate change is expected to add downward pressure beyond the decline observed over the last 40 years (Drudi et al., 2018).

3.3 Climate change and the proper conduct of monetary policy

Climate change involves a combination of supply and demand shocks that is difficult to manage, not to mention the uncertainty of its impact on macroeconomic variables. The impact of climate change on inflation is unclear, partly because climate supply and demand shocks can push inflation and output in opposite directions, and generate a trade-off for central banks between stabilising inflation and stabilising output fluctuations (Debelle, 2019). However, central banks must take these considerations into account when designing the correct monetary policy reaction to the climate shock. Traditionally, central banks design their monetary response based on the size and persistence of a shock. If they estimate the shock is short-lived and does not affect the medium-term inflation outlook, they may "look through" it, meaning that they may tolerate its temporary effects on inflation without taking any action, in order not to cause undue volatility in output. However, if the shock is more persistent and it threatens to destabilise inflation expectations, monetary policy action may be necessary. However, as climate change amplifies the frequency and severity of supply shocks, making them more persistent, "looking through" such shocks may become increasingly difficult for central banks (Batten et al., 2018). Climate change and monetary policy operate on different timescales, as the former imply both short- and medium-term effects on the economy, which may require extending policy horizons for price stability. However, the central bank could be compromised if the time horizon is extended too far into the future and inflation targets are missed too often.

Another issue related to the proper conduct of monetary policy is the policy space, which can be constrained by further decline in the natural interest rate, partially caused by climate change (see Section 3.2). The lower the natural rate, the tighter the policy space for central banks to implement expansionary monetary policy, increasing the risks of reaching the lower bound on nominal interest rate and compounding uncertainty of climate change's impact on the output gap. In this case, unconventional monetary policy, like the quantitative easing programme, intervenes to compensate for the reduced policy space of interest rate monetary policy. This leads us to consider not only how climate change affects monetary policy, but also to question whether and how monetary policy itself can contribute to the overall macroeconomic policy effort to mitigate global warming.

3.4 Monetary policy effects on climate change

Central bank operations are not only affected by the risks posed by climate change, but in turn they can also play a role in contributing to the overall effort against it. Therefore, an interesting question is to what extent a central bank, and the ECB in particular, given the EU's leading role in climate policy, can effectively help facilitate the transition to a carbon-neutral economy. The reactions of central banks could be varied, ranging from protecting their balance sheets and preserving the ability to deliver on their price stability mandate against climate risks, to proactively promoting the transition to a low-carbon economy through an active use of their balance sheets (Boneva et al., 2022). Defensive and awareness measures help central banks adapt to ongoing changes that impact standard operations. These include assessing the impact of climate change on the economy and developing a resilient monetary policy strategy. In contrast, proactive measures aimed at "greening" central bank portfolios raise concerns about their mandate and operations, and about their legitimacy.

In a low-interest-rate environment, characterised by the effective lower bound, the central bank prioritises its balance sheet over direct interest rate management as a monetary policy tool. In recent years, central banks have increasingly relied on unconventional monetary policies, such as quantitative easing (QE), as a way to respond to the financial crisis that had compromised the transmission mechanism of monetary policy. The purchase of assets in the market allows liquidity to be injected into the financial system, thus seeking to improve financing conditions for households and businesses and, ultimately, to support aggregate demand. Green QE has been proposed as a way for central banks to align their asset purchase programmes with climate goals, as argued by De Grauwe (2019). His green QE proposal also includes concerns about the risk of inflationary pressures that could arise due to new money created by monetary institutions. He suggests that maturing government and corporate bonds in the ECB's asset purchase programme could be replaced with new "environmental" bonds on the market. This would contribute on the one hand to financing green projects, without creating pressure on prices, and on the other hand, to orient their asset purchases according to climate-related risks. Furthermore, the ECB could begin to accept green assets as collateral that would otherwise not be suitable to incentivise the financing of sustainable projects by private banks (Breitenfellner and Pointner, 2021). However, the operational feasibility of these measures is questioned by two main issues, namely the eligibility criteria and the legal mandate of the ECB.

The ECB's holding of corporate bonds under its private sector purchase programme is characterised by high carbon intensity, as it implicitly creates better financing conditions for carbon-intensive activities, thus favouring capital allocation towards more carbon-intensive sectors (Dafermos et al, 2020). The principle of market neutrality is the reason for the carbon bias, which means that the ECB should minimise the impact of its purchasing operations on relative prices and reduce unintended side effects on the functioning of the market. Considering the market structure, the ECB's market-neutral interventions are biased towards carbon intensive companies, as they are typically capital intensive and issue more corporate bonds. The reason for the overrepresentation of carbon intensive bonds is due to the eligibility criteria of the ECB's asset purchase programme, according to which eligible assets must be issued by non-financial firms (Liebich et al, 2023). Given that the financial (and low-emission) sector dominates the European bond market, excluding it would cause the ECB's portfolio to automatically overrepresent more carbon-intensive sectors, such as manufacturing, electricity and gas. However, adjusting the underlying eligibility criteria and revising the principle of market neutrality are controversial issues as they sit on the edge of what is legally legitimate for central banks to do.

How far central banks can go in incorporating climate risks into their core policy operations depends significantly on their legal mandate (Dikau and Volz, 2021). The ECB's primary objective - price stability – must be read in conjunction with both the overall EU economic policies to which the ECB has to contribute and the climate-related risks affecting monetary policy. In general, the price stability mandate must take into account the full implications of climate change for the proper conduct of central banks, based on the impact that climate-related risks have on inflation and the proper transmission mechanism of monetary policy.

The Treaty on the Functioning of the European Union (TFEU) clearly states that "without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Union" (Art. 127). However, it is not clear which of the "general economic policies" of the EU – among those relating to "high level of protection and improvement of the quality of the environment" pursuant to Art. 3 of the Treaty on the EU – is to be prioritised, as it would be a political choice, to which democratically elected institutions are bound. In this sense, the ECB is a *policytaker* (Breitenfellner and Pointner, 2021) within a larger policy framework comprising more detailed and timely climate policies. By acknowledging this context, the ECB can contribute to the overall climate effort, while respecting the limits of its mandate.

4. Carbon pricing and its macroeconomic effect

To address the economic damage resulting from climate change, the EU has taken measures to reduce GHG emissions to net zero by 2050, as set out in its green agenda for the next decades, the EGD. Furthermore, several measures are outlined in the EU "Fit for 55" package, with the aim of reducing GHG emissions by 55% by 2030 (compared to1990 levels). It includes a comprehensive approach based on regulatory measures, expected massive green investments and above all carbon pricing. Economists widely agree that putting a price on carbon emissions is the most cost-effective way to reduce greenhouse gas emissions[2]. The simplest way to apply the "polluter pays" principle to emitters is carbon pricing, i.e., setting a direct or indirect price for the emission of carbon dioxide (CO_2). It can be implemented as a fiscal measure, the carbon tax, or as a market tool, through an emission trading system.

The EU adopted its Emission Trading System (EU ETS) in 2005 as a flagship climate policy initiative to achieve its climate targets, which have been frequently revised upwards since the ratification of the Kyoto Protocol in 2002 (Delbecke and Vis, 2015). This is a cap-and-trade system in which the EU legislator sets a total amount of emissions ("cap") allowed for a certain period and issues tradable emission permits ("trade"). These permits, each corresponding to 1 tonne of CO_2, reflect the price in the carbon market. Within the Euro area, twelve countries have adopted measures to mitigate emissions both at the national level, through carbon taxes, ranging from €2/tCO_2 in Estonia to

[2] See the Economists' Statement on Carbon Dividends at https://clcouncil.org/economists.statement/

€76/tCO_2 in Finland, and at the European level, through the EU ETS, with an increasing trend in the market price since 2018, varying between €65/tCO_2 and €104/tCO_2 between 2022 and 2023 (tab. 2). Furthermore, other national environmental taxes, such as excise taxes on fossil fuels, indirectly put a price on carbon emissions.

In December 2022, the EU agreed to reform its ETS, due to the additional effort required by the challenge of climate change. Indeed, in 2021, greenhouse gas emissions in the EU were down by 30% compared to 1990 levels. However, the pace of reduction in carbon emissions will have to be accelerated in the current decade, to achieve the EU's intermediate target for 2030, a 55% reduction of emissions compared to the 1990 level – the aim of the "Fit for 55" package. The main issues are the inclusion of maritime transport emissions in the current system, a more ambitious linear reduction of allowances leading to lower cap and the creation of a new parallel emissions trading system (ETS2) covering sectors such as construction, road transport and fuel from 2026. Furthermore, the introduction of a Carbon Border Adjustment Mechanism (CBAM) is bound to impose a carbon price on certain imports into the EU from countries without a similar level of ambition in their national jurisdiction. The CBAM has been widely debated and viewed as a unilateral "green protectionism" measure (Sapir and Horn, 2020), although it should be considered *in primis* as a climate policy addressing a problem of global nature that requires a global solution.

Table 2. Carbon pricing in Eurozone countries

	Carbon Tax Rate	Share of Jurisdiction's Emissions Covered (2018)	Year of implementation
Austria	32.50 €	40%	2022
Estonia	2.00 €	6%	2000
Finland	76.92 €	36%	1990
France	44.55 €	35%	2014
Germany	30.00 €	40%	2021
Ireland	48.45 €	40%	2010
Latvia	14.98 €	3%	2004
Luxembourg	44.19 €	65%	2021
Netherlands	51.07 €	12%	2021
Portugal	23.90 €	36%	2015
Slovenia	17.30 €	52%	1996
Spain	14.98 €	2%	2014
EU ETS	65 €*	40%	2005

Source: World Bank Carbon Pricing Dashboard. *EU Carbon Permits on 29th January 2024.

From a macroeconomic perspective, putting a price on a negative externality (carbon emissions), previously overlooked in production decisions, is like an adverse supply shock, resembling the oil shocks of the 1970s (Pisani-Ferry, 2021). The introduction of a carbon price implies an increase in energy prices, as observed during the oil shock, leading to inflationary pressures. However, although conceptually similar, the economic aspects of climate policy and fossil fuel price shocks have significant differences, due to some mitigating effects (IMF, 2022). First, carbon pricing generates revenues (fiscal- or market-based) that can be allocated in various ways, to partly offset their negative effect on consumption and investment. Second, unlike temporary and sudden fossil fuel price shocks, which act as adverse supply shocks, carbon pricing is a permanent measure designed to be implemented gradually. Third, a change in relative prices (achieved by tightening emission regulations) is set to unleash a new wave of technological progress. Basing their analysis on a growth model with environmental constraints and limited resources, Acemoglu et al. (2012) find that, provided the elasticity of substitution between clean and dirty inputs is sufficiently high, optimal environmental regulation (whether taxation or research subsidies) should result in an immediate shift of R&D resources towards clean technologies, followed by a gradual shift of all production to clean inputs.

In general, the carbon pricing policy spreads across national economic sectors through different channels, concerning the private sector (households, firms and financial institutions), the public sector and the rest of the world. Carbon prices lower real household incomes and corporate profits, thereby dampening domestic demand, due to rising energy prices that have both an indirect impact on commodity prices and a direct impact on production costs. Furthermore, governments could have a compensating function, through revenues generated from carbon market allowances and/or fiscal payments. However, if distributional concerns about the regressive effects of carbon prices are strong, these measures could adversely affect climate mitigation efforts, as they might weaken the incentive to reduce energy consumption. Interestingly, existing analysis has found no adverse effects on the economy from the combination of ETS and national carbon taxes (where applicable). Metcalf and Stock (2020) estimate a zero to modest positive impact of EU carbon pricing on GDP and total employment growth rates and no solid evidence of a negative effect on employment or GDP growth.

In an assessment of the macroeconomic impact of rising carbon prices in the Eurozone countries, Brand et al. (2023) estimate that in a scenario where carbon pricing is assumed to increase linearly from €85/tCO2 in 2021 to €140/tCO2 in 2030 (provisional values aligned with a net-zero scenario by 2050), the impact on the economy is generally negative in the short- to mid-term. GDP will fall between 0.5% and 1.2% below the baseline in 2030, private consumption and investment will tend to decline, although positive effects could occur. On the one hand, fiscal policy can implement lump-sum transfers of tax revenue to households, acting as a buffer for the negative impact on household purchasing power. As energy demand is inelastic, particularly among poorer households who spend a significantly higher share of their expenditure on energy, the regressive effects of carbon pricing should not compromise emission reductions. Therefore, targeted fiscal policies could be an effective way to reduce economic costs (Känzig, 2023). On the other hand, a significant sectoral reallocation of capital involving large investments in the renewable energy sector could overcompensate for huge capital losses in the fossil fuel sector.

The European agenda for sustainable development, the European Green Deal, which has placed climate policy at the centre of a comprehensive redefinition of economic policy, both at European and national levels, encompasses technological, fiscal and social aspects that need to be considered when designing an orderly transition in a limited period of time. These aspects have relevant implications for their macroeconomic impact and for the proper conduct of monetary policy in times of climate transition.

5. Carbon price effect on monetary policy

In addition to the effect on components of aggregate demand, carbon pricing also has an effect on the inflation rate. Both carbon taxes and the ETS have the main effect of increasing energy prices, albeit with some differences (Mc Kibbin et al., 2020). For example, in case of carbon taxes, the trajectory is clear from the beginning, while in the ETS, the carbon price and its future path are determined by market forces, which implies a high degree of uncertainty about the impact of carbon prices on monetary policy[3].

It has been observed that the effect of carbon pricing on monetary policy is rather modest and gradually fades away, implying that the typical monetary policy dilemma created by climate-related risks seems limited (Brand et al., 2023; IMF, 2022). As Coenen et al. (2023) claim, "the short and medium-term effects depend on the monetary policy reaction, on the path of the carbon tax increase and on its credibility, while expanding clean energy supply is key for containing the decline in GDP." In other words, a combination of factors – the ambition of fiscal policies and regulators, as well as the capacity of the supply side to accommodate the transition – will contribute to the direction of monetary policy against climate change.

According to Schnabel (2022) in a "new age of energy inflation" it is important to distinguish between three distinct, but interconnected, types of inflation arising from different shocks: climateflation, fossilflation and greenflation. Climateflation is linked to climate-related physical risks, such as natural disasters and severe weather events, which put upward pressure on prices due to shortages. Fossilflation reflects the cost of our dependence on fossil fuels, which has not reduced to a great extent in recent past decades. Climate-related transition risks, like increasing carbon prices, contribute to keeping this component artificially high. These two types of inflation share many of the characteristics of an adverse supply shock, which requires a carefully balanced response from a monetary perspective. In the past, central banks have typically "looked through" energy shocks, as most of the time such shocks have been short lived. However, the cost of looking through supply shocks is the potential for inflation expectations to become de-anchored. As Beaudry et al. (2023) observe, the canonical neo-Keynesian model which recommends that policy makers should never "look through" such shocks, since a policy that adjusts output to its natural level will achieve a "divine coincidence" in which inflation and output gaps are simultaneously closed, is not a good way to address recent energy shocks. Instead, they suggest that it would be optimal for central banks to initially look through supply shocks until a *threshold* is reached, and then pivot intermittently to a more aggressive anti-inflationary stance.

However, the threshold was crossed recently, when an extraordinary combination of shocks, namely the post-pandemic recovery (demand shock) and the energy crisis (supply shock, causing fossilflation) linked to the war in Ukraine, caused extraordinary changes in sectoral prices, with inflation peaking at 10.6% in October 2022; this triggered a rapid increase in policy rates throughout 2022 and 2023. However, as the energy shock is winding down, the ECB is expected to gradually ease its monetary policy. In the Euro area, while overall inflation has started a downward process, core inflation is still above target, with potential risks of de-anchoring inflation expectations.

[3] To address this risk, the EU introduced the Market Stability Reserve and revised it in 2021 to better align the EU ETS to carbon neutrality objectives, with the aim to address the case of surplus of allowances due to economic crisis, undermining the proper functioning of the carbon market price signal.

However, as assessed by Guerrieri et al. (2023), long-term expectations are anchored between 2% and 2.5%, suggesting that it may be possible to accommodate some additional inflation. In practice, supply-side shocks would warrant a deviation from the target in the short term, provided price stability is restored in the medium term and inflation expectations remain anchored.

A third type of inflation is "greenflation", which could be defined as increased costs associated with the high costs of producing green energy. Most clean technologies require large quantities of critical raw materials, such as copper, lithium and cobalt. Prices of many minerals and metals essential for the green transition have recently soared due to a combination of rising demand, disrupted supply chains and concerns about tightening supply (IEA, 2022). In the coming years, more and more companies will undertake the necessary fuel conversion to low-emission technologies. As Schnabel (2022) observes, this pressure on greenflation is the result of a persistent and large demand-side shock: "once the nature of the shock changes, and the more benign price effects of the green transition start to dominate, the trade-off for monetary policy becomes less relevant." In other words, as soon as greenflation has a greater impact on consumer prices than fossilflation (as seems to be the case until now), a central bank will have to initiate a restrictive monetary policy to address both inflation and the positive output gap.

In general, the effect of climate policies on inflation is difficult to ascertain, as it depends on the level of ambition of mitigation measures and on the contribution of fiscal policy in supporting the transition. As the scope of climate policies in the EU is set to increase, covering previously excluded sectors, the pressure on inflation will increase the ECB's difficulty in dealing with climate-related shocks. The IMF (2023) believes that two conditions are necessary to alleviate concerns that the current high-inflation environment could undermine the ability to control inflation without further depressing the economy. First, the transition must take place in an orderly manner to avoid severe consequences for the economy. However, If the transition is too slow, a precipitous and messy intervention will be required subsequently. However, if it is too rapid, it could have major consequences for the economy's capacity to adjust and for the ECB's ability to manage its monetary policy trade-off. It is estimated that climate policy would imply energy inflation by 13.5% a year in a disorderly scenario, while in a well-managed transition prices would rise by 3.5% a year (Drudi et al., 2021). Second, credibility is key to keeping inflation expectations anchored to the target over the medium term. This will make it difficult to accommodate the more ambitious decisions on carbon pricing and climate polices in general, as they can increase fossilflation, and the introduction of investments in clean technologies, which will necessarily define the pace of the transition, even if further pushing up greenflation.

6. Conclusion

Climate change and monetary policy have a complex, two-way relationship. Many risks and consequences influence key economic variables relevant to monetary policy in contradictory ways. Climate-related risks can exacerbate central banks' traditional dilemma between looking through supply shocks or controlling inflation expectations. They can undermine the transmission mechanism of monetary policy and increase the already downward pressure on the natural interest rate.

Climate policies, such as carbon pricing, further contribute to these developments, making it more difficult for central banks to address the trade-off between inflation mandates and output stabilisation. In recent years, the role of central banks (including the ECB) in decarbonising the economy has been questioned, although most of them already have a mandate to explicitly promote sustainable growth and development or to support government economic policies (Dikau and Volz, 2021). Integrating climate-related risks into the monetary policy strategy is an exceptionally complex challenge for the ECB.

First of all, the trade-off between the EU climate policy and the ECB monetary policy is very strong. Indeed, the ECB is bound by the mandate of price stability, while operating within a framework that has embraced one of the most ambitious climate policies in the world. The EGD cannot exempt the ECB from contributing to the climate transition, especially as it is the European institution responsible for one of the two pillars of European economic policy, even more so considering the typical asymmetric institutional set-up of the EU. The presence of a decentralised fiscal policy, based on coordination between member countries that are different from each other in terms of their energy mix, combined with a European budget that is inadequate in size compared to the investment gap required by decarbonisation, necessarily leads to a reconsideration of the role, mandate and operations of the ECB[4].

A further obstacle arises from the difficulty of supporting the ecological transition process without too many delays at a historical moment when the ECB's monetary policy is gradually easing after a tough restrictive phase due to further unforeseen events (the pandemic and the war in Ukraine) leading to supply shocks. However, this implies significant delays in a climate roadmap in which what happens between now and 2030 will be critical to triggering a downward trend compatible with the Paris target. Missing the intermediate target could mean having to subsequently implement a disorderly transition, with very stringent mitigation measures fuelling high inflationary pressures and therefore a worsening of the monetary policy trade-off.

Finally, the uncertainty that characterises the relationship between climate change and monetary policy is increased by what happens outside the EU's borders. The climate is a global public good because emissions have no borders. This requires action at a global level, or at least by the three largest emitters, both from historical (the US and the EU) and current (the US and China) perspectives (Tagliapietra and Wolf, 2021). If ambitious climate policies are not pursued with the same determination, the efforts pursued by the EU will be undermined by the lack of commitment of others, resulting in a fundamental problem of policy fragmentation. This will ultimately make climate change an increasingly urgent problem and further challenge the traditional role of the ECB's monetary policy.

[4] In the EU, the investment gap until 2030 for climate and energy security is estimated at €1.25 trillion, including both public and private investments (Abraham et al., 2023).

References

Abraham, L., O'Connell, M. & Arruga Oleaga, I. (2023). The legal and institutional feasibility of an EU Climate and Energy Security Fund. *ECB Occasional Paper*, (2023/313).

Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). "The Environment and Directed Technical Change." American Economic Review, 102 (1): 131-66.

Angeli, M., Archer, C., Batten, S., Cesa-Bianchi, A., D'Aguanno, L., Haberis, A., ... & Young, C. (2022). Climate change: possible macroeconomic implications. *Bank of England Quarterly Bulletin*.

Batten, S. (2018). Climate change and the macro-economy: a critical review. Staff Working Paper No. 706, Bank of England.

Batten, S., Sowerbutts, R. and M. Tanaka (2016). 'Let's talk about the weather: the impact of climate change on central banks,' Bank of England Staff Working Paper no. 603.

Beaudry, P., Carter, T. J., & Lahiri, A. (2023). The Central Bank's Dilemma: Look Through Supply Shocks or Control Inflation Expectations? No. w31741. National Bureau of Economic Research.

Boneva, L., Ferrucci, G., & Mongelli, F. P. (2022). Climate change and central banks: what role for monetary policy? *Climate Policy*, *22*(6), 770-787.

Breitenfellner, A., & Pointner, W. (2021). The impact of climate change on monetary policy. OeNB, Monetary Policy & the Economy Q, 3, 59-80.

Brand, C., Bielecki, M., & Penalver, A. (2018). The natural rate of interest: estimates, drivers, and challenges to monetary policy. ECB Occasional Paper, (217).

Brand, C., Coenen, G., Hutchinson J., & Saint Guilhem, A. (2023). The macroeconomic implications of the transition to a low-carbon economy, in ECB Economic Bulletin, Issue 5/2023.

Carney, M. (2015) 'Breaking the tragedy of the horizon – climate change and financial stability,' Speech at Lloyd's of London, 29 September 2015. https://www.bis.org/review/r151009a.pdf

Cesa-Bianchi, A., Harrison, R., & Sajedi, R. (2023). Global R*. Staff Working Paper No. 990. Bank of England.

Coenen, G., Priftis, R., & Lozej, M. (2023). Macroeconomic Effects of Carbon Transition Policies: An Assessment Based on the Ecb's New Area-Wide Model with a Disaggregated Energy Sector.

Coeuré, B. (2018). Monetary Policy and Climate Change. Speech at a conference on Scaling up Green Finance: The Role of Central Banks organised by the Network for Greening the Financial System, the Deutsche Bundesbank and the Council on Economic Policies, Berlin, 8 November. https://www.ecb.europa.eu/press/key/date/2018/html/ecb.sp181108.en.html

Dafermos, Y., Gabor, D., Nikolaidi, M., Pawloff, A., & van Lerven, F. (2020). Decarbonising is easy – beyond market neutrality in the ECB's corporate QE, New Economics Foundation.

Dafermos, Y., Kriwoluzky, A., Vargas, M., Volz, U., & Wittich, J. (2021). The price of hesitation: How the climate crisis threatens price stability and what the ECB must do about it (No. 173). DIW Berlin: Politikberatung kompakt.

Debelle, G. (2019). Climate change and the economy. In Speech at public forum hosted by Centre for Policy Development, Sydney, Australia, March (Vol. 12).

Delbeke, J., & Vis, P. (Eds.) (2015). *EU climate policy explained*. Routledge.

De Grauwe, P. (2019). Green money without inflation. Vierteljahrshefte zur Wirtschaftsforschung, 88(2), 51-54.

Dikau, S., & Volz, U. (2021). Central bank mandates, sustainability objectives and the promotion of green finance. *Ecological Economics*, *184*, 107022.

Drudi, F., Moench, E., Holthausen, C., Weber, P. F., Ferrucci, G., Setzer, R., ... & Ouvrard, J. F. (2021). Climate change and monetary policy in the euro area, Occasional Paper Series No. 271, ECB.

ECB (2021). ECB presents action plan to include climate change considerations in its monetary, Policy strategy, press release, July 8.

Eggertsson, Gauti B., Neil R. Mehrotra, & Jacob A. Robbins (2019). "A Model of Secular Stagnation: Theory and Quantitative Evaluation." American Economic Journal: Macroeconomics 11 (1): 1–48.

Fankhauser, S. (2013). A practitioner's guide to a low-carbon economy: lessons from the UK. Climate Policy, 13(3), 345-362.

Guerrieri, V., Marcussen, M., Reichlin, L., & Tenreyro, S. (2023). The Art and Science of Patience: Relative Prices and Inflation, Geneva Reports on the World Economy 26, CEPR Press.

Känzig, D. R. (2023). *The unequal economic consequences of carbon pricing* (No. w31221). National Bureau of Economic Research.

IEA (2022). Critical minerals threaten a decades-long trend of cost declines for clean energy technologies. IEA, Paris.

IMF (2023). The natural rate of interest: Drivers and implications for policy. Chapter 2. *World economic outlook,* April.

IMF (2022). Near-term macroeconomic impact of decarbonization policies. Chapter 3. World Economic Outlook, October.

Lagarde, C. (2020). The monetary policy strategy review: some preliminary considerations, Speech at the "ECB and Its Watchers XXI" conference.

Liebich, L., Nöh, L., Rutkowski, F., & Schwarz, M. (2023). Unconventionally Green: Monetary Policy between Engagement and Conflicting Goals. *Review of Economics*, *74*(1), 53-77.

McKibbin, W. J., Morris, A. C., Wilcoxen, P. J., & Panton, A. J. (2020). Climate change and monetary policy: issues for policy design and modelling. *Oxford Review of Economic Policy*, *36*(3), 579-603.

Metcalf, G. E., & Stock, J. H. (2023). The macroeconomic impact of Europe's carbon taxes. American Economic Journal: Macroeconomics, 15(3), 265-286.

Pisani-Ferry, J. (2021). Climate policy is macroeconomic policy, and the implications will be significant. Peterson Institute for International Economics (PIIE), August. https://www.piie.com/sites/default/files/documents/pb21-20.pdf

Sapir, A., & Horn, H. (2020). Political Assessment of possible reactions of EU main trading partners to EU border carbon measures. In: Briefing Requested by European Parliament's Committee on International Trade. https://doi.org/10.2861/93094

Schnabel, I. (2021). Climate change and monetary policy. Finance & Development, 58(3), 53-55.

Schnabel, I. (2022). A new age of energy inflation: climateflation, fossilflation and greenflation. In Speech at a panel on "Monetary Policy and Climate Change" at the ECB and its Watchers XXII Conference, https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220317_2~dbb3582f0a.en.html

Tagliapietra, S., & Wolff, G. B. (2021). Form a climate club: United States, European Union and China. Nature, 591(7851), 526-528.

TCFD (2017). "Recommendations of the Task force on climate-related financial disclosures", available at: https://assets.bbhub.io/company/sites/60/2021/10/FINAL-2017-TCFD-Report.pdf

Woodford, M. (2003). Interest and Prices: Foundations of a Theory of Monetary Policy, Princeton, N.J.; Woodstock, Oxfordshire England: Princeton University Press.

CENTRO STUDI SUL FEDERALISMO
Piazza Arbarello 8
10122 Torino - Italy
Tel. +39 011 15630 890
info@csfederalismo.it
www.csfederalismo.it