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GREEN MONETARY POLICY INSTRUMENTS – IDENTIFICATION AND ANALYSIS

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ABSTRACT: Green monetary policy is a monetary policy that, in addition to maintaining price stability, also aims to increase social welfare and promote environmental sustainability. The main aim of the paper is the identification and exegesis of the central banks' activities towards green monetary policy. The research verifies the hypothesis stating that modern central bank instruments are evolving toward more sustainable tools of implementing monetary policy. The paper presents new instruments of green monetary policy, created by incorporating emission reduction targets into traditional monetary policy instruments. The controlled comparative case study indicates that major central banks have different approaches to redirecting their monetary policy toward sustainable development. Some of them, like the FED, remain sceptical about green monetary policy instruments, while others (like the ECB or Bank of Japan) incorporate them into monetary policy. The research allowed for the identification of the main green monetary policy instruments, and it also proved that at the moment, it is difficult to assess whether they are effective and achieve the desired objectives.

KEYWORDS: central bank, sustainable monetary policy, green monetary policy instruments, sustainable development

Introduction

Sustainable development is an extraordinary modern challenge for humanity in all areas of socio-economic life in the coming decades. According to the *World Economic Forum Global Risks Report*, among the 10 greatest risks to our planet identified there, special attention was paid to those related to the environment, including natural disasters, extreme weather events and failure to mitigate climate change. The lack of adaptation to climate change and the loss of biodiversity were also highlighted. Therefore, the commitment of the world to transition to a carbon-neutral economy is no longer just a possibility, but a necessary imperative, which at the same time requires the mobilisation of significant financial resources.

In recent years, changes towards sustainable development have been observed in many different economic areas and activities. Sustainable development has become an important part of companies' strategies, which have started to involve environmental, social and governance (ESG) issues in their operations. Banks also got interested in these aspects, incorporating them into banking activity, firstly of their own accord, and then under the pressure of legal regulations. Central banking and monetary policy also did not remain indifferent to these changes. The growing awareness of the seriousness of the climate and environmental crisis has motivated monetary authorities to focus on actions that would counteract climate change, take care of the natural environment, increase the level of social inclusion and comply with the principles of corporate governance (Aguila & Wullweber, 2024). Currently, there is an emerging consensus that central banks cannot ignore climate change due to its effects on financial stability (NGFS, 2018, 2019, 2020; Bolton et al., 2020). The debate on the need to include environmental issues, social responsibility and corporate governance in central bank policy gained significant momentum at the end of the second decade of the 21st century. This was a period characterised by low inflation and accommodative monetary policy. At that time, central banks conducted low (including zero and negative) interest rate policies and implemented asset purchase programmes conducted on a large scale as a part of the Quantitative Easing policy. Interest in the issue of sustainability resulted from the fact that environmental and climate risks were considered a significant threat to the stability of the entire financial system (Carney, 2015; Chenet et al., 2021; Christophers, 2017; NGFS, 2019; Quorning, 2023; Thiemann et al., 2023). The situation in monetary policy has changed significantly after the outbreak of the war in Ukraine, when inflation rates reached extremely high levels, unseen for over 40 years all over the world. The previously conducted ultraexpansionary monetary policy was replaced by a restrictive one, gradually raising the level of main interest rates and initiating Quantitative Tightening (QT) programs. The new macroeconomic environment, which required actions to restore price stability as an overriding monetary policy objective, has posed completely different challenges to central banks, pushing the idea of sustainable development into the background.

However, there is a knowledge gap in the existing literature on what green (sustainable) monetary policy instruments should look like. This paper aims to fill this gap by identifying new green monetary policy instruments. The contribution of this paper is twofold. First, it presents new tools of sustainable monetary policy by incorporating emission reduction targets into traditional monetary policy instruments. Second, it illustrates the results of a case study analysis of major central banks that started to implement sustainable monetary policy instruments. To achieve the main objective of the article, the following research questions were formulated:

1. *What is sustainable monetary policy?*
2. *What are the instruments for achieving the goals of sustainable monetary policy?*
3. *What is the degree of implementation of green monetary policy instruments by major central banks?*

Currently existing studies, although they present the issue of central banks' involvement in sustainable development issues, do so only in a fragmentary manner, not identifying and comprehensively systematising the possible green monetary policy instruments. On this basis, a research hypothesis was formulated stating that:

RH: Modern central bank instruments are evolving towards more sustainable tools of implementing monetary policy.

The article is structured as follows. Section one presents the results of in-depth international literature studies, concentrated on justifying the need to include sustainable development assumptions

into monetary policy, as well as identifying the essence of sustainable monetary policy. Section two discusses the methodology of empirical research. The next section “Results and discussion” presents the results of empirical research, which has the character for proposals of a set of green monetary policy instruments. This part also includes case study analysis, presenting the first experiences of the major central banks in implementing green monetary policy instruments and discussing the results and views presented in the literature. The article ends with a section summarising the conducted theoretical and empirical research. It also offers conclusions, limitations and raises the remaining issues to be addressed by future studies.

Literature review

The idea of sustainable development is a new approach intended to ensure the sustainability of human development by meeting the needs of current generations, without depriving future generations of the ability to meet their needs (ONZ, 1991; Broniewicz et al., 2024). In the literature, the commitment of central banks to the implementation of sustainable development assumptions and goals is identified with sustainable (in other words – green) monetary policy. George et al. (2022) point to sustainability-linked monetary policy, in which central banks include sustainable development in their policy objectives. In their opinion, this is a monetary policy that, in addition to maintaining price stability, also aims to increase social welfare and promote environmental sustainability. It includes adjusting interest rates and collateral requirements in response to activities related to the size of carbon dioxide emissions. Moreover, Schoenmaker (2021) proposes that central banks should adapt their operational frameworks to support governments in the transition to a low-carbon economy. Therefore, the conducted literature studies indicate that there are many different approaches and definitions of sustainable monetary policy, but all of them emphasise the need to integrate environmental, social and governance concerns into traditional monetary policy frameworks in order to promote long-term economic and ecological stability.

Roy (2024) also emphasises the need to integrate environmental objectives into the monetary policy framework, proposing the *Green Monetary Policy (GMP) Framework* that includes the integration of sustainable development goals into traditional monetary policy instruments. He points out the important role of central banks in solving climate change problems. He believes that a strategic change in credit allocation from high-carbon to low-carbon industries is necessary, using selective credit control instruments by central banks. Using panel VAR and Impulse Response Functions (IRF), he studied the economies of the European Union, the United States, Brazil, China, and India between 2004 and 2020, and proved that increasing capital flows towards green loans leads to a reduction in carbon dioxide emissions while maintaining price stability. This creates a ‘potential synergy between sustainable development and economic stability’. Thus, he demonstrated that central banks can achieve at the same time the goal of maintaining price stability and implement assumptions of sustainable development by exercising effective control over emissions.

However, in the literature, there are opinions that the possibility of achieving sustainable development goals depends on the monetary policy strategy (expansionary or restrictive monetary policy) that is implemented. As Schnabel (2023) noted, green monetary policy is more difficult to implement when monetary authorities represent a restrictive attitude. In her opinion, for example, greening corporate bond portfolios is only possible during the implementation of Quantitative Easing (QE). Aguila and Wullweber (2024a) also indicated that restrictive monetary policy is detrimental to green transformation. The impact of higher interest rates on sustainable investments is greater than on investments with high greenhouse gas emissions because the former are more capital-intensive and require higher initial capital outlays that must be financed and therefore require greater leverage. As a result, they are more sensitive to increases in capital costs than high-emission investments. For this reason, restrictive monetary policy – with high interest rates – tends to have a disproportionately higher impact on sustainable initiatives, thus delaying the transformation of the whole economy. Furthermore, quantitative tightening leads to the end of green-tilted asset purchases, reducing the QE potential to support green investments through easier access to financing and lower borrowing costs. On the other hand, expansionary monetary policy significantly supports achieving sustainable development goals through financing green investments and supporting green-friendly banks. Therefore,

these authors advocate for a “greener and cheaper” monetary policy that addresses sustainability challenges and seeks price stabilisation, suggesting that monetary authorities should consider the environmental impact of their decisions regarding the direction of monetary policy and the level of main interest rates.

On the other hand, some economists, researchers and central bankers argue that monetary authorities should not be responsible for sustainable development. Among other reasons, the transformation towards green monetary policy may contradict its fundamental objective, undermine the political independence of central banks and raise questions about the legitimacy and increased power of some of these banks (Rosa, 2025). Issing (2021) emphasises that “there is no such thing as green monetary policy” because it means including areas that are not within the scope of central banks’ responsibility in their mandates. In this approach, opponents of sustainable monetary policy point out that:

- a) Central banks should not favour any entity or sector in their operations, and their concentration on green investments can lead to unequal treatment.
- b) Limited knowledge of monetary authorities about climate change and other sustainability challenges may lead to reduced effectiveness of monetary policy and thus undermine the credibility of central banks.
- c) Effective implementation of sustainable monetary policy may put pressure on central banks to intervene in other pressing political or socioeconomic issues.
- d) Expanding the mission of central banks without a formal mandate can make their actions illegal and undermine their independence, to the extent that this is due to political pressure from governments and other national or international organisations.
- e) The potential extension of legal mandates may burden central banks with conflicting objectives and instruments, turning the monetary policy framework into a complex and inconsistent policy area.

The literature discussion also includes the essence and scope of green monetary policy instruments that central banks can use to achieve “sustainable” objectives. Shapoval (2024), presenting a framework for integrating monetary policy with the concept of sustainable development, suggests that central banks can implement two types of sustainable monetary policy instruments:

- “*light green*” – such as adjusting asset purchases or regulating liquidity to promote environmentally friendly assets, within the current institutional structure;
- “*bright green*” – which include more transformational changes, including direct financing of ecological transition projects, which may require significant institutional adjustments.

Coupey-Soubeyran (2020) also indicates practices in which central banks can integrate sustainability into their monetary policy framework. She classifies potential actions and tools into the following:

- 1) *protective measures* – protecting balance sheets from ESG risks,
- 2) *awareness-raising initiatives* – promoting green finance, and
- 3) *proactive strategies* – actively mitigating climate change through selected tools.

McConnell et al. (2022) analyzing different green monetary policy instruments along the dimensions of feasibility of implementation and impact on the transition process, emphasize that “brown” collateral haircuts that can be included in a collateralised lending framework is the most promising conduit of green monetary policy instrument. On the other hand van’t Klooster and van Tilburg (2020) state that Green TLTROs has a unique contribution to make that cannot be easily replaced by any other monetary policy tool.

Rosa (2025), undertaking to define green monetary policy instruments, indicates that they refer to central bank policy decisions aimed at embedding environmental considerations in monetary policy operations – for instance, by establishing new policy instruments or reforming existing ones in ways that mitigate climate-related risks and provide financial incentives towards investments in firms, projects, or sectors that contribute to the quality of the environment. This approach was also adopted in this article. However, the main problem is that currently no general theoretical framework or classification exists that allows the discussion of these numerous and diverse green monetary policy instruments in a systematic way. In order to fill this gap and to allow for systematic analysis of the potential of the diverse existing green monetary policy instruments, the paper provides their identification and systematisation.

Research methods

The research carried out in this article was based on the controlled comparative case study method, which aimed to identify green monetary policy instruments and their implementation by selected central banks. This method involves examining a deliberately selected group of central banks in order to gain a deeper understanding of their monetary policy (Gerring & Cojocar, 2016). The case study analysis covers green monetary policy instruments of the major central banks in the world, i.e. the Federal Reserve System, European Central Bank, Bank of England, Bank of Japan and People's Bank of China. The adoption of such a research sample resulted from the fact that actions and instruments undertaken by the indicated central banks within the scope of sustainable monetary policy can develop practices used all over the world. All empirical data are publicly available on central banks' websites. This material has been complemented with information published by other relevant organisations, existing international literature and newspaper articles.

Results and discussion

Central banks, achieving the objectives set out in their strategies, implement classic (standard) monetary policy instruments. As shown by the global financial crisis of 2008+, the pandemic crisis of 2020+ and the geopolitical crisis of 2022+, in times of financial instability, they may also decide to use unconventional tools, including non-standard interest rate policy, extraordinary balance sheet policy and, in addition, communication policy (Nocoń, 2024). Along with a sustainable approach to conducting monetary policy, central banks start to use monetary policy instruments that they already have by greening them. This is a process in which previously well-known and used monetary policy instruments are directed towards achieving sustainable development goals.

The empirical research indicates that some of the major central banks have adopted and boldly implemented the assumptions of sustainable monetary policy. The undoubted pioneers in this area in Europe are the European Central Bank, Bank of England, Sveriges Riksbank, and in Asia – Bank of Japan and People's Bank of China. They have published sustainable monetary policy roadmaps, indicating that actions for the environment, including stopping climate change and social responsibility, are within their assigned mandates (Bank of England, 2023; Bank of Japan, 2021b; ECB, 2021; Sveriges Riksbank, 2020). A particular acceleration in real actions has been observed after 2021, marked by a number of events that contributed to the intensification of central banks' involvement in the environmental crisis. Other central banks, such as the Federal Reserve System, approach the greening of their monetary policy with significant caution, limiting activities in this area. One reason is doubts about whether central banks equipped with a specific mandate can and should support the green transformation.

Adoption of the sustainable monetary policy approach indicates the incorporation of the so-called green instruments into monetary policy. The comparative case study analysis among major central banks allowed identifying green monetary policy instruments implemented by the monetary authorities to varying extents and scales since 2017. Figure 1 presents their systematisation. On the one hand, their use results from the central banks' greater awareness of the need to get involved in counteracting climate change, supporting social responsibilities and governance issues, which prompts them to make an effort to incorporate sustainable development objectives into their monetary policy. However, on the other hand, they are aware that these tools also have an anti-inflationary nature, and therefore can support implementation of their overriding objective – maintaining price stability.

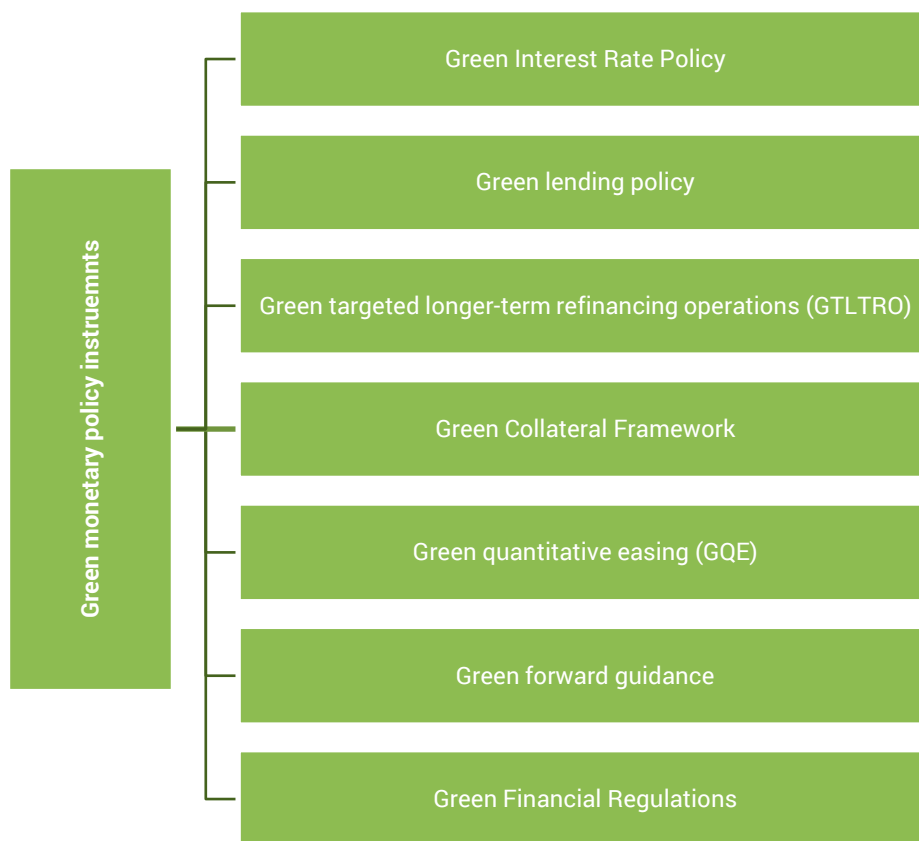


Figure 1. Green monetary policy instruments

Green Interest Rate Policy

One of the key instruments of sustainable monetary policy is *green interest rate policy*. It means that monetary authorities conduct a preferential interest rate policy toward banks or investments that are consistent with sustainable development. In turn, they pursue different interest rate policies towards institutions that do not follow the ESG path, e.g. are characterised by a high level of CO₂ emissions or finance projects that are environmentally unfriendly. The green interest rate policy can also solve two significant problems:

- 1) *Supporting green transformation within the framework of restrictive interest rate policy* – during monetary tightening, high interest rates disproportionately affect green investments, for example, renewable energy projects that require significant upfront investment. In turn, green interest rate policy, through preferential interest rates for sustainable investments, would eliminate this drawback and direct financing towards green projects.
- 2) *Combating inflation by reducing dependence on fossil fuels* – dependence on oil and gas is a key inflation driver. Supporting clean energy investment through preferential rates, a green interest rate policy could alleviate inflationary pressures caused by volatile fossil fuel prices, contributing to maintaining price stability.

Green lending policy

The green interest rate policy also sets the framework for the *green lending policy*, which involves the use of measures to differentiate the central bank's interest rates according to the green lending volume in commercial bank portfolios. This provides cheaper financing to banking institutions that stand out with a green loan portfolio and encourages them to undertake sustainable activities (van 't Klooster & van Tillburg, 2020). As a part of green lending, a central bank can adjust the level of interest rate on refinancing operations, e.g. by a premium (positive or negative) set on the basis of an average degree of climate risk related to loans that commercial banks grant to their clients. Imple-

mentation of the so-called climate premium on the interest rate on main refinancing operations, therefore, means imposing an additional cost for granting carbon credits or awarding a premium for financing sustainable projects. Thus, commercial banks financing climate-friendly investments can obtain refinancing from a central bank at lower interest rates. Therefore, a lower green interest rate may encourage commercial banks to increase financing for projects aimed, among others, at clean energy production and energy efficiency operations. Green lending policy is also related to green direct credit allocation, i.e. the intervention policy of central banks in the area of credit allocation, aimed at limiting the financing of mindless expansion of traditional industries and allocating capital where it will be used in accordance with the sustainable development assumptions.

As part of a green lending policy, central banks can also use selective credit control instruments, which will allow an increase in capital flows to banking institutions that finance green investments. This tool actively redirects capital towards sustainable projects, while limiting financing of high-emission ones (Figure 2).

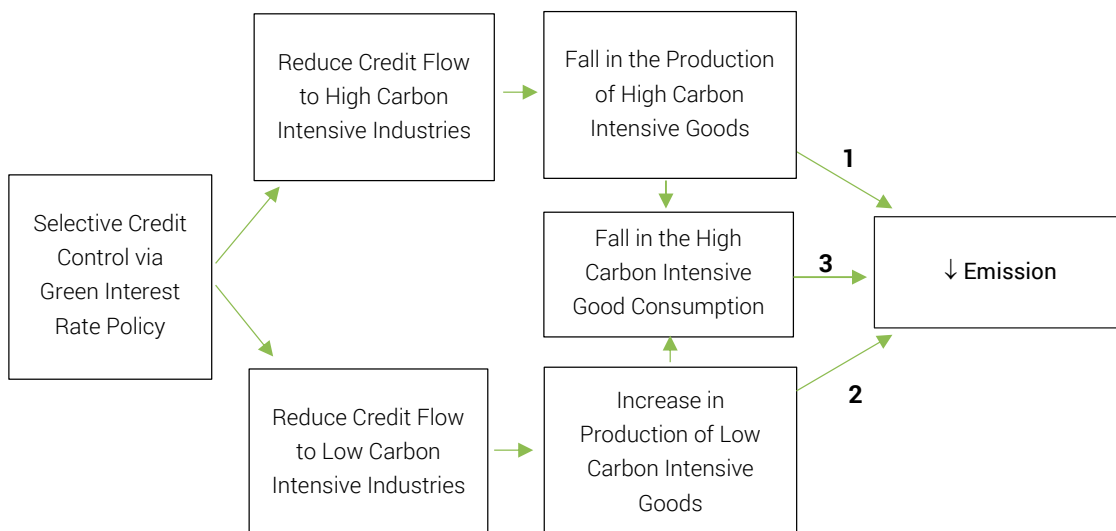


Figure 2. Transmission mechanisms of selective credit control and Green Interest Rate Policy

Source: author's work based on (Roy, 2024).

Figure 2 illustrates that the impact of selective credit control through the green interest rate policy is achieved through two different channels: the production channel (1 and 2) and the consumption channel (3). The green interest rate policy promotes an increase in the share of loans granted to entities from industries striving to reduce emissions in the overall lending activity of commercial banks. In turn, a decrease in the financing of industries with high carbon dioxide emissions reduces their capital formation and productivity. As a result, there is a decrease in the production of high-emission goods, and consequently, CO₂ emissions also decrease. However, as the production of high-carbon intensity raw materials, such as oil and coal, decreases, their supply and subsequent consumption also fall, which leads to a reduction in emissions in the consumption channel. At the same time, the production of low-emission goods increases, resulting in a greater supply and consumption of these products, which additionally reduces the level of CO₂ emissions (Roy, 2024).

Central banks are currently initiating the first green refinancing schemes with lower interest rates for green loans (Dikau & Ryan-Collins, 2017). Major central banks in the world, such as the ECB, Federal Reserve and Bank of England, already have the tools to offer dual interest rates. The European Central Bank, initially sceptical about the dual interest rate for green lending, is currently considering the practical implementation of a green interest rate policy. However, it emphasises that it is a difficult challenge for a central bank. Despite this, they believe that this is the only way to financially support the energy transformation. The People's Bank of China is also one of the supporters of green lending. The new targeted green lending, implemented by the Chinese central bank, supports the development of clean energy, energy conservation, environmental protection, CO₂ emission reduction technologies and other key areas.

Green targeted longer-term refinancing operations (GTLTROs)

Targeted Long-Term Refinancing Operations (TLTROs) are open market operations conducted by a central bank that provide credit institutions with long-term financing of their liquidity needs. Their use was particularly observed during the global financial crisis and the pandemic crisis, and the undoubted leader in their use is the European Central Bank. Under TLTROs, commercial banks receive long-term financing from a central bank on attractive terms, which stimulates their lending and has a positive impact on financing the real economy. In turn, *green TLTROs* are an instrument that is a modification of the long-term refinancing operations that have been used so far, aimed at supporting green lending to banks (Krebel & van Lerven, 2022). Not only does it provide access to financing, but it is also intended to encourage banking institutions to allocate capital for green investments. The interest rate on Green LTRO credit is set based on the volume of loans granted by commercial banks that are in line with the assumptions of sustainable development and are consistent with the adopted green taxonomy.

The European Central Bank is currently considering transforming the Targeted Longer-Term Refinancing Operations (TLTROs) that have been running for several years into GTLTROs (Elderson, 2023; Schnabel, 2023). In turn, the Bank of Japan and the People's Bank of China have implemented GTLTROs so far, providing interest-free financing to lenders that support climate change efforts. In 2022, the Japanese central bank held GTLTRO auctions with a total value of 2.048 tln JPY (17.9 bln USD). At the same time, it announced that they would be held twice a year, and loans could be extended even until 2030. However, credit institutions that want to participate in GTLTROs are required to publish information in accordance with the recommendations of the Taskforce for Climate-related Financial Disclosures (TCFD). In addition, they must disclose the criteria for qualifying investments or loans as climate-related and refer to relevant national or international standards. The Governor of the Bank of Japan, arguing for the implementation of GLTROs, emphasised that climate actions are fully within the central bank's mandates on price stability and financial stability, and additionally support macroeconomic policy to stop climate change in the long term. In turn, the People's Bank of China decided to implement GTLTROs in 2021, introducing the Carbon Emission Reduction Facility (CERF). These are low-interest loans offered to financial institutions that finance investments by economic entities and, as a result, reduce carbon dioxide emissions. According to the Chinese central bank, this structural monetary policy instrument sends a clear policy signal, which aims to increase financial institutions' awareness of the importance of green transformation, encourage them to support green, low-emission industries and promote the philosophy of ecological life, green production and circular economy, which can contribute to achieving the carbon neutrality goals of the Chinese economy. Banks using GTLTROs are obliged – as in Japan – to publicly disclose information on loans and investments they finance that help reduce emissions.

Green Collateral Framework

Another tool used by monetary authorities to support the green transformation of a banking sector is the change in the *collateral framework* (Dafermos et al., 2021; Gabor et al., 2019; Schoemaker, 2021). Currently, in order to meet the eligibility criteria for collateral in transactions with a central bank, banks must hold high-quality securities. Monetary authorities set a list of assets, defined in terms of eligibility and haircuts applied to the relevant assets. During accommodative monetary policy, this list is significantly expanded, while with monetary tightening, the list of assets that can be used as collateral is limited. However, in conventional monetary policy, the framework for these collateral does not take into account the ESG risk (van Lerven et al., 2020; Gabor et al., 2019). This means that assets financing environmentally unfriendly activities can also be used as collateral.

Within the process of greening monetary policy instruments, three scenarios can be defined that change the existing eligibility requirements and make the collateral framework more sustainable:

- 1) *First scenario* – the list of eligible assets remains unchanged, but haircuts of the assets are adjusted in line with their carbon footprint. This means imposing higher haircuts and margin requirements for nongreen assets.
- 2) *Second scenario* – a share of collateral from entities with a high carbon footprint is limited, and/or the acceptance of 'dirty' securities is completely prohibited.

3) *Third scenario* – green assets of low-emission issuers are added to the list of collateral in transactions with the central bank. In this scenario, a list of collateral undergoes a significant change.

In addition, monetary authorities may specify that under the *green collateral framework*, they will only accept assets from entities that comply with the requirements for the disclosure and reporting of sustainable activities (in the EU – CSRD directive) as collateral for their operations.

As part of the process of greening monetary policy, in July 2022, the European Central Bank took steps to take into account sustainability issues when determining the list of assets accepted as collateral in transactions with the central bank. It limited the possibilities of using assets issued by companies with a large carbon footprint as collateral. Moreover, it started considering climate change risks when reviewing haircuts applied to corporate bonds. It also implemented mandatory climate disclosures for assets eligible as collateral by the end of 2026. Despite this, 59% of corporate bonds accepted as collateral in transactions with the ECB are still issued by high-carbon companies (Dafermos et al., 2021). The People's Bank of China (PBoC) and the Bank of Japan (BoJ) have also decided to accept green bonds as collateral for credit lines offered to commercial banks (Bank of Japan, 2021a; Barmes & Livingstone, 2021). Furthermore, the People's Bank of China has given these bonds a first-among-equals status, meaning they have priority over other bonds.

The preference to sustainable assets as collateral for refinancing operations is an important central bank instrument of active contribution to green transformation. There are more and more voices saying that including climate risk as a part of the collateral framework is the right move by monetary authorities. McConnell et al. (2022) consider such an instrument as promising because it can help the economy stay below a certain emission target with a lower carbon price. It also supports fiscal policy actions aimed at reducing taxes paid on carbon dioxide emissions. Therefore, these actions can be considered as complementary instruments of monetary and fiscal policy aimed at achieving emission reduction. At the same time, it can make a timely transition to a carbon-neutral economy more politically feasible.

Green Quantitative Easing (GQE)

Green Quantitative Easing (GQE) is a central bank asset purchase program in which monetary authorities purchase securities in special programs, including corporate, government and local government bonds and investment bank bonds, similar to classic QE, but their main goal is to finance green investments (Anderson, 2015). Green QE also includes a prohibition on buying bonds from high carbon dioxide emissions sectors, unless they are specifically intended to finance green projects (Dafermos et al., 2020).

In the literature, the issue of green QE was addressed, among others: Battiston & Monasterolo (2019); Dafermos et al. (2020); Dafermos et al. (2022); Matikainen et al. (2017). Matikainen et al. (2017) conducted a detailed analysis of assets purchased by central banks under QE. They showed that in the special QE programs conducted by central banks around the world, assets of issuers from high-emission sectors, such as manufacturing and utilities, constituted a disproportionately large share of all purchased securities. In turn, Ferrari and Nispi Landi (2023) indicated that green QE is able to reduce emissions by transferring demand from the brown to the green sector. However, they noted that the effectiveness of green QE in reducing negative climate impacts decreases over time. In the short term, it is much greater, while in the long term, when the carbon tax comes into effect, its effectiveness decreases.

Dafermos et al. (2018) proved that, on the one hand, green quantitative easing leads to an increase in the prices of green corporate bonds, which results in a decrease in their yields. The decrease in yields, in turn, leads to lower borrowing costs for companies and a decrease in their dependence on bank loans. On the other hand, they found, similarly to Ferrari and Nispi Landi (2023), that green QE has a moderate impact on reducing CO₂ emissions and curbing climate change. Despite this, they considered that this instrument can play an important role in combination with a well-structured fiscal policy.

Currently, most central banks around the world that have implemented quantitative easing policies are trying to assess the possible effectiveness of GQE in achieving their goals. Furthermore, many of those that have implemented QE still hold a significant value of the securities purchased in special asset purchase programs on their balance sheets. Central banks, such as the ECB, Bank of England and Sveriges Riksbank, have also begun to explore how to decarbonise their balance sheets, which

have been increased by QE policy. Decarbonising their balance sheets could involve reshuffling the portfolio from brown to green industries/enterprises. However, actively rebalancing their portfolios towards issuers with better climate records during a period of QE deceleration or complete suspension is not easy. The strategy of targeting purchases on sustainable securities will only become possible when central banks start to loosen their monetary policy again, resume QE programmes and see purchases of securities as necessary to maintain price stability.

Green forward guidance

Forward guidance is a communication policy instrument used to inform and communicate to the market what monetary policy a central bank intends to conduct in a horizon longer than the next meeting of the monetary policy committee (Dutkiewicz & Przybylska-Kapuścińska, 2017). It is emphasised that the central bank's communication has a significant impact on financial markets (Altavilla et al., 2019). However, central banks can make this tool more sustainable as part of green monetary policy. By actively communicating, educating and raising awareness about sustainable development, the need to engage in activities to stop climate change, social responsibility or corporate governance, a central bank can influence green asset markets. However, communicating the urgent need to green the financial system may be perceived by opponents of such actions as an attempt to expand the responsibilities of the central bank and increase its authority (Boneva et al., 2022).

An important tool among green forward guidance is speeches given by central bank representatives, in which they address the issue of sustainable development in the context of conducted monetary policy. The first green ECB speech was delivered by Sabine Lautenschläger in 2018 (ECB, 2018). Since then, as of 2024, there are 78 speeches on climate change available in the ECB speech database, 25 of which were delivered by the President – Christine Lagarde (ECB, 2024).

In the literature, Neszveda and Siket (2023) analysed the impact of the ECB's green speeches on asset markets. They indicated that these communications have a statistically significant impact on financial markets and can thus help implement sustainable development. Sangiorgi and Schopohl (2021) also showed that monetary authorities can influence the green bond market. Asset managers would be more willing to invest in the green bond market if policymakers encouraged them to do so.

Green Financial Regulations

Central banks and financial regulators also have regulatory tools that can encourage banks to green their credit portfolios and reduce the financing of high-emission investments. One solution under *green financial regulations* is to increase the reserve requirement ratio for banks that finance high-carbon investments in order to limit their lending. Similarly, monetary authorities can lower the reserve requirement ratio for entities that finance green investments, thereby increasing the amount of funds available in banks for financing environmentally friendly initiatives (Barnes & Livingstone, 2021).

However, in the literature, it is indicated that increasing the reserve requirement ratio is more effective than lowering it. This is especially noticeable in countries where central banks have not set the reserve requirement ratio (e.g. Australia, Canada, New Zealand or Sweden), so any reductions would not apply. Furthermore, in countries with excess liquidity in the money markets, lowering the reserve requirement ratio would not limit high-emission lending either (Campiglio, 2016). In turn, a lower reserve requirement ratio could encourage banking institutions to undertake excessive risk, and as a result, lead to financial instability (D'Orazio & Popoyan, 2019).

Another tool among green financial regulations is the differentiation of interest rates on reserves. For example, the central banks of China and Japan pay higher interest rates on required reserves to banks with better results in terms of green financing (Barnes & Livingstone, 2021). Another incentive that central banks can use is the possibility of accepting sustainable assets as legal parts of bank reserves (Volz, 2017).

An important regulation towards sustainable monetary policy and meeting environmental commitments is also a possible change in capital adequacy rules. This applies not only to central banks' actions, but also to regulatory authorities (Dafermos & Nikolaidi, 2021). One solution is to modify the risk weights for green assets. The risk weights currently used are somewhat biased against sustaina-

ble assets, due to their longer payback period. In turn, this modification could take into account the extent to which assets are green or carbon-intensive (D’Orazio & Popoyan, 2019; Esposito et al., 2019; Gabor et al., 2019; Schoenmaker & Van Tilburg, 2016). It would also be possible to increase capital requirements for banks that finance investments that have a negative impact on the environment (“dirty penalising factor”) and/or reduce capital adequacy requirements for institutions using green lending practices (“green supporting factor”) (Campiglio, 2016). As with the reserve requirement, it seems that a potential increase in capital adequacy requirements would be more effective than their reduction, due to concerns about the impact on financial stability. A similar mechanism could apply to countercyclical capital buffers as a way to help foster a more sustainable financial system. This strategy could be implemented in banks to build a buffer during periods of high-carbon credit growth. This would increase the resilience in two ways. First, it would allow banks to set aside a certain amount of capital that could not be used for further credit expansion. Second, it would provide an adequate capital base for banks to absorb potential losses in the event of a cyclical reversal or a climate shock that could leave assets stranded (D’Orazio & Popoyan, 2019).

Conclusions and limitations

Events observed in the global economy resulting from climate change, loss of biodiversity, environmental pollution, lack of respect for social responsibility and corporate governance are becoming the subject of both public debate and an important problem for modern financial safety net institutions. Actions undertaken for sustainable development should not be ignored by the monetary authorities either. The consequences of their noncompliance may have significant economic consequences, which are important for central banks. Physical risks (including temperature rise or increased frequency of extreme weather events) and transition risks related to climate change (e.g. due to CO₂ emission prices or regulatory tools) may affect inflation and production, increase macroeconomic volatility, and also impact financial markets. Some of the consequences may lead to higher inflation volatility and increase the overall level of instability, making it difficult to achieve the main objectives of monetary policy.

Considerations regarding sustainability have remained outside the scope of monetary authorities for many years. Although it was widely accepted that weather fluctuations and particularly extreme weather events could have significant macroeconomic effects, central banks considered them as transitory and therefore less relevant to their monetary policy, which mainly aimed at maintaining price stability in the medium term. Sustainability in monetary policy has become a subject of interest following the Paris Agreement signed after the 21st UN Climate Change Conference in 2015. Since then, central banks have been working towards integrating sustainability principles into their monetary policy.

This article indicates that the need to implement instruments for sustainable development in the area of monetary policy is currently becoming another important issue for central banks, similarly to the goal of maintaining financial stability, which was assigned to them after the global financial crisis. However, the results of the conducted analysis show that the major central banks have different approaches to redirecting their monetary policy towards sustainable development. On the one hand, the Federal Reserve System has emphasised that it is not and will not be a decision-maker in the field of climate policy (Phillips, 2023). On the other hand, the European Central Bank represents a completely different approach and takes the next steps to take into account the challenges of sustainable development, especially climate change, in its monetary policy (ECB, 2022). It recognised that the Treaty clearly states that the main monetary policy objective is price stability, but with the proviso that the ECB should also support the European economic policy. In connection with this, it announced a set of actions aimed at reducing the financial risk associated with climate change and supporting sustainable finance. It also sets targets for reducing greenhouse gas emissions.

The conducted theoretical and empirical research also indicates that greening monetary policy should be a new mandate of central banks. Climate change affects the effectiveness of conventional monetary policy by reducing production growth, increasing volatility and uncertainty of inflation. Consequently, central banks should adopt a green monetary policy framework, which includes carbon dioxide emission reduction targets and increases the flow of green credits. This does not mean

abandoning the overarching goal of monetary policy, which is currently in most countries around the world to maintain price stability. It also does not mean abandoning the additional goal imposed on monetary authorities after the global financial crisis – maintaining financial system stability. However, it does mean adopting a new mandate, which is the greening of monetary policy. Opponents of this approach may object that imposing another obligation on the already burdened central bank, in many countries also responsible for the implementation of macroprudential policy, is not the right move. On the other hand, the current global actions for sustainable development and curbing climate change cannot be ignored by such an important institution as the central bank. Moreover, joining the process of capital flows to green investments, which is taking place in commercial banks, should be an indispensable element of the monetary authorities' activities. All the more so because supply shocks caused by climate change, asset price volatility and increased uncertainty may limit the ability of central banks to maintain price stability using only conventional monetary policy instruments.

Finally, the conducted research allowed for the positive verification of the adopted research hypothesis, which stated that *modern central banks' instruments are evolving toward more sustainable tools of implementing monetary policy*. However, at the moment, there is no empirical evidence that would allow us to assess the impact of central banks' actions on the implementation of sustainable development goals. Undoubtedly, monetary authorities should support the green transformation and seek ways and instruments to green their monetary policy that would correspond with other initiatives undertaken by the state as part of sustainable economic policy. On the other hand, it should be noted that the more central banks try to implement the idea of sustainable development, the stronger potential conflicts with their mandate and the greater risk to their credibility with respect to the main objective.

The theoretical and empirical considerations that result are presented in the article and constitute an important contribution to the science of finance, as they identify and systematise the green monetary policy instruments. They also illustrate the first attempts to implement them, undertaken by major central banks. However, these considerations are not without limitations. They present the only general analysis about their use by central banks without the detailed assessment in relation to the achievement of the sustainable development goals. At the same time, they constitute a basis for further in-depth research, which may concentrate on the analysis of the degree of green monetary policy instruments implementation by specific central banks, but also an attempt to assess their effectiveness in the context of achieving the goals placed in them. Furthermore, the next studies may try to assess to what extent do they support the achievements of climate neutrality or halting climate change? However, due to dynamically changing reality and its unpredictability, the issue of green monetary policy instruments requires systematic updating, and at the same time, going beyond the framework of simple exemplification of central banks' activities towards a universal theory that will make a significant contribution to the discipline of finance, as well as an element of novelty and "freshness" to the current state of knowledge.

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ZIELONE INSTRUMENTY POLITYKI PIENIĘŻNEJ – IDENTYFIKACJA I ANALIZA

STRESZCZENIE: Zielona polityka pieniężna to rodzaj polityki pieniężnej, która oprócz utrzymania stabilności cen, ma również na celu zwiększenie dobrobytu społecznego i promowanie zrównoważonego rozwoju. Głównym celem artykułu jest identyfikacja i egzegeza działań banków centralnych w kierunku zrównoważonej polityki monetarnej. W badaniach weryfikuje się hipotezę głoszącą, iż współczesne instrumenty banków centralnych ewoluują w kierunku bardziej zrównoważonych narzędzi realizacji polityki pieniężnej. Artykuł prezentuje i systematyzuje zielone instrumenty polityki pieniężnej, powstałe poprzez włączenie celów redukcji emisji do tradycyjnych instrumentów polityki pieniężnej. Przeprowadzone kontrolowane porównawcze studium przypadku wskazuje, że główne banki centralne różnie podchodzą do przekierowania swojej polityki pieniężnej w kierunku założeń zrównoważonego rozwoju. Niektóre z nich, tak jak FED, pozostają sceptyczne wobec zielonych instrumentów polityki pieniężnej, podczas gdy inne (jak np. EBC czy Bank Japonii) – włączają je do swojej polityki. Przeprowadzone badania pozwoliły zidentyfikować zielone instrumenty polityki pieniężnej, jednak wykazały również, że na obecnym etapie trudno jest ocenić, czy są one skuteczne i osiągają pokładane w nich cele.

SŁOWA KLUCZOWE: bank centralny, zrównoważona polityka pieniężna, zielone instrumenty polityki pieniężnej, zrównoważony rozwój